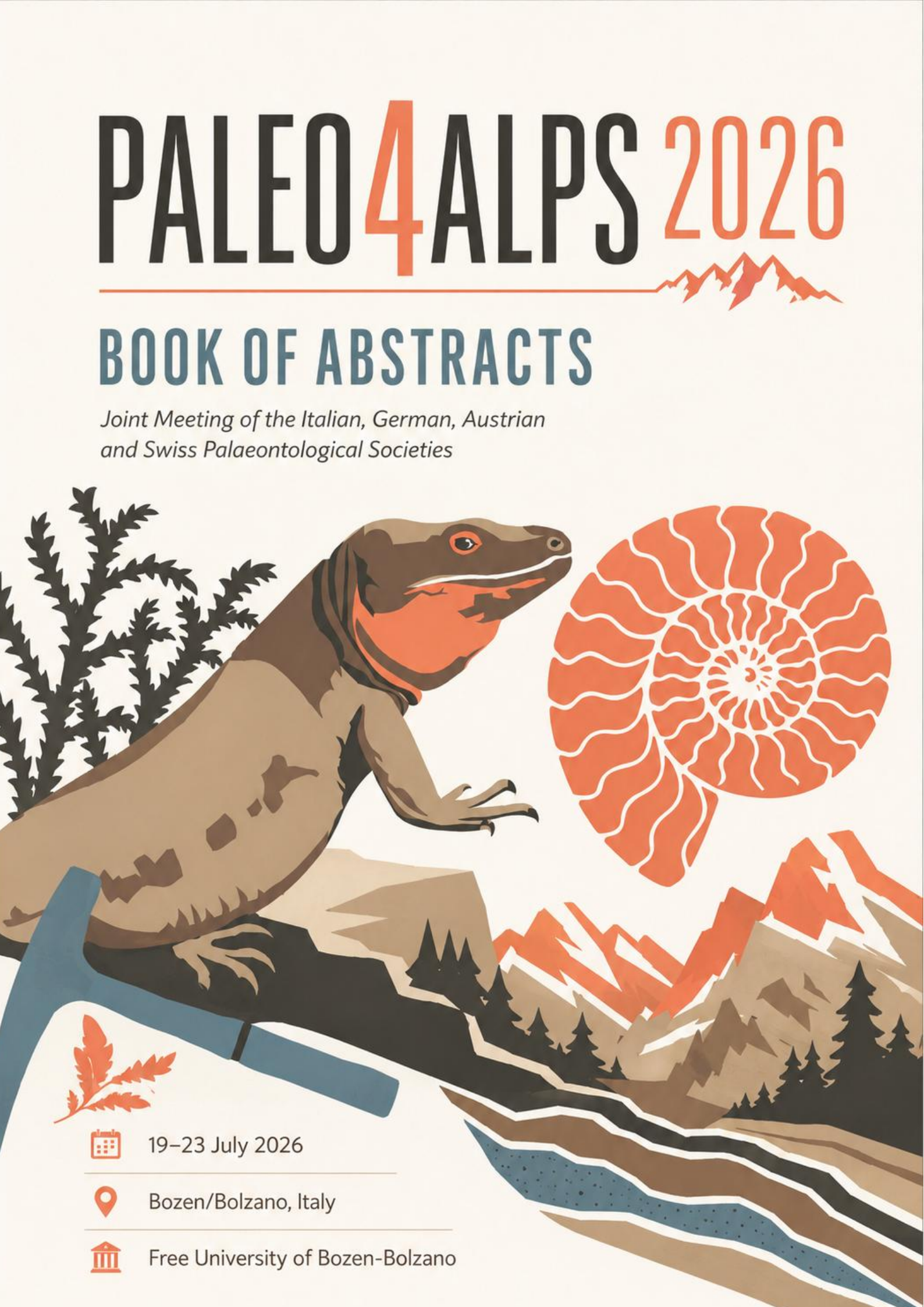


PALEO4ALPS 2026



BOOK OF ABSTRACTS

*Joint Meeting of the Italian, German, Austrian
and Swiss Palaeontological Societies*



19–23 July 2026



Bozen/Bolzano, Italy



Free University of Bozen-Bolzano



Paleo4Alps

Joint Meeting of the Italian, German, Austrian and Swiss Paleontological Societies

Book of abstracts

Bozen/Bolzano (Italy), July 19–23, 2026

Free University of Bozen-Bolzano

PALEO4ALPS corresponds to the **XXVI Paleodays of the Società Paleontologica Italiana (SPI)**, the **97th Annual Meeting of the Paläontologische Gesellschaft (PalGes)**, the **30th Annual Meeting of the Österreichische Paläontologische Gesellschaft (ÖPG)** and the **Meeting of the Swiss Paleontological Society**. This first joint meeting is intended to create a shared forum at the heart of the Alpine region. The conference is explicitly open beyond the membership of these societies and welcomes participants from all areas of paleontological research worldwide.

PALEO4ALPS aims to unite paleontologists working across a wide range of disciplines, geological time periods, fossil groups, and methodological approaches. By fostering exchange between different research traditions and perspectives, the meeting seeks to stimulate discussion, encourage interdisciplinary dialogue, and promote new scientific collaborations within the paleontological community.

The scientific program addresses both current and emerging topics in paleontology, ranging from Alpine case studies to global perspectives. A broad selection of multidisciplinary symposia provides a platform for integrative discussions. At the same time, field excursions to Bolca, the Dolomites, the Southern Alps, and the Carnic Alps will offer participants the opportunity to engage directly with the exceptional geological and paleontological heritage of the Alpine region.

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Società Paleontologica Italiana, Paläontologische Gesellschaft (PalGes), Österreichische Paläontologische Gesellschaft (ÖPG) and Swiss Paleontological Society



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Venue:

Free University of Bozen-Bolzano
Universitätsplatz 1, piazza Università 1
39100 Bozen/Bolzano, Italy

With the patronage of

UNESCO Dolomites Foundation



Grants and awards

Thanks to the support from the four societies and several local and international sponsors, we were able to bestow a series of awards and travel grants to:

Category Paleoart (sponsored by the Swiss Paleontological Society)

- Best contribution by a non-permanently employed paleoartist
- Best contribution among all participants

Category Awards (sponsored by sponsors of the Paleo4Alps and PalGes)

- WOLF Haus award (Jury): Best talk on plants in a changing climate and environment
- 3 Helper awards: Best talk by junior scientists (outreach value, sponsored by AR)
- 3 Helper awards: Best talk by senior scientists (outreach value, sponsored by AR)
- *Young scientist award*: Best talk by junior researchers (for members of the PalGes only)

Category Posters (sponsored by SPI/ÖPG, sponsors of the Paleo4Alps)

- 5 Poster awards (SPI, ÖPG)
- 2 Poster awards (everybody can vote, sponsored by AR)

Category Travel grants (sponsored by the SPS, PalGes, sponsors of the Paleo4Alps)

- 8 travel grants for non-permanently employed junior researchers or researchers with disadvantaged backgrounds (sponsored by the Swiss Paleontological Society)
- 3 travel grants for non-permanently employed junior researchers (sponsored by the Paläontologische Gesellschaft)
- 2 travel grants for non-permanently employed junior researchers (sponsored by EMP, E. Schweizerbart'sche Verlagsbuchhandlung)

With support of:



Our field trips

Pre-conference field trip to the Carnic Alps

This three-day excursion will begin in Trieste at 8:00 a.m. on Thursday, July 16th, and end in Bozen/Bolzano in the late afternoon of Saturday, July 18th, 2026. The itinerary includes visits to several classic and new sections and outcrops of different Paleozoic ages in the central Carnic Alps. Most of these sites are accessible via easy walks. The only exception is the famous Cellon section, which requires a 20-minute hike on a steep but well-marked trail. The participation fee includes transportation, two nights' accommodation in a double room in Mauthen, Austria, and all meals. Participants are responsible for their own accommodation in Trieste before the excursion and in Bozen/Bolzano after the excursion.

Download the guide at: <https://doi.org/10.3301/GFT.2026.07>



Pre-conference field trip to Verona and Bolca

This one-day excursion will start at 8:00 a.m. and end at 6:30 p.m. in Bozen/Bolzano on Saturday, July 18th, 2026. We will visit the Museo di Storia Naturale di Verona, where the historical collections of Bolca are preserved, and then the classic outcrops of Bolca.

Download the guide at: <https://doi.org/https://doi.org/10.3301/GFT.2026.06>



Pre-conference field trip to Lavini di Marco

This one-day field trip will take us on Saturday, July 18th, 2026 to the famous dinosaur footprint site of Lavini di Marco. Due to the season, the outcrop visit will take place early in the morning, followed by a visit to the MUSE in Trento.

Download the guide at: <https://doi.org/10.3301/GFT.2026.09>



Post-conference field trip to the Dolomites

This three-day excursion will begin in Bozen/Bolzano at 8:00 a.m. on Friday, July 24th, and end in Bozen/Bolzano in the late afternoon of Sunday, July 26th, 2026.

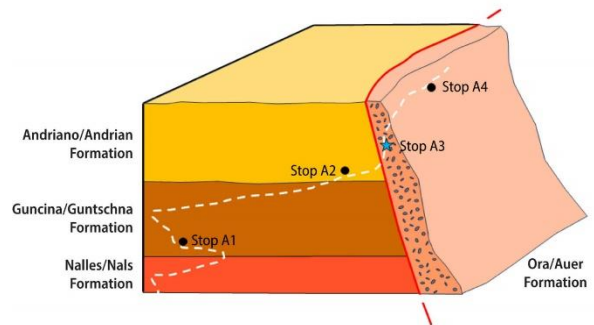
Several classic sections and outcrops, fundamental to understanding the geological evolution of the Dolomites, will be visited. Most localities are accessible via walks and short hikes. The only exception is the famous Bletterbach trail, where a well-marked trail includes a steep 150 m ascent out of the valley. The other sections you will be able to visit are Seceda, Bulla/Pufels and the Pralongià outcrops of the famous St. Cassian Formation.



Self-guided excursion to the city and surroundings of Bozen/Bolzano to learn more about the Supervolcano of Bolzano

This half-day self-guided urban geoheritage excursion starts in the center of Bozen/Bolzano and follows a walking route from the Oswald promenade to the historic city center, ending at Domplatz/Piazza Duomo. Along the route, participants will examine Permian volcanic outcrops of the Athesian Volcanic Group and trace the same rocks, as well as their sedimentary derivatives, in historic buildings, churches, castle walls and pavements.

The excursion is entirely on foot and includes paved streets, stairways and short uphill and downhill sections on established paths. It is intended for geologists, paleontologists, volcanologists and heritage specialists interested in the connection between bedrock geology, urban architecture and the geological history of Bozen/Bolzano.



Keynote talks



Valentina Rossi

In the Darkness Bind Them: Deciphering Melanin Molecular Taphonomy

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Molecular paleontology is transforming our understanding of the evolution and biology of ancient life. Over almost two decades, melanin pigments have emerged as a central focus of this field, offering a remarkable window into the biology of extinct animals. Since the early studies, fundamental challenges have arisen, from the characterization of the distribution and abundance of melanosomes (i.e., melanin-bearing organelles) in living vertebrates, through understanding the diversity of melanin molecules, their properties and functions in the broader tree of life, to probing how these fundamental molecules preserve in the rock record and how we can confidently detect them in fossils. The research community has embraced a multi-disciplinary approach through direct analyses of fossil specimens and their extant analogs, and via controlled laboratory experiments, coupled with advanced chemical analyses, including synchrotron X-ray fluorescence imaging, X-ray absorption near-edge structure spectroscopy, mass spectrometry techniques, and Raman and Infrared spectroscopy, to systematically test the stability of melanosomes and melanin molecules across diverse tissues and organisms and to detect their signatures in the fossil record.

A fundamental challenge in studying ancient biomolecules, however, is that thermal maturation progressively degrades the diagnostic chemical signatures that characterize biomolecules in extant organisms. During diagenesis (e.g., burial, passage of fluids), original melanin chemistry can transform into geologically stable macromolecules. Whether these newly formed fossil macromolecules retain any chemical fingerprint linked to their biological past is the question my most recent research is trying to answer. Here, I will review recent advancements in the field of fossil melanin research, with a particular focus on how to best study thermally altered fossils at the molecular level.

Biography

Valentina Rossi is a paleontologist specializing in soft tissue preservation, fossil geochemistry, and chemical imaging. Her research has pioneered the use of non-destructive analytical techniques to investigate fossil preservation, identify melanin in ancient tissues, uncover new pathways of soft tissue fossilization, and detect fossil forgeries. Her work has received international recognition, including selection as a Charlemont Scholar by the Royal Irish Academy, inclusion among the “25 Scientists Based in Ireland to Know” in 2024, and the UCC Research and Innovation Award – UCC 180 Professor Adrian Dixon Prize for Postdoctoral Researcher of the Year in 2025. Alongside her research, she is actively engaged in science communication and public outreach, promoting paleontology through lectures, public events, and social media.



Derek E.G. Briggs

Opening and closing taphonomic windows

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The importance of exceptional preservation in revealing the history of life on Earth has gained increasing currency since Seilacher coined the term fossil *Lagerstätten* and considered patterns in the environmental distribution of such remarkable preservations (Seilacher et al., 1985). Allison and Briggs (1991) extended this approach by identifying 'taphonomic windows' that yield soft-bodied fossils (*Konservat-Lagerstätten*) in various depositional settings at different times through the fossil record. *Konservat-Lagerstätten* have received much attention recently with a focus, for example, on documenting their number and distribution through time (Muscente et al., 2017), considering what qualifies as a *Fossil-Lagerstätte* (Kimmig & Schiffbauer, 2024), and identifying anactulistic (in effect extinct) modes of preservation that account for the prevalence of *Konservat-Lagerstätten* in Ediacaran and early Paleozoic settings (Gaines & Droser, 2025). This symposium, on linking ancient records to processes, provides an opportunity to reassess the utility of the concept of 'taphonomic windows' of exceptional preservation through geologic time with the aid of particular examples.

- Allison, P.A. & Briggs, D.E.G. (1991). Taphonomy of non-mineralized tissues. in Allison, P.A. & Briggs, D.E.G. (eds) *Taphonomy: releasing the data locked in the fossil record*: 25–70. Plenum Press.
- Gaines, R.R. & Droser, M.L. (2025). Fossil Lagerstätten and the enigma of anactulistic fossil preservation. *Paleobiology* 51: 29–43.
- Kimmig, J. & Schiffbauer, J.D. (2024). A modern definition of Fossil-Lagerstätten. *Trends in Ecology and Evolution* 39: 621–624.
- Muscente, A.D. et al. (2017). Exceptionally preserved fossil assemblages through geologic time and space. *Gondwana Research* 48: 164–188.
- Seilacher, A., Reif, W.E. & Westphal, F. (1985). Sedimentological, ecological and temporal patterns of fossil Lagerstätten. *Philosophical Transactions Royal Society B* 311: 5–23.

Biography

Derek Briggs is the G. Evelyn Hutchinson Professor in the Department of Earth and Planetary Sciences at Yale University and a curator and former director of the Yale Peabody Museum. His primary research interest is in the preservation and evolutionary significance of *Konservat-Lagerstätten* including the Cambrian Burgess Shale of Canada, the Ordovician Fezouata formations of Morocco, the Silurian Herefordshire biota of the UK, and the Devonian Hunsrück Slate of Germany. He showed how soft tissues are fossilized through replication by minerals and the diagenetic alteration of organic cuticles and other tissues. He and collaborators determined the vertebrate affinity of conodonts and demonstrated how melanosomes can reveal the color of feathered dinosaurs. He is a Fellow of the Royal Society and a member of the American Academy of Arts and Sciences.



Nikolay Oskolkov

aDNA as a Tool for Paleoecology

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Ancient DNA (aDNA) has transformed paleoecology by enabling direct exploration of past biodiversity and ecosystem dynamics from archaeological and environmental materials. In particular, ancient environmental DNA (aeDNA) recovered from sediments, ice, and other substrates offer unprecedented opportunities to reconstruct past communities even in the absence of visible macrofossils. This presentation will provide an overview of recent advances in ancient environmental metagenomics and discuss how emerging computational and sequencing approaches are expanding our ability to study long-term ecological change. Attention will be given to the challenges associated with ancient microbial and environmental metagenomics, including contamination, taxonomic misclassification, and reference database limitations.

Biography

Nikolay Oskolkov is Group Leader of the Metabolic Research Group at the National Institute of Research and Innovation (NIRI) in Latvia and is affiliated with Lund University, Sweden. His research focuses on the application of mathematical statistics, machine learning, and artificial intelligence to complex biological data, with expertise in multi-omics integration, ancient DNA, metagenomics, microbiome research, and precision medicine. He has authored more than 60 scientific publications, with over 4,400 citations and an h-index of 27. His work has been recognized with several international awards, including the Young Investigator Award of the European Association for the Study of Diabetes and the Helmholtz Zentrum München Award for Interdisciplinary Cooperation. Alongside his research, he is actively involved in teaching and developing AI-driven approaches for the Life Sciences.

Public outreach talk

(in Italian language at the Museum of Nature South Tyrol)

Dinosauri ai raggi X: le nuove frontiere della Paleontologia

Immaginate di osservare una vecchia fotografia con una lente potentissima: ogni dettaglio — dai volti ai particolari sullo sfondo — racconta una storia. Lo abbiamo fatto con una “fotografia” di 80 milioni di anni: i fossili del Villaggio del Pescatore, vicino a Trieste. Non ci sono solo dinosauri: la roccia conserva coccodrilli, rettili volanti, piante, pesci e organismi visibili solo al microscopio. Con il sincrotrone Elettra — la nostra lente potente come miliardi di soli — e tomografie ad altissima risoluzione trasformiamo la roccia in una finestra sul passato: vediamo nervi, vasi sanguigni, la composizione dei tessuti e persino indizi sull'ultimo pasto degli animali.

Venite a scoprire come si leggono le storie nascoste nei fossili e come le tecnologie moderne danno nuova vita a mondi scomparsi.

Federico Fanti è un paleontologo e National Geographic Explorer, celebre per le sue scoperte sui dinosauri e la sua attività di divulgazione scientifica.



Paleoart Exhibition

Ancient Horizons: Reimagining the Lost Worlds of Europe

The Paleo4Alps Paleoart Exhibition, *Ancient Horizons: Reimagining the Lost Worlds of Europe*, is organized by the **PaiP** (Palaeontologists in Progress) Committee of the Società Paleontologica Italiana (SPI) in collaboration with **Fabio Manucci** (Associazione Paleontologica Paleoartistica Italiana).

The exhibition brings together selected paleoartists, primarily from Austria, Germany, Italy, and Switzerland, presenting a diverse and contemporary artistic perspective on life in the deep past. Through a broad range of artistic styles and media, the exhibition demonstrates how paleoart connects scientific evidence with artistic interpretation, transforming paleontological discoveries into compelling visual reconstructions.

The exhibited works portray extinct organisms and ancient European landscapes, celebrating the exceptional diversity of Europe's fossil heritage while promoting dialogue between scientists and artists. By bringing together researchers, illustrators, and the public, the exhibition aims to strengthen the European paleoart community and to highlight the importance of visual communication in paleontology.

The exhibition will be officially opened on **July 19th, 2026, at 5 p.m.** and will remain open throughout the meeting. The artworks will be displayed in the poster area, which is co-curated by the PaiP Committee together with **Aart van Bezooijen** and **Seçil Ugur Yavuz** from the Faculty of Design and Art of the Free University of Bozen-Bolzano.

A special **Paleoart Meet & Draw** session will take place during the lunch break on Monday, July 20th, 2026, in the poster area. Participants are warmly invited to meet the artists, discuss the role of paleoart in scientific communication, and contribute their own sketches at the drawing corner. Selected drawings will remain on display for the remainder of the conference. On Thursday, July 23rd, immediately before the Closing Ceremony, the exhibited artworks will be auctioned. The proceeds will support the activities of the Società Paleontologica Italiana, with a particular focus on initiatives for early career researchers and science outreach.



List of Symposia

S1 Advanced techniques for visualizing and characterizing the paleontological heritage

Conveners: Elena Ghezzi¹, Joachim T. Haug²

¹University of Padua, Italy; ²Ludwig-Maximilians Universität München, Germany

Textual descriptions of fossil specimens are often insufficient to fully convey the results of scientific research. For this reason, the interpretation of the fossil record through precise visual representation has become increasingly important, especially considering that the paleontological heritage is highly heterogeneous and requires specialized expertise for interpreting it. While in the past documentation relied mainly on drawings and simple two-dimensional light-based photography, researchers today can take advantage of advanced imaging techniques such as photogrammetry, UV-filtered photography, spectral imaging, computed tomography, SEM, profilometry, or confocal microscopy. These advanced imaging approaches frequently guide analyses and scientific interpretations, leading to the development of new standard protocols and deepening our understanding of the fossil record and the complexity of paleontological preservation. They allow scientists not only to document fossils with precision, but also to reveal morphological and structural information that would otherwise remain inaccessible with traditional methods and eventually share those data interactively. In this session, contributors are invited to present their approaches, results, and any innovative protocols or interdisciplinary methods developed to address their case studies. The focus is on identifying and discussing the most advanced practices for presenting paleontological data in a way that is suitable for scientific publications, while also considering practical aspects such as time and cost efficiency.

S2 AI in paleontology – potential, pitfalls, and recent advances

Conveners: Thomas A. Neubauer¹, Alessandro P. Carniti², Andrea Baucon³

¹SNSB - Bavarian State Collection for Palaeontology and Geology, Germany; ²Nanjing University, China; ³University of Cagliari, Italy

The integration of artificial intelligence (AI) into paleontology is significantly transforming the field, offering unprecedented opportunities in the study of past life. Recent studies highlight the use of AI in taxonomy, encompassing identification, classification, and trait scoring. Advances in machine learning-driven morphometrics and quantitative analyses are enhancing morphological studies, reconstructions of past biodiversity, and paleoecological interpretations. Furthermore, AI facilitates automated image segmentation, feature extraction, and digital preparation. Generative applications, such as AI-driven paleoart and text generation, are also emerging as powerful tools, offering innovative ways to visualize extinct organisms and synthesize paleontological data. However, key challenges remain limited labeled datasets and benchmarks related to the relatively small size of biological and paleontological datasets, limited accessibility to data behind paywalls, domain shift between modern and fossil material, explainability of black-box models, and reproducibility of workflows.

This session seeks contributions related to all aspects of AI in paleontology: from methodological applications and innovations, dataset processing, benchmark proposals, reproducible pipelines and software, case studies applying AI to novel fossil problems, machine learning-supported quantitative analyses, to best practices for AI in paleontology and discussions of ethics and community standards. Negative results that clarify limitations are equally welcome. Join us to share new results, tools, ideas, and standards that will shape reproducible, interpretable AI workflows for the future of the fossil record.

S3 Big Paleontology: Synthesizing paleontological knowledge with interdisciplinary approaches

Conveners: Wolfgang Kiessling¹, Francesca Bosellini², Danijela Dimitrijevic¹, Catalina Pimiento³, Martin Zuschin⁴

¹Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany; ²University of Modena and Reggio Emilia, Italy; ³University of Zurich, Switzerland; ⁴University of Vienna, Austria

Paleontology increasingly addresses complex, multi-scale questions that cannot be resolved within disciplinary boundaries alone. Community-driven initiatives have highlighted a set of Big Questions in Paleontology—including the controls on biodiversity dynamics, ecosystem resilience, and biological

responses to environmental change—that require integrative approaches combining fossil data with methods and concepts from ecology, climate science, Earth system science, evolutionary biology, and quantitative modeling.

This symposium aims to showcase and advance interdisciplinary synthesis as a central mode of inquiry in modern paleontology. It is inspired by the Paleosynthesis Project, which promotes international synthesis workshops to overcome fragmentation of data, methods, and theoretical frameworks in the field. PaleoSynthesis has demonstrated that structured synthesis across subdisciplines can generate new insights, research agendas, and collaborative networks that extend beyond individual datasets or case studies.

We welcome contributions that integrate paleontological evidence across temporal, spatial, or organizational scales, or that combine fossil data with independent lines of evidence such as ecological observations, geochemical proxies, climate reconstructions, or computational approaches. We particularly encourage presentations that engage with Big Questions in paleontology, demonstrate methodological or conceptual synthesis, or reflect on the challenges and opportunities of interdisciplinary research.

By bringing together researchers working at disciplinary interfaces, the symposium seeks to foster dialogue, identify shared conceptual frameworks, and strengthen the role of synthesis in addressing fundamental questions about the history of life and its relevance for understanding present and future biosphere change.

S4 Conservation Paleobiology – The past is key to the present and future

Conveners: Bettina Bachmann¹, Kristína Kocáková², Gregor Mathes³, Lukas Schweigl^{1,4}

¹University of Vienna, Austria, ²University of Zurich, Switzerland, ³University of Passau, Germany, ⁴University of Bologna, Italy

Earth's biota has been affected by anthropogenic stressors, such as biological invasions, climate change, eutrophication, land-use change, and overexploitation, for centuries to millennia. These pressures have caused major ecological shifts and an accelerating rate of species extinction. Given that scientific surveys and monitoring capture only a short temporal window, they are insufficient to fully assess ecological states before human impacts and predict long-term responses to current and future environmental change. In recent decades, there has been a growing focus on using the (sub-) fossil record to provide historical information and a more holistic framework for biological conservation. This has led to the emergence of conservation paleobiology as a distinct subfield within paleontology.

Conservation paleobiology comprises two complementary approaches. The first, near-time conservation paleobiology, uses the young (sub-) fossil record from the past few million years to understand the long-term responses of extant species and ecosystems to environmental change and to reconstruct historical baselines prior to the onset of anthropogenic impact. The second approach focuses on ecological and evolutionary processes in deep time to explore how Earth's biota responded to environmental conditions not experienced today but predicted for the future and what traits make species more resilient to change or vulnerable to extinction.

This symposium welcomes case studies from both near-time and deep-time perspectives. We aim to foster dialogue across disciplines and timescales, strengthening integration between paleosciences, archaeology, historical ecology, and taphonomy. We are especially interested in studies that link paleo-evidence to contemporary conservation challenges or future ecological projections, using the past to anticipate tipping points, resilience mechanisms, and biodiversity trajectories. By doing so, we highlight how insights from Earth's history can inform more effective responses to ongoing and future biodiversity loss.

S5 Crossing Continents: The Role of Africa–Eurasia Interchanges in Shaping Europe's Vertebrate Record

Conveners: Elpiniki Maria Parparousi¹, Leonardo Sorbelli^{2,3}, Beatrice Azzarà¹, Marco Cherin¹, Faysal Bibi², Johannes Müller²

¹University of Perugia, Italy, ²Museum of Natural History of Berlin, Germany, ³Institut Català de Paleontologia Miquel Crusafont, Spain

Africa–Eurasia faunal exchanges were among the most influential processes shaping Europe's vertebrate diversity in the last 25 million years. This symposium aims to stimulate new discussions about the relationships between the two realms through an integrated perspective, combining new fossil

evidence, paleogeographic reconstructions, and emerging macroevolutionary approaches. Three well-known major tipping points stand at the center of this reappraisal: the Gomphotherium Landbridge event (20-17 Ma), the rise and fall of the Old-World savanna biome (12-7), and the setup of the Quaternary glacial-interglacial cycle (ca. 2.6 Ma). Each episode reconfigured the European vertebrate communities and shaped the evolutionary and ecological trajectories of many taxa. The symposium will also highlight the importance of relatively minor transitional phases in the history of the European faunas, such as the Miocene Climatic Optimum and the Early-Middle Pleistocene Transition, among others. Understanding events at both global and regional scales is crucial for interpreting long-term patterns of biodiversity, habitat restructuring, and lineage persistence into the Quaternary of the European continent.

New fossil discoveries and refined stratigraphic, paleoclimatic, and paleogeographic frameworks now allow a more comprehensive evaluation of these events. Thanks to the integration of data from a broad spectrum of taxonomic groups, paleontologists can better trace the timing and dynamics of dispersals, identify faunal turnovers across different paleoenvironments, and reconstruct how European ecosystems responded to successive episodes of connectivity and isolation with Asia and Africa.

By bringing together specialists across vertebrate groups and methodological backgrounds, this session aims to foster cross-disciplinary dialogue and start developing a holistic view of how intercontinental dispersal routes shaped both past and present European biodiversity.

S6 Exceptional soft tissue preservation in fossils and the reconstruction thereof based on osteological covariation

Conveners: Christine Böhmer¹

¹Kiel University, Germany

Soft tissues are typically lost rapidly post-mortem because of microbial decay and cellular autolysis. Consequently, fossilized soft tissues are extremely rare. Yet, such discoveries provide valuable insights into the biology of extinct organisms, particularly those lacking recent analogues. Fossilized body silhouettes, internal organs, gut contents and even muscle fibers yielded a wealth of information on the anatomy and evolution of diverse taxonomic groups. For example, exceptional specimens of extinct birds preserve ovarian follicles and illuminate the evolution of avian reproductive organs toward a single functional ovary. Virtually complete plesiosaur fossils preserve skin traces, indicating that these extinct animals retained reptilian scaly skin, unlike other Mesozoic marine reptiles, such as ichthyosaurs. A very rare specimen of iconic ammonites revealed three-dimensionally preserved muscles that are not present in Nautilus, suggesting that their swimming technique differed. If soft tissues are not directly preserved, reconstructions based on osteological correlates are possible. Quantitative covariation analyses in extant analogues can then be used to better infer the anatomy of the extinct relatives. Overall, this symposium explores groundbreaking advancements in our understanding of soft tissue anatomy in extinct organisms, highlighting rare and exceptional fossils as well as cutting-edge methods. Recently discoveries showed how they have been transforming our view of ancient life.

S7 Faunal Responses to Late Pleistocene Climate Change in Europe: From Cave Bears to Modern Humans

Conveners: Anneke H. van Heteren^{1,2}, Doris Nagel³, Doris Döppes⁴, Gernot Rabeder³

¹SNB - Zoologische Staatssammlung München, Germany; ²Ludwig-Maximilians-Universität München, Germany; ³University of Vienna, Austria; ⁴Reiss-Engelhorn-Museen, Germany

The late Pleistocene has a complex climate history, and recent studies of European sites show local differences in fauna as well as local climatic differences. The radiocarbon method now allows for more detailed analyses of the last 50,000 years, covering MIS 3 to the Holocene.

The alpine cave bears, vegetarians found at an altitude of over 1,500 metres above sea level in MIS 3, when everything should have been covered by glaciers, led to calls for more detailed analyses of ecological changes in the Alpine region. Additionally, the arrival of modern humans falls into the same period.

Faunal finds from the Mediterranean region and Western, Central and Eastern Europe are necessary to compare local differences and identify gaps in our knowledge, especially in the datable period from MIS 3 to the Holocene, in order to better understand these events.

Against this background, the aim of this symposium is to bring together researchers working on Late Pleistocene faunal records across Europe to discuss how climatic variability, ecological change, and human presence shaped mammalian communities from MIS 3 to the Holocene. Particular emphasis will

be placed on key taxa such as cave bears and other large mammals, as well as on the interactions between faunal dynamics and the dispersal of modern humans. Through interdisciplinary exchange, the symposium aims to refine our understanding of faunal responses to rapid climate oscillations and to highlight future research directions necessary for reconstructing Late Pleistocene ecosystems in Europe.

S8 Fossil fishes

Conveners: Werner Schwarzhans¹, Giorgio Carnevale², Iris Feichtinger³

¹Natural History Museum of Denmark, Denmark; ²University of Torino, Italy; ³Natural History Museum Vienna, Austria

Many advances have been achieved in surveying and in the understanding of fossil fishes in recent years. Such advances comprise: i) discoveries of new fossil fish *Lagerstätten*, and review of legacy collections. New discoveries comprise, for example, an Oligocene reef fish fauna from northern Italy and from the Middle Miocene from Ukraine (the latter otolith-based), or new faunas from the Oligocene to Miocene Serbian Lake System. Reviews of legacy collections comprise the early Eocene Moler fish fauna of Denmark and the Badenian otolith collections from the Central Paratethys. ii) Refinements of the evolution of fishes and their interrelationships, primarily in Chondrichthyes and Osteichthyes. Extinction and survival of fish communities across the end Permian Great Dying or the K/Pg boundary event have been topics of recent studies, as well as the evolution of modern reef biota. iii) Improvements in the understanding of the evolution of fishes in interactions with the development of physical, chemical and biological factors surrounding them. Studies have, for example, been undertaken to illuminate effects on fish evolution related to the Eocene-Oligocene Transition that triggered the change of deep ocean circulation, the early-Middle Miocene reef bloom, or the Late Miocene-Early Pliocene biogenic bloom.

S9 Fossil mollusks

Conveners: Alexander Nützel¹, Baran Karapınar², Christian Klug³, Daniele Scarponi⁴, Simon Schneider⁵

¹SNSB - Bavarian State Collection for Palaeontology and Geology, Germany; ²University of Leeds, United Kingdom; ³Naturhistorisches Museum der UZH, Switzerland; ⁴University of Bologna, Italy; ⁵University of Oxford, United Kingdom

Mollusks constitute one of the most species-rich animal phyla in today's environments, and their contribution to the fossil record is even more significant. The Mollusk Symposium aims to provide insights into the latest research on fossil mollusks with respect to phylogeny, taxonomy, diversity, ecology, and morphology. Hence, we invite contributions on a broad range of topics. These may include reports on newly discovered taxa or faunas just as well as molecular phylogenetic research or studies on the role of mollusks in paleoenvironmental reconstructions. Likewise, presentations on the large proportion of mollusks in natural history collections and related aspects of curation and digitization, or potential applications of AI in collection management and mollusk research are welcome.

S10 Fossil-Lagerstätten – linking ancient records to processes

Conveners: Joachim Reitner¹, Jan-Peter Duda¹, Mike Reich², Evelyn Kustatscher³, Giuseppe Marramà⁴

¹University of Göttingen & Göttingen Academy of Science and Humanities in Lower Saxony, Germany; ²Landesmuseum Braunschweig, Germany; ³Tiroler Landesmuseen, Austria; ⁴University of Torino, Italy

Fossil-Lagerstätten sensu Seilacher (1970) formed under special preservation conditions and provide valuable insights into former environments and ecosystems. Spectacular examples are *Fossil-Lagerstätten* with completely preserved specimens (i.e. *Konservat-Lagerstätten*), such as the Middle Triassic organic-rich deposits of Monte San Giorgio and the Upper Jurassic lithographic limestones of southern Germany, as well as those characterized by extraordinary fossil enrichments (i.e. *Konzentrat-Lagerstätten*), such as the ammonite-rich Triassic Hallstatt facies and various Jurassic tectonic fissure and cave fillings from the Alpine realm. Because the fossil record is biased toward organisms with mineralized hard parts, which are more resistant to decay than soft-bodied organisms (analyses of modern marine communities have shown that only about 40% or fewer are likely to be preserved as fossils), the investigation of *Fossil-Lagerstätten* helps to reveal biases in the fossil record. Likewise,

understanding the processes that lead to special taphonomic preservation provides valuable paleoenvironmental and paleoecological information.

This session welcomes contributions on all types of *Fossil-Lagerstätten*, covering topics ranging from sedimentology and diagenesis through taphonomy and (forensic) biogeochemistry to the reconstruction of past organisms and ecosystems. Contributions may also address regional occurrences (e.g. Alpine–Tethyan) or sites characterized by specific preservation styles, such as Weng'an- and Orsten-style phosphatization, Burgess Shale–type deposition, Rhynie Chert–type silicification, and “pickling” in evaporites.

S11 From ultrastructure to molecules: advances in the study of soft tissue: preservation and experimental taphonomy

Convenors: Valentina Rossi¹, Orla Bath Enright²

¹University College Cork, Ireland; ²Naturkundemuseum Stuttgart, Germany

Konservat-Lagerstätten offer high-resolution snapshots into the evolution of life through the preservation of soft tissues and non-biomineralizing organisms. To understand this, the taphonomic pathways that lead to exceptional preservation must be comprehensively assessed, which is often challenging given the inherent complexity of the processes that control preservation.

Experimental taphonomy allows us to probe fossilization processes via a series of hypothesis-driven, laboratory-based experiments. Experimental data, in turn, can be used to build predictive models of pathways that control the preservation of biological structures, ultimately refining their detection in the fossil record. Recent developments in the field have driven significant discoveries in paleontology, ranging from understanding the intricacies of decay to *in situ* non-destructive molecular analysis of soft tissues and the discovery of novel modes of preservation.

This symposium aims to bring together experts to share new advancements in experimental design and technology, and to discuss the challenges. We propose the following exciting topics: 1) the implementation of laboratory-controlled experiments for understanding soft tissue preservation in diverse organisms; 2) the analysis of ultrastructural preservation of soft tissues in the fossil record; 3) molecular analysis of fossilized soft tissues; and 4) novel approaches in experimental design and data analysis. Priority will be given to presenters who are early-career researchers, to strengthen our network, foster new collaborations, and showcase our highly interdisciplinary field, spanning chemistry, biology, sedimentology, and paleontology.

S12 Microfossils as keys to Earth's past and future — advancements and perspectives in multiproxy studies

Conveners: Anna Pint¹, Ella Quante^{2,3}, Silvia Kolomaznik², Peter Frenzel², Luca Pellegrino⁴, Annalisa Ferretti⁵

¹Universität Hamburg, Germany; ²Friedrich-Schiller-Universität Jena, Germany; ³Max Planck Institute of Geoanthropology, Germany; ⁴University of Torino, Italy; ⁵University of Modena and Reggio Emilia, Italy

The use of microfossils has long extended beyond traditional micropaleontology and is increasingly developing as an integrated tool within multiproxy studies, within e.g., paleoceanography, palaeoclimatology, geochemistry, applied geology, physical geography and geoarchaeology. Microfossil assemblage compositions, morphological variations, and shell chemistry allow various paleoenvironmental and palaeoecological reconstructions in aquatic or terrestrial environments, and their biostratigraphic ranges are extremely valuable when correlating and assigning relative ages to strata. The small size of microfossils and their high diversity enable studying large associations, often with well preserved and complete individuals even from small samples as typical from sediment cores. However, e.g., preservation-issues, or sampling- and observer-bias may lead to inaccurate interpretations and complicate the development and evolution of micropaleontological proxies as integrated applications.

This session aims to bring together researchers working with all groups of microfossils throughout the Phanerozoic, from traditional microfossils such as foraminifers, diatoms, conodonts, ostracods, pollen, and nannofossils, to microremains derived from larger organisms (e.g., plants, vertebrates), to highlight recent advances, innovative methodologies, and emerging multi-proxy applications that extend far beyond classical micropaleontology. Special focus will be reserved to: i) novel methodological approaches, including imaging, geochemical proxies, statistical modelling, and AI-based classification; ii) applications in multiproxy studies, integrating microfossils with sedimentology, geochemistry,

stratigraphy, and climate archives; iii) case studies from marine, lacustrine, terrestrial, and extreme environments; iv) interdisciplinary perspectives, including links to ecology, conservation, archaeology, astrobiology and environmental monitoring.

S13 Paleoherpetology of the Alps and peri-Alpine basins

Convenors: Andrea Villa¹, Jordan Bestwick²

¹Institut Català de Paleontologia Miquel Crusafont (ICP-CERCA), Spain; ²University of Zurich, Switzerland

The Alps can undoubtedly be considered a paleoherpetological treasure trove, offering a plethora of opportunities for scholars studying fossil amphibians and reptiles. From Mesozoic marine and terrestrial reptiles to Cenozoic assemblages, from highly informative articulated body fossils to astounding ichnological records, people interested in all kinds of aspects of paleoherpetology can find significant inspiration for research in the Alpine area and surrounding basins. This symposium aims at gathering scholars working with amphibian and reptile fossils from the Alpine and peri-Alpine geographic domain, covering all groups and stratigraphic ranges, to promote exchange of ideas and knowledge within the community. Research at all scales is welcome, from the level of specific assemblages to macroevolutionary studies, and potential topics might include (but are not limited to) taxonomy, phylogeny, paleobiogeography, macroevolution, paleofaunistics, conservation paleobiology, etc. We invite all to explore together this fascinating component of the Alpine (paleo)faunas.

S14 Plants under pressure in a changing climate

Conveners: Camilla Wellstein¹, Manuel Steinbauer², Lutz Kunzmann³ & Evelyn Kustatscher⁴

¹Free University of Bozen-Bolzano, Italy; ²Universität Bayreuth, Germany; ³Senckenberg Naturhistorische Sammlungen Dresden, Germany; ⁴Tiroler Landesmuseen, Austria

Climate change has repeatedly reshaped terrestrial ecosystems throughout Earth's history. Plants, as primary producers and key ecosystem engineers, respond to environmental change through modifications of functional traits, evolutionary adaptation, phenotypic plasticity, and shifts in floristic composition. Understanding these responses is essential both for reconstructing past ecosystems and for placing modern biotic reactions to ongoing climate change into a long-term perspective. This symposium aims to bring together paleontologists and biologists working on fossil and extant plants to explore how plant traits and floristic composition respond to climate change across different temporal and spatial scales. Contributions about biodiversity are also welcome. We explicitly encourage contributions that bridge modern and fossil perspectives, fostering dialogue between researchers studying present-day ecosystems and those investigating deep-time plant responses. We welcome presentations addressing, but not limited to, the following topics: the use of functional plant traits as indicators of climatic and environmental change; morphological, anatomical, physiological, and ecological adaptations of plants to changing climate conditions; shifts in floristic composition, diversity, and dominance patterns during climate transitions; and resilience, vulnerability, and tipping points in plant communities under climatic stress as well as changes in plant-animal interactions. Studies integrating multiple proxies, comparative approaches between past and present systems, and links to ecological or evolutionary modelling are particularly encouraged. By combining evidence from the fossil record with insights from modern biology and ecology, this symposium seeks to highlight the unique role of paleontology in understanding plant-climate interactions and to demonstrate how deep-time perspectives can inform current and future responses of terrestrial ecosystems to climate change.

S15 Reading the past through palynology: multidisciplinary insights into stratigraphy, climate, and environments

Conveners: Amalia Spina¹, Nicoletta Buratti², José Bienvenido Díez Ferrer³, Shao Longyi⁴, Evelyn Kustatscher^{5,6}, Iván Rodríguez-Barreiro⁶, Ingrid C. Romero⁷, Emanuele Ruiu¹, Haidra Saleh¹

¹University of Perugia, Italy; ²Total Energies, Pau, France; ³Universidade de Vigo, Spain; ⁴China University of Mining and Technology, China; ⁵Tiroler Landesmuseen, Austria; ⁶Museum of Nature South Tyrol; ⁷Smithsonian National Museum of Natural History, USA

This session aims to highlight recent advances in research and to explore the pivotal role of organic matter, palynofacies, and palynological studies in multidisciplinary geoscience applications across the deep time. Emphasis is placed on the integration of palynological and organic matter-based approaches

into paleoenvironmental and paleoclimatic reconstructions, as well as stratigraphic and basin-scale interpretations.

The session seeks to stimulate discussion and foster collaboration on the following key themes: i) taxonomy, stratigraphy, and evolutionary patterns of palynomorphs across deep time; ii) integrated palynofacies, organic facies, and sedimentological analyses as key tools for paleoenvironmental reconstruction and basin analysis; iii) paleobiogeographic, paleogeographic, paleoclimatic, and paleoenvironmental reconstructions based on organic facies and marine and terrestrial palynomorph assemblages; iv) assessment of the thermal maturity of organic matter using classical and emerging proxies, including spore and pollen color indices, vitrinite reflectance, and geochemical indicators; v) Applications of vibrational spectroscopy (e.g., FTIR, Raman) to investigate chemical composition, preservation state, environmental signals, and thermal maturity of organic materials, alongside complementary techniques.

Participants are invited to present methodological developments and significant case studies addressing depositional environments, paleoclimatic change, and high-resolution stratigraphic frameworks, including chronostratigraphy, cyclostratigraphy, and sequence stratigraphy. Overall, this session aims to emphasize the growing importance of organic matter and palynology as fundamental components of multidisciplinary geoscience research and Earth system reconstructions through deep time.

S16 Resilience and turnover: Ecosystem change across past environmental crises

Conveners: Silvia Danise¹, William J. Foster², Herwig Prinoth³, Elke Schneebeil-Hermann⁴

¹University of Florence, Italy; ²University of Hamburg; ³Museum Ladin Ciastel de Tor, Italy; ⁴University of Zurich, Switzerland

Environmental crises have played a major role in shaping ecosystems throughout Earth's history. The fossil record documents how episodes of environmental stress affected biodiversity, community structure, and ecological functioning, often in complex and uneven ways. This symposium aims to explore patterns of resilience and turnover in marine and terrestrial ecosystems across deep time, with a focus on paleontological evidence for biological change during and after environmental crises.

We welcome contributions that address extinction, survival, and recovery across different taxonomic groups, environments, and geological intervals. Topics may include changes in biodiversity and community composition, ecological selectivity, body-size trends, functional reorganization, and the dynamics of post-crisis recovery. Comparative approaches that examine similarities and contrasts among different crisis intervals, or across regions and depositional settings, are particularly encouraged.

An important aspect of the symposium is the integration of biological patterns with their environmental and stratigraphic context. Contributions based on well-constrained stratigraphic frameworks, and studies that combine paleobiological data with sedimentological, geochemical, or paleoenvironmental information are especially welcome. Both marine and terrestrial records, and datasets ranging from microfossils to macroscopic organisms, fall within the scope of the session.

The symposium is intended as a forum for exchange among researchers working with different materials, time intervals, and methodological approaches. By bringing together these perspectives, the session aims to improve our understanding of how ecosystems respond to severe environmental change over geological timescales, and how resilience, collapse, and re-organization are recorded in the geological archive.

S17 Student session: building the future of the paleontology community

Conveners: Alessandro P. Carniti¹, Fabio Franceschi², Gianmarco Minniti³, Riccardo Rocchi⁴, Dustin Schmidt⁵

¹Nanjing University, Nanjing, China; ²University of Torino, Italy; ³University of Catania, Italy; ⁴University of Bologna, Italy; ⁵University of Münster, Germany

The session is aimed at creating a supportive, dynamic, and relaxed environment dedicated specifically to bachelor, master, and PhD students at their first conference experiences. Contributions on any topic of paleontology (taxonomy, paleoecology, biostratigraphy, novel methods and applications) and any taxonomic group (microfossils, fossil plants, invertebrate and vertebrate macrofossils) are welcome. Presentations may include original research ideas, preliminary results, or early-stage projects, with the purpose of offering a space to test hypotheses and receive constructive feedback.

A key objective of the session is to provide an inclusive platform where early-career researchers can build confidence in presenting their work in English and develop essential scientific communication skills.

Special emphasis will be placed on encouraging interdisciplinary dialogue among students with different academic backgrounds and research perspectives, fostering cross-field understanding and collaboration. The session conveners will actively support participation through guided discussion, interactive Q&A formats, and informal networking opportunities designed to stimulate the exchange of ideas. By promoting open interaction and a sense of community, the session aims to strengthen professional relationships among young paleontologists and contribute to the creation of a collaborative and engaged new generation of researchers.

We specify that students are also welcome to engage in all other sessions of the conference.

S18 Triassic *Fossil-Lagerstätten* of the Alps and beyond

Conveners: Claudia Dojen¹, Torsten M. Scheyer², Nicole Klein³

¹Landesmuseum Kärnten, Austria; ² University of Zurich, Switzerland; ³Staatliches Museum für Naturkunde, Germany

Following the end-Permian mass extinction, Earth's largest biotic crisis, the Triassic experienced a fluctuation of times of recoveries and turnovers before reaching more stable conditions in the terrestrial and marine realms. The Triassic also saw the emergence of modern ecosystem structures, and many extant organisms and clades have their roots or times of significant diversification within this early Mesozoic. Furthermore, many important *Fossil-Lagerstätten* are situated in the Alpine region, well embedded in the larger European context. The present symposium thus aims to bring together expertise of different fields including vertebrate and invertebrate paleontology, paleobotany and palynology, to paleoecology and macroevolution.

S19 Vertebrate ichnology, quo vadis? Perspectives of our practice

Conveners: Matteo Belvedere¹, Michael Buchwitz², Diego Castanera³, Christian Meyer⁴, Lara Sciscio⁵

¹University of Florence, Italy; ²Museum für Naturkunde Magdeburg, Germany; ³Universidad de Zaragoza, Spain; ⁴University of Basel, Switzerland and Museo de Historia Natural Alcide d'Orbigny, Bolivia; ⁵Jurassica Museum and University of Fribourg, Switzerland

Progress in fossil vertebrate traces is not only advanced by the discovery and description of new trace occurrences, technological innovations, and increasing data availability, but also by a better understanding of how such traces, especially when ichnotaxonically well-defined, can be related to extinct and extant producers. As an exemplary case of "reciprocal illumination" in science, the study of these traces may enhance our understanding of the producers' biology and vice versa, facilitating integrated studies on faunal events, paleobiogeography, biostratigraphy, locomotion, soft tissues, fossoriality, as well as social and trophic structures. Trace formation represents a physical and biological process that can be informed by the study of present-day vertebrate taxa and their ecosystems, taking into account the phylogenetic relationships and evolutionary history of a specific trace-maker group. Additionally, the analysis of the sediment and sedimentary environments in which traces occur forms an important component of understanding trace generation. During the last decade, methodological advances have improved the availability of objective data (i.e., 3D models); however, much still needs to be done in terms of technical access (e.g., online databases), but also philosophical approach (easy data access).

This symposium is created to bring together diverse experiences and viewpoints in vertebrate ichnology. We invite contributions presenting new fossil trace or neoichnological data, experimental and technical approaches, data sharing and ichnotaxonomic perspectives. Altogether, the hope is to assess the current state of vertebrate ichnology, highlight methodological approaches and advances, while discussing, broadly, further research priorities.

OT Other Topics

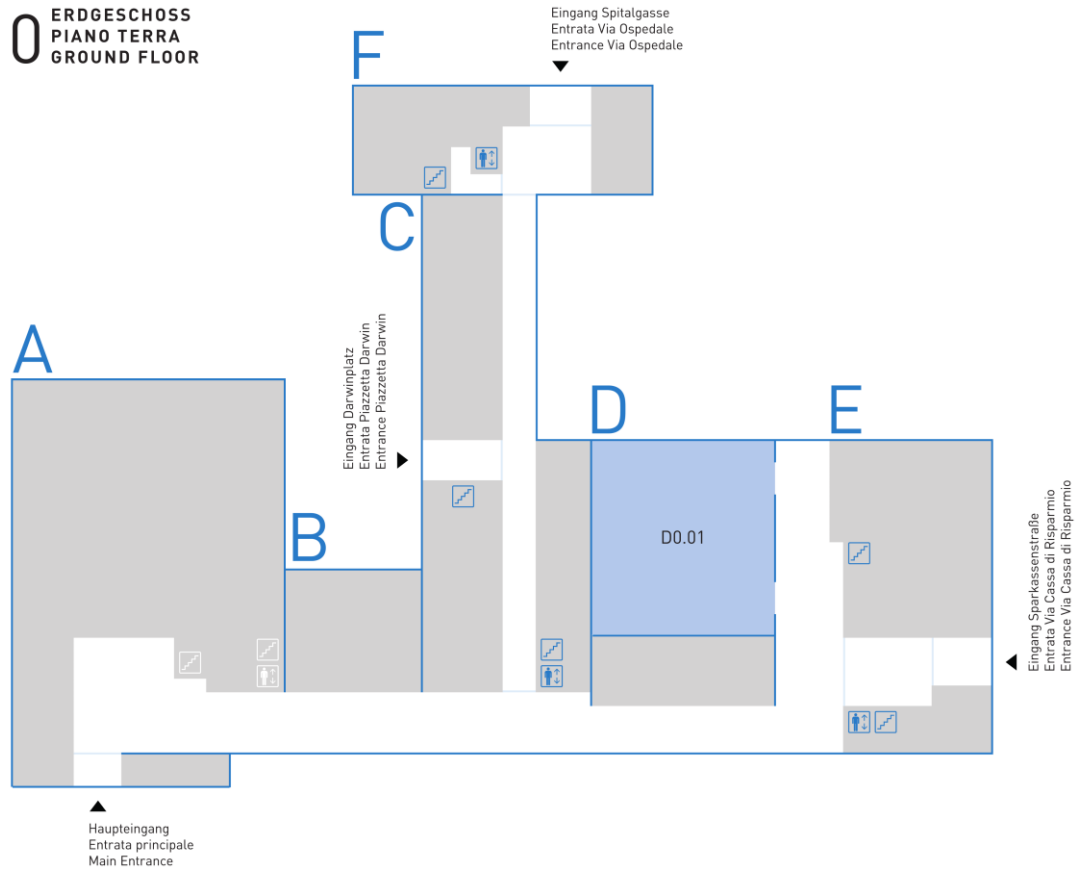
Conveners: Evelyn Kustatscher¹ & Camilla Wellstein²

¹Tiroler Landesmuseen, Austria; ²Free University of Bozen-Bolzano, Italy

This symposium includes all topics of paleontology not covered by the other symposia.

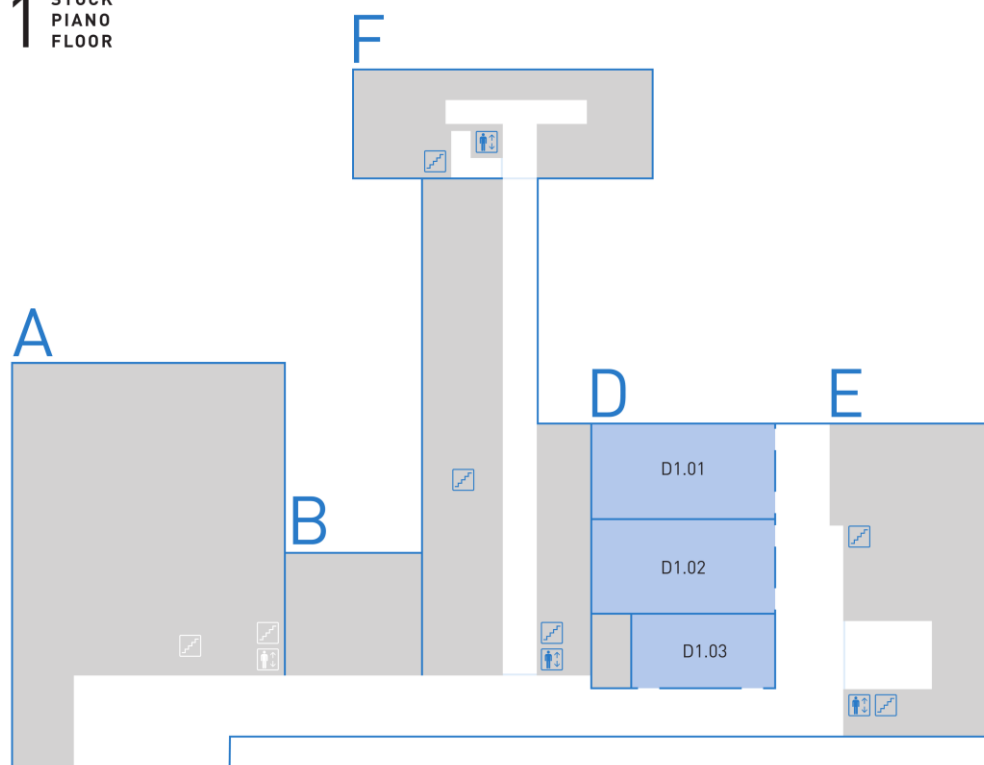
Floor plans

Floor plans of the conference venue, the Free University of Bozen-Bolzano. The rooms used during the meeting are highlighted in blue.



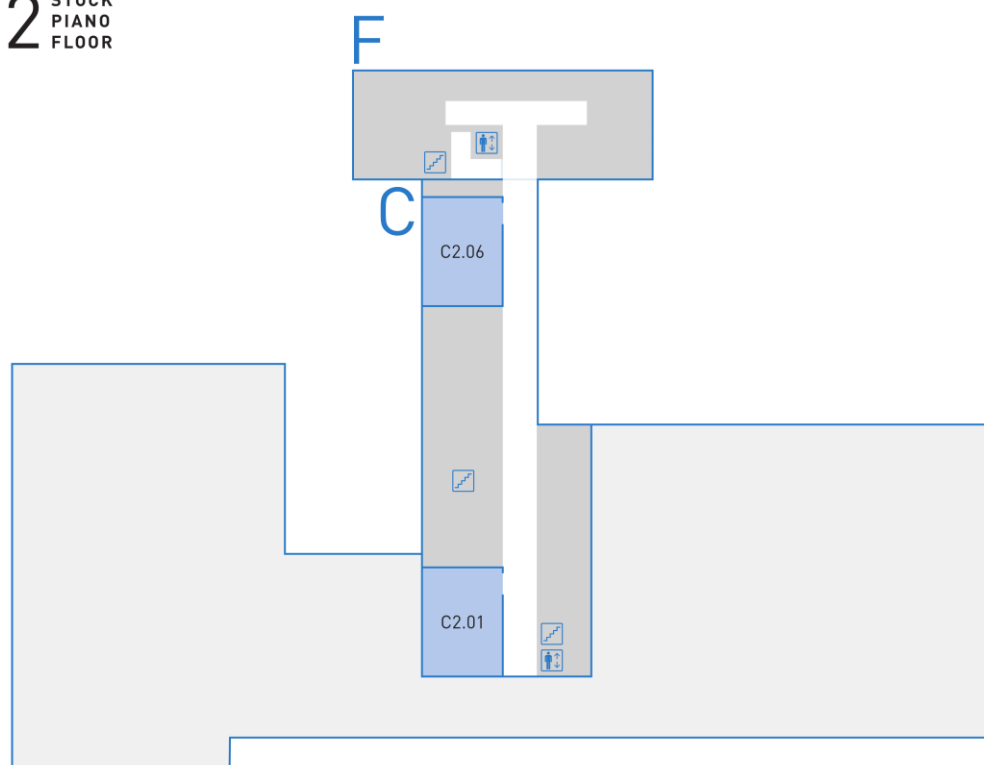
Ground floor (Piano terra). Room D0.01.

1 STOCK
PIANO
FLOOR



First floor (Primo piano). Rooms D1.01, D1.02, D1.03.

2 STOCK
PIANO
FLOOR



Second floor (Secondo piano). Rooms C2.01, C2.06.

Detailed Program

Sunday, 19 July 2026

Room: D1.01

The **Early Career Researchers (ECR) Day** will take place on July 19, 2026 in Room D1.01. The program will begin in the morning with an open discussion on the role of students and early career researchers in European Paleontology, providing an opportunity to exchange ideas, identify current challenges, and discuss future perspectives. In the afternoon, participants will take part in a hands-on workshop exploring novel approaches and emerging techniques in paleontological museology. The ECR Day is organized by the **PaiP** (Palaeontologists in Progress) Committee of the Società Paleontologica Italiana (SPI): **Alessandro P. Carniti**, **Fabio Franceschi**, **Gianmarco Minniti**, and **Riccardo Rocchi**.

10:00–12:00 Roundtable: Early Career Researchers and fossil enthusiasts in European Paleontology

Alessandro P. Carniti, Palaeontologists in Progress referee, SPI
Miriam Slodownik, Early Career Research Officer, PalAss
Dustin Schmidt, Representative WG Early Career Researchers, PalGes
Javier Mora, organizer of EJIP 2026, Encuentro de Jóvenes Investigadores en Paleontología

12:00–13:00 Lunch break (lunch not provided)

13:00–15:00 Roundtable: Challenges and Perspectives in Modern Paleontological Museology (virtual museums, AI, augmented reality)

Alessio Baglioni (Università degli Studi di Bologna): “New techniques for old fossils”
Christian Klug (University of Zurich): “Pros and cons of digital: a critical view on the use of digital media in museums”
Imelda Hausmann (Bayerische Staatssammlung für Paläontologie und Geologie München): “Using 3D-printed fossil models in exhibitions: insights and thoughts”
Gabriele Bindellini (Museo di Storia Naturale di Milano): “Digitization as a tool for preservation and research”

17:00–17:30 Opening of the exhibition: Ancient Horizons (artists available at the exhibition from 15:00 onwards)

17:30–20:30 Icebreaker Party (18:00–20:30)

Monday, 20 July 2026

Room: D1.01

09:00–09:30 Opening ceremony of the Conference

09:30–11:00 S12: Microfossils as keys to Earth’s past and future (chairs: Anna Pint & Annalisa Ferretti)

09:30–10:00 Gomez Correa et al. (invited talk): Shallow-marine ostracods during the Permian–Triassic climate crisis in the Southern Alps

10:00–10:15	Lehnert et al.: The Latest Cambrian through Tremadocian in the Eastern Precordillera of Western Argentina – A global standard succession for $\delta^{13}\text{C}$ chemostratigraphy controlled by its conodont record
10:15–10:30	Kranner: Reevaluation of the brackish “Oncophora (=Rzehakia) Beds” in the Bavarian North Alpine Foreland Basin
10:30–10:45	Briguglio et al.: Giant <i>Bathysiphon</i> (Foraminiferida) and associated ichnodiversity in the Building Stones of the Priamar Fortress in Savona (Italy)
10:45–11:00	Raimondi et al.: Pliocene-Pleistocene planktonic foraminiferal biostratigraphy from ODP Site 967: western and eastern correlation
11:00–11:30	<i>Coffee break</i>
11:30–12:45	S12: Microfossils as keys to Earth’s past and future (chairs: Luca Pellegrini & Silvia Kolomaznik)
11:30–11:45	Girone et al.: Planktonic foraminifera response to orbital and millennial-scale climate variability in the western Mediterranean (ODP Site 975) during Marine Isotope Stages 20 and 19
11:45–12:00	Mazzini & Parisi: Ostracod-based palaeoenvironmental reconstruction of the Corinth Rift during the last 450 ka: Insights from IODP Expedition 381
12:00–12:15	Arena et al.: Multiproxy insights into the initial stage of the Oligocene transgression of the central-eastern Tertiary Piedmont Basin (NW Italy)
12:15–12:30	Vitolo et al.: Circalittoral benthic foraminiferal and ostracod assemblages from the Gulf of Pozzuoli (Tyrrhenian Sea, Italy)
12:30–12:45	Auer et al. Middle–Late Miocene nutrient cycle changes and their impact on Indian Ocean productivity: Insights from nannoplankton assemblages
12:45–13:45	<i>Lunch break</i>
13:45–15:15	S18: Triassic Fossil-Lagerstätten of the Alps (chairs: Torsten Scheyer & Claudia Dojen)
13:45–14:00	Karapınar: Regionally heterogeneous food web restructuring across the Permian–Triassic mass extinction and the impact of temporal scale on ecological inferences
14:00–14:15	Scheyer et al.: Jadersdorf biota – an emerging Middle Triassic ‘Monte San Giorgio-type’ vertebrate lagerstätte in southern Carinthia, Austria
14:15–14:30	Dalla Vecchia & Cau: A New Archosaur (Reptilia, Diapsida) from the Triassic of Austria
14:30–14:45	Furrer: The Prosanto Formation near Davos - an amazing Middle Triassic <i>Konservat-Lagerstätte</i> in the Eastern Swiss Alps
14:45–15:00	Pople et al.: A three-dimensional reconstruction of the skull of <i>Neusticosaurus pusillus</i> , the archetypal pachypleurosaur from Monte San Giorgio
15:00–15:15	Rauhut et al.: New finds of basal sauropodomorph dinosaurs from the Late Triassic of Thuringia, Germany
15:15–15:45	<i>Coffee break</i>
15:45–17:30	S13: Paleoherpertology (chairs: Andrea Villa & Jordan Bestwick)
15:45–16:00	Bestwick et al.: A Late Triassic fossil mud trap from Switzerland reveals sauropodomorph dinosaurs surrounded by pterosaurs and rhynchocephalians
16:00–16:15	Guerra et al.: New insights into protostegid (Pan-Chelonioidea) evolution from the Upper Cenomanian of northeastern Italy
16:15–16:30	Monti et al.: Latest Oligocene amphibians from Coderet (France)

16:30–16:45	Barbini et al.: Analysis of the endocranial anatomy of the Miocene European crocodylian <i>Diplocynodon ratelii</i> with phylogenetic, ecological and ontogenetic implications
16:45–17:00	Navarro Rodríguez et al.: Investigating the generic affinities of European Miocene chameleons (Squamata, Chamaeleonidae) using Geometric Morphometrics: Preliminary results
17:00–17:15	Villa & Vasilyan: The diversity of Late Miocene squamates in the eastern Alps: new occurrences from three understudied localities in Austria
17:15–17:30	Gauweiler & Kustatscher: An overview of alpine terrestrial reptiles during the Carnian Pluvial Episode in the Alps
17:30–19:30	Poster session

Room: D1.02

09:30–11:00	S3: Big Paleontology (chair: Wolfgang Kiessling)
09:30–10:00	Neubauer & Harzhauser (invited talk): Terra incognita of deep time: mapping the uncharted frontiers of the Phanerozoic shallow-marine fossil record
10:00–10:15	Kocsis et al.: An extensible Earth data entity network
10:15–10:30	Macaluso et al.: simTax: a novel tool to measure weighted taxonomic similarity among fossil assemblages in R
10:30–10:45	Mandic et al.: Biodiversity forcing by the small mountain ranges: patterns from the Miocene intramountain lake-basins in the Dinaric Alps of SE Europe
10:45–11:00	Mondal et al.: Faunal restructuring in the aftermath of the Arabian hotspot collapse: Patterns from western India
11:00–11:30	<i>Coffee break</i>
11:30–13:00	S3: Big Paleontology (chair: Francesca Bosellini)
11:30–12:00	Hagen, Oskar (invited talk): Deutero-gen3sis: A grammar for biotic forcing of the Geosphere
12:00–12:15	Guo & Kiessling: Global patterns are key to understanding macroevolution
12:15–12:30	Pyko & Kiessling: Climate cascades across time: a multi-scale synthesis of climate-driven extinction mechanisms
12:30–12:45	Dimitrijevic & Kiessling: Reef crises and marine biodiversity loss
12:45–13:00	Mariani et al.: Skeletal assemblage shifts within persistent reef framework across Cenozoic warming intervals
13:00–13:45	<i>Lunch break</i>
13:45–15:15	S3: Big Paleontology (chair: Danijela Dimitrijevic)
13:45–14:15	Patzkowsky (invited talk): Interpreting the causes and timing of mass extinctions: the role of species ecology and stratigraphic architecture
14:15–14:30	Warnock et al.: The impact of speciation mode on macroevolutionary rates through time
14:30–14:45	Capobianco & Höhna: Total-evidence tip-dating reveals macroevolutionary dynamics in deep-sea squaliform sharks
14:45–15:00	Darlim et al.: Assessment of Notosuchia phylogenetics through tip-dating Bayesian inference

15:00–15:15	Marx et al.: Ecological, behavioural, and phylogenetic links to cochlear shape variation in odontocetes
15:15–15:45	<i>Coffee break</i>
15:45–17:15	S3: Big Paleontology (chair: Mark Patzkowsky)
15:45–16:15	Haug C. et al. (invited talk): Large questions require large-scale comparisons: an example from quantitative morphology in Euarthropoda
16:15–16:30	Pasinetti: Hiding between the fronds: secrets of the "Ediacaran Garden"
16:30–16:45	Kimmig & Bicknell: The Cambrian fecal revolution: Fuel for the Cambrian Radiation
16:45–17:00	Cervellieri et al.: Unravelling biomineralization processes in modern brachiopods: integrating structural analyses with high-resolution elemental mapping and ecology
17:00–17:15	Kiessling et al.: The Lilliput effect and the illusion of size selective extinction
17:30–19:30	Poster session

Room: D1.03

09:30–11:00	S5: Crossing Continents (chairs: Elpiniki Maria Parparousi & Leonardo Sorbelli)
09:30–09:45	Camanni et al.: The early Pliocene Accipitridae (Aves, Accipitriformes) from Langebaanweg, south-western Cape Province, South Africa
09:45–10:00	Cirilli et al.: Dawn of a dynasty: the origin and early evolution of the Afro-Eurasian hipparion three-toed horses
10:00–10:15	Croitor et al.: No heroic "Out-of-Africa" dispersal, just a passive Afrotropical realm extension follow-up
10:15–10:30	Iannucci et al.: New insights on late Early Pleistocene carnivores of Europe from the hyenas of Pirro Nord and Slivia (Italy)
10:30–10:45	Marchitelli et al.: A preliminary analysis of the palaeoherpetofauna from Bone Cave, Pleistocene of Botswana
10:45–11:00	Minniti et al.: Reconstructing the Life and Death of <i>Palaeoloxodon ex gr. falconeri</i> : New evidence from the historical Accordi & Colacicchi Collection
11:00–11:30	<i>Coffee break</i>
11:30–12:30	S5: Crossing Continents (chairs: Beatrice Azzarà & Elpiniki Maria Parparousi)
11:30–11:45	Parparousi et al.: New perspectives on Dama-like deer from the latest Early Pleistocene: taxonomy, biochronology, and dispersal dynamics
11:45–12:00	Rössner: The rise and fall of Miocene tragulids: recent advances in paleobiology
12:00–12:15	Siarabi et al.: Suid dispersals into the Vallès-Penedès Basin around the Aragonian/Vallesian transition
12:15–12:30	Sorbelli & Bibi: The rise and fall of the Old-World savanna paleobiome through tragopithecine bovids
12:30–13:00	S19: Vertebrate ichnology, quo vadis? (chair: Diego Castanera & Christian Meyer)
12:30–12:45	Buchwitz et al.: Approaches to trackmaker evolution

12:45–13:00	Dal Sasso et al.: First record of dinosaur footprints in Lombardy (Italy): the exceptionally rich Stelvio megatracksite (Late Triassic, Austroalpine Domain)
13:00–13:45	<i>Lunch break</i>
13:45–15:15	S19: Vertebrate ichnology, quo vadis? (chairs: Michael Buchwiz & Lara Sciscio)
13:45–14:00	Meyer et al.: The vertebrate track record of the Norian Dolomia Principale/Hautp'dolomit of Italy and Switzerland
14:00–14:15	Castanera et al.: New dinosaur tracks in the Late Jurassic Cañadón Calcáreo Formation (Argentina): the first evidence of <i>Deltapodus</i>
14:15–14:30	Etzler et al.: Decoding the Late Cretaceous Austroalpine palaeoenvironment: Evidence from vertebrate coprolites at Muthmannsdorf
14:30–14:45	Krapovickas et al.: Integrative ichnological reconstruction of Miocene paleoecosystems in the Vinchina Basin, Northwestern Argentina
14:45–15:00	Belvedere et al.: Introducing the Central Mediolateral Line: quantification of sauropod footpad complexity
15:00–15:15	Sciscio & Marques: Morphology, preservation and machine learning in vertebrate ichnology
15:15–15:45	<i>Coffee break</i>
15:45–17:15	S1: Advanced techniques (chairs: Elena Ghezzi & Joachim Haug)
15:45–16:00	Hörnig et al.: Challenges in imaging of insect amber inclusions
16:00–16:15	Clarke et al.: A new ornithomimid dinosaur species and theropod-rich egg assemblage from the mid-Cretaceous of Aphaedo, Korea
16:15–16:30	Jung et al.: More than a pattern - chorionic microstructure of insect eggs in Eocene amber
16:30–16:45	Trotolo et al.: Cracking the enigma: ancient proteins reveal the identity of Early Pliocene fossil eggshells from Lanzarote
16:45–17:00	Rocchi et al.: Detailed neuroanatomy at the base of the crocodylian radiation provides new perspectives into the paleoecology of European eusuchians of the latest Cretaceous
17:00–17:15	Zazzeri et al.: Diving capacities of an extinct marine turtle: comparative study on bony elements of <i>Psephophorus polygonus</i> with finite elements analysis and biological implications.
17:15–17:30	Gobbo et al.: The first detailed description of the rostral neurovascular system in a sauropod dinosaur: paleobiological implications and reconstruction of perioral soft tissues
17:30–19:30	Poster session

Tuesday, 21 July 2026

Room: Aula Magna

08:45–09:45	Keynote: Valentina Rossi: In the Darkness Bind Them: Deciphering Melanin Molecular Taphonomy
09:45–10:45	S1: Advanced techniques (chairs: Elena Ghezzi & Joachim Haug)
09:45–10:00	Schwab et al.: Back to the water - mosaic evolution of the inner ear and cervical spine during the aquatic transition in carnivorans

10:00–10:15	Colledanchise Masella et al.: Weighing a Pleistocene giant: digital body mass estimation in <i>Palaeoloxodon antiquus</i>
10:15–10:30	Alfieri & Veneziano: Unlocking fossil bone archives: advanced visualisation and extraction protocols to study vertebrate trabecular bone
10:30–10:45	Contessi et al.: RTI a new tool for imaging fossil tracks
10:45–11:15	<i>Coffee break</i>
11:15–12:15	S11: From ultrastructure to molecules (chair: Daniel Falk)
11:15–11:30	Bath Enright et al.: Shedding new light on the preservation of the enigmatic hydrozoan medusae from the Grès à Voltzia <i>Lagerstätte</i>
11:30–11:45	Branz et al.: Fungal colonization of plant fossils: implications for preservation and conservation strategies
11:45–12:00	Ianni et al.: The oldest fossil insect from Italy: description and comparative study of a spiloblattnid hind wing from the Carboniferous of southwestern Sardinia
12:00–12:15	Maruca et al.: Characterization of Mediterranean coralligenous bioconstructions by lipid biomarkers: sources and implications
12:15–13:30	<i>Lunch break</i>
13:30–14:30	S11: From ultrastructure to molecules (chair: Orla Bath Enright)
13:30–13:45	Mehta et al.: Ancient chitin in 1.0 billion-year-old protist reveals the organic scaffold for skeletal biomineralization
13:45–14:00	Palmer et al.: Microbial controls on pine needle preservation across redox conditions
14:00–14:15	Rossi et al.: Understanding the frontier of molecular preservation of melanin in deep time using novel high pressure-temperature experiments
14:15–14:30	Böhmer et al.: Covariation in the craniomandibular system of seals
14:30–15:00	S6: Exceptional soft tissue (chair: Christine Böhmer)
14:30–14:45	Falk et al.: Ecological implications of soft tissues in anurans and fish from the Eocene Geiseltal <i>Konservat-Lagerstätte</i>
14:45–15:00	Fröbisch et al.: Exceptional soft tissue preservation from the terrestrial early Permian of the Thuringian Forest, central Germany
15:00–15:30	<i>Coffee break</i>
15:30–17:00	S6: Exceptional soft tissue preservation in fossils (chair: Christine Böhmer)
15:30–15:45	Hu et al.: First paleohistology study of the regeneration tail in an early-branching sauropterygian (Reptilia: Neodiapsida)
15:45–16:00	Klug & Fuchs: Exceptional preservation of Mesozoic cephalopods as important sources of palaeobiological information
16:00–16:15	Magnani & Ragni: A new specimen of <i>Lariosaurus</i> with skin preserved from the Middle Triassic of Monte San Giorgio
16:15–16:30	Muscioni et al.: Functional significance of the hadrosaur beak: a micro-ct study of <i>Tethyshadros insularis</i>
16:30–16:45	Schmitz et al.: Reconstructing sensory ecology in Temnospondyli: Insights from the osteological correlates of eyes and lateral lines

17:00–17:30	Ismene Seeberg-Elverfeldt: DFG national and international projects
17:30–19:30	Poster session: 17:30-19:30
20:00–22:00	Museum of Nature South Tyrol (outreach talk in Italian language): Federico Fanti: Dinosauri ai raggi X: le nuove frontiere della paleontologia

Room: C2.01

09:45–10:45	S16: Resilience and turnover (Chairs. William Foster & Elke Schneebeli-Hermann)
09:45–10:00	Pauly et al.: Sea urchins from the Chesterian regional stage (Visean/Serpukhovian) of the USA illuminate the late Mississippian decline in echinoid diversity
10:00–10:15	De Baets et al.: Palaeoparasitological potential of Permian-Triassic vertebrate coprolites
10:15–10:30	Della Giustina & Fischer: Abiotic drivers of cranial functional disparity in Mesozoic marine reptiles
10:30–10:45	Le Pallec et al.: Preliminary insights into the Carnian palynology of the Dolomites (Northwestern Tethys)
10:45–11:15	<i>Coffee break</i>
11:15–12:30	S16: Resilience and turnover (chairs: Herwig Prinoth & Silvia Danise)
11:15–11:30	Doubrawa et al.: Environmental evolution of the U.S. Atlantic Coastal Plain from the late Paleocene into the Paleocene-Eocene Thermal Maximum (PETM)
11:30–11:45	Sanfilippo et al.: Serpulid bioconstructions as proxies of pre-evaporitic stress: insights from the Upper Miocene of SE Sicily
11:45–12:00	Gebhardt et al.: Paleoecological changes based on micro- and nannofossil assemblages during the Badenian-Sarmatian transition in the eastern Vienna Basin
12:00–12:15	Delfino et al.: Resilience and turnover of the reptiles in the Aldabra Atoll (Seychelles)
12:15–12:30	Melis et al.: Environmental and anthropogenic controls on benthic foraminifera: a comparison between living assemblages and historical records from a northern Adriatic Lagoon (Italy)
12:30–13:15	<i>Lunch break</i>
13:15–15:00	S14: Plants and biodiversity under pressure in a changing climate (chair Camilla Wellstein)
13:15–13:30	Foggetti et al.: On the southern margin of the Central Pangaea Mountains: Integrated macrofossil and palynological insights from Iano (Tuscany) across the Late Carboniferous–Early Permian
13:30–13:45	Forapponova et al.: Earliest and new <i>Willsiostrobus</i> with in situ pollen from the Early Triassic of Tunguska Basin, Siberia
13:45–14:00	Giehl et al.: A diverse Carnian (Late Triassic) flora from Monte Pora (Southern Alps, Italy): systematics, paleoecology, and implications for vegetation dynamics during the Carnian Pluvial Episode
14:00–14:15	Kustatscher et al.: Terrestrial floras during the Carnian Pluvial Episode in the Northern Calcareous Alps (NW Tethys)
14:15–14:30	Kunzmann et al.: Fossil <i>Magnolia</i> (Magnoliaceae) from Paleogene subtropical evergreen broadleaved assemblages in central Germany and its paleobiogeographic implications
14:30–14:45	Teichert et al.: Decoupling long-term climate forcing and event-scale disturbance in coralline algae skeletal archives

14:45–15:00	Konrad & Roth-Nebelsick: Paleoecological context as a basis for CO ₂ reconstruction from fossil plants
15:00–15:30	<i>Coffee break</i>
15:30–17:00	S15: Reading the past through palynology (chair: Ivan R Barreiro & Emanuele Ruiu)
15:15–15:45	Nowak et al. (invited talk): The origin of dinoflagellates and the biological affinities of acritarchs
15:45–16:00	Barreiro et al.: The Cisuralian of the Southern Alps: A supervolcano complex key for Permian palynostratigraphy
16:00–16:15	Delfosse-Allain et al.: The invertebrate Paleozoic–Mesozoic fossil record of pre-angiosperm palynivory
16:15–16:30	Schneebeil-Hermann et al.: Palynology of the Siles Section, Jaén, Andalusia, Spain
16:30–16:45	Ruiu et al.: Palynological insights from a Dinosaur <i>Fossil-Lagerstätte</i> (Villaggio del Pescatore, Northeastern Italy)
16:45–17:00	Borgognone et al.: Pollen record of the Last Interglacial Complex from Valle di Castiglione Paleolake (Central Italy): Vegetation Dynamics and Climate Variability

Room: C2.06

09:45–10:45	S17: Student session (chairs: Alessandro P. Carniti & Gianmarco Minniti)
09:45–10:00	Messina et al. (invited talk): Paleoart strategies for communication: an interactive installation from the Paleontological Museum of the University of Calabria
10:15–10:30	Baglioni & Braga: Investigating misconceptions in paleontology for education and science communication: design and preliminary results of the PaleoConcept questionnaire
10:30–10:45	Quarto et al.: Rediscovery of invertebrate fossils from Italian geological expeditions of 19th and 20th centuries in the Earth Sciences Museum in Bari
10:45–11:15	<i>Coffee break</i>
11:15–12:15	S17: Student session (chairs: Alessandro P. Carniti & Gianmarco Minniti)
11:15–11:30	Gerbe et al.: Reinvestigation of an assemblage of phosphatised Ordovician arthropodans from Öland island, Sweden
11:30–11:45	Mueller et al.: Life on the edge of a supervolcano: study of lower Permian bioturbations at Sesto
11:45–12:00	Seidl et al.: Light availability controls multi-decadal trends in crustose coralline algal cell elongation
12:00–12:15	De Leo et al.: Not what they eat, but where they live: habitat, not diet, drives cranial evolution in living and fossil odd-toed ungulates (Perissodactyla)
12:15–13:30	<i>Lunch break</i>
13:30–14:45	S17: Student session (chairs: Fabio Franceschi & Riccardo Rocchi)
13:30–13:45	Serena De Maria et al.: Unusual guests at the Antena Banquet: hidden theropod diversity in the Huincul Formation
13:45–14:00	Gigante et al.: Triceratops and Torosaurus synonymy and possible implications for ceratopsian systematics

14:00–14:15	Zanirato et al.: A forgotten giant: anatomy, taphonomy, and history of a <i>Temnodontosaurus platyodon</i> Skull from Dorset housed in Padua, Italy
14:15–14:30	Gottardo et al.: Craniocervical biomechanics of <i>Ouranosaurus nigeriensis</i> (Dinosauria: Ornithopoda): a virtual approach
14:30–14:45	Berto et al.: New sauropod and theropod specimens from the Turonian Portezuelo Formation (southern Neuquén Basin, Patagonia, Argentina) and their phylogenetic implications on the Late Cretaceous clades Titanosauria and Megaraptora
14:45–15:15	Coffee break
15:30–17:00	Other topics (chair: Joshua Gauweiler)
15:30–15:45	Audo & Pavia: The Late Miocene Accipitridae (Aves, Accipitriformes) from the Gargano Terre Rosse, southern Italy
15:45–16:00	Nobile et al.: A local peregrine: a second record of <i>Squalodon peregrinus</i> Dal Piaz, 1971 from the Colle della Croce quarry (northeastern, Italy), and morphofunctional considerations on the <i>Squalodon</i> species from the Venetian-Friulian Basin
16:00–16:15	Orcutt: Sexual Dimorphism in German Palaeogale
16:15–16:30	Rotatori et al.: Island of ‘Dragons’: diversity of iguanodontian dinosaurs from the Lower Cretaceous Wealden Group of the Isle of Wight
16:30–16:45	Segurado Broquetas et al.: Preliminary study of the ungulate remains (Artiodactyla and Perissodactyla) from the Eocene of Mallorca (Balearic Islands, Western Mediterranean)
16:45–17:00	De Sario et al.: Resizing the predators: estimation of body mass and in-vivo reconstruction of two Sphenacodontidae family members

Wednesday, 22 July 2026

Room: Aula Magna

08:45–09:45	Keynote: Derek Briggs: Opening and closing taphonomic windows
09:45–10:45	S10: Fossil-Lagerstätten (chair: Evelyn Kustatscher)
09:45–10:00	Fu et al.: Taphonomic insights into Burgess Shale-type preservation: Evidence from the Cambrian Qingjiang Lagerstätte
10:00–10:15	Izzo et al.: Chinese Radiodonts in Canada? The Early Cambrian Mural Formation and the first giant predatory arthropods of North America
10:15–10:30	Kerp et al.: Preservation in the Rhynie chert – An Early Devonian hot-spring ecosystem frozen in time
10:30–10:45	Franke et al.: Indirect evidence for predation on crinoids from the Lower Devonian Hunsrück Slate, Germany
10:45–11:15	Coffee break
11:15–12:15	S10: Fossil-Lagerstätten (chair: Mike Reich)
11:15–11:30	Bel Haouz et al.: A highly diverse Asterozoan ichnofauna from the Famennian Aoufilal Lagerstätte of the eastern Anti-Atlas of Morocco
11:30–11:45	Lagnaoui et al.: A remarkable arthropod resting trace fossil from the Famennian Aoufilal Lagerstätte in the eastern Anti-Atlas (Morocco)

11:45–12:00	Mussini & Butterfield: Exceptionally preserved biotas from North Dakota reveal cryptic Ordovician shelf ecologies
12:00–12:15	Chellouche et al.: The Piesberg in Osnabrück (NW Germany) – a window of exceptional preservation into the Pennsylvanian (upper Moscovian, Westphalian D) biodiversity of palustrine and lacustrine palaeoenvironments
12:15–13:30	<i>Lunch break</i>
13:30–15:00	S10: Fossil-Lagerstätten (chair: Giuseppe Marramà)
13:30–13:45	Reitner: Taphonomy of microbial structures within alpine Triassic Black Shales
13:45–14:00	Tintori et al.: Late Triassic ichthyofaunas from the Alps: state-of-the-arts
14:00–14:15	Franceschi et al.: Unraveling the exceptional preservation of the Sinemurian (Jurassic) Osteno <i>Konservat-Lagerstätte</i> (Como, NW Italy).
14:15–14:30	Linhart et al.: Snakefly larvae of the Cretaceous – past development was more gradually than nowadays
14:30–14:45	Fanti et al.: Monsoon-driven genesis of a Cretaceous dinosaur <i>Lagerstätte</i>
14:45–15:00	Wings et al.: New volcanic lake <i>Fossil-Lagerstätten</i> from the Late Cretaceous of Northern Cape, South Africa
15:00–15:30	<i>Coffee break</i>
15:30–17:30	S10: Fossil-Lagerstätten (chair: Joachim Reitner)
15:30–15:45	Wedmann et al.: Paleogene hymenopteran insects: diversity and interactions with flowers
15:45–16:00	Benites Palomino et al.: Shark feeding traces on Eocene archaeocetes from the Pisco Basin <i>Lagerstätten</i> (Peru)
16:00–16:15	Reich et al.: The world's first molpadid holothurian body fossil (Echinodermata) – discovered at the Miocene Meljski hrib <i>Konservat-Lagerstätte</i> in Slovenia
16:15–16:30	Ferretti et al.: Born in calcium, preserved in iron: microbial pathways to skeletal fossilization
16:30–16:45	Assemat et al.: 40 years of conservation in the Southern Alps (South-East France): Progress, feedbacks, and prospects.
16:45–17:00	Zippel: New finds of wood-associated beetle larvae
18:00–21:00	PaleoPizza Night

Room: D1.01

09:45–10:45	S8: Fossil fishes (chair Iris Feichtinger)
09:45–10:15	Schwarzahns & Carnevale (invited talk): 66 million years of evolutionary interactions in teleost fishes
10:15–10:30	Calzoni et al.: The Chiavon <i>Lagerstätten</i> (Vicenza, N Italy): A forgotten tropical ichthyofauna of the Veneto Region
10:30–10:45	Ridolfi et al.: The first fossil tube-eye fish (Teleostei, Stylephoriformes)
10:45–11:15	<i>Coffee break</i>
11:15–12:15	S8: Fossil fishes (chair: Werner Schwarzahns)

11:15–11:30	Cawley: The fishes of St. Margarethen: an overview of the biodiversity of fishes from a Middle Miocene marine ecosystem
11:30–11:45	von Ehr et al.: Micro-CT assisted osteological analysis of the extant dwarf goby <i>Corcyrogobius</i> Miller 1972 (Teleostei: Percomorpha)
11:45–12:00	Carnevale et al.: A new marine otophysan fish (Teleostei: Ostariophysi) from the Eocene of Bolca, Italy
12:00–12:15	Bradić-Milinović & Schwarzahns: Fish evolution in the Serbian Lake System during from the late Early Miocene to the Sarmatian
12:15–13:30	<i>Lunch break</i>
13:30–15:00	S8: Fossil fishes (chair: Giorgio Carnevale)
13:30–13:45	Norton et al.: The fossil record of armoured catfishes (Callichthyidae).
13:45–14:00	Yang et al.: The origin and early evolution of endemic snow carp (Cyprinidae, Schizothoracinae) in the Qinghai-Tibet Plateau
14:00–14:15	Wu et al.: Palaeoichthyological Discoveries in the Tethyan Himalaya Region of the Mesozoic era
14:15–14:30	Conedera et al.: Late Ladinian (Middle Triassic) Alpine ichthyofaunas compared
14:30–14:45	Giles & Fasey: Revisiting parasemionotid (Actinopterygii) anatomy and relationships using X-ray CT and synchrotron tomography
14:45–15:00	Giritzer & Kriwet: First Campanian record of gars (Neopterygii, Lepisosteiformes) from the Late Cretaceous of Austria
15:00–15:30	<i>Coffee break</i>
15:30–17:00	S8: Fossil fishes (chair: Iris Feichtinger)
15:30–16:00	Villalobos-Segura et al. (invited talk): Sharks, rays and skates in deep time: phylogeny, divergence times and rates of morphological evolution in crown elasmobranchs
16:00–16:15	McCormack et al.: Deep-sea Megalodon teeth provide clues regarding the extinction of the gigantic shark
16:15–16:30	Marramà et al.: The oldest Neogene vertebrate assemblage of the Pisco Basin, Peru
16:30–16:45	Amalfitano et al.: Neighbors but strangers: late Paleocene-early Eocene chondrichthyan assemblages from northeastern Italy
16:45–17:00	Fischer et al.: The fossil shark egg capsule <i>Fayolia</i> and the curious case of <i>Fayolia bohémica</i> from the Pennsylvanian of Nýřany, western Czech Republic
17:00–17:30	PalGes Society Meeting
18:00–21:00	PaleoPizza Night

Room: D1.02

09:45–10:45	S4: Conservation Paleobiology (chair: Lukas Schweigl)
09:45–10:00	Reddin et al. (invited talk): A 'control-treatment' approach can unite neo- and paleo-biology to reveal how marine life responds to global warming

10:15–10:30	Kocáková et al.: Extinction mechanisms of sharks and rays: The role of age and geographic range across 145 million years of evolutionary history
10:30–10:45	Danise et al.: Molluscan biodiversity in the Mediterranean Sea during the Last Interglacial
10:45–11:15	<i>Coffee break</i>
11:15–12:15	S4: Conservation Paleobiology (chair: Kristína Kocáková)
11:30–11:45	Bachmann et al.: The fragmentary fossil record of echinoderms: reconstructing Holocene communities based on isolated elements
11:45–12:00	Nawrot et al.: Temporal resolution of deep-sea invertebrate and otolith death assemblages from the southern Adriatic Sea
12:00–12:15	Schweigl et al.: Holocene turnover of molluscan communities in the northeastern Adriatic Sea in response to post-glacial sea-level changes
12:15–13:30	<i>Lunch break</i>
13:30–15:00	S4: Conservation Paleobiology (chair: Bettina Bachmann)
13:30–13:45	Scarponi et al.: When high live-dead agreement reflects sedimentary memory loss: molluscan assemblages along an acidification gradient off Panarea, Italy
13:45–14:00	Altieri et al.: Spatial variability of benthic foraminiferal assemblages along a coast–offshore gradient: insights from the Gulf of Tigullio (NW Mediterranean Sea)
14:00–14:15	Bracchi & Basso: Bioconstructions in Conservation Paleobiology near-time perspective
14:15–14:30	Mulè et al.: Preliminary report on dental calculus analyses in mammutid and gomphothere teeth from the Italian Pliocene
14:30–14:45	Haug: Quantitative morphology provides a diversity measure that is sensitive where taxonomic measures are not
14:45–15:00	Fontana et al.: A palaeoecological approach to inform nature conservation in alpine areas
15:00–15:30	<i>Coffee break</i>
15:30–17:00	S2: AI in paleontology (chairs: Andrea Baucon & Alessandro Carniti)
15:30–16:00	Hu & Yasuhara (invited talk): From static labels to dynamic retrieval for taxonomy: introducing the Ostracod Foundation Model
16:00–16:15	Carniti et al.: Application of Large Language Models to palaeontological taxonomy: test cases with palynomorphs and brachiopods
16:15–16:30	Schuessler & Neubauer: A framework for species delimitation in fossil gastropods using machine learning
16:30–16:45	Dirnberger et al.: Exploring hamster diversification and diversity with Bayesian and deep learning approaches
16:45–17:00	Baucon et al.: Ecosystem dynamics in the Permian Bolzano caldera (Italy): an integrated ichnological and artificial intelligence approach
17:00–17:30	SPI Society Meeting
18:00–21:00	PaleoPizza Night

Thursday, 23 July 2026

Room: Aula Magna

08:45–09:45	Keynote: Nikolay Oskolkov: aDNA as a tool for paleoecology
09:45–10:45	S9: Fossil mollusks (chairs: Alexander Nützel)
09:45–10:15	Suarez & Hautmann (invited talk): Non-random extinction restructured the bivalve tree of life during the end-Permian mass extinction: evidence from taxonomic distinctness
10:15–10:30	Coan et al.: The d'Orbignys and their molluscs
10:30–10:45	Nützel et al.: On the biota and facies of the Late Triassic Heiligkreuz Formation at its type locality (Heiligkreuz, Santa Croce, N Italy)
10:45–11:15	<i>Coffee break</i>
11:15–12:30	S9: Fossil mollusks (chairs: Gabriela Suarez Perez)
11:15–11:30	Klug et al.: Cephalopod body size in deep time
11:30–11:45	Hausmann et al.: Detailed examination of bicuspid hooks in <i>Hoploscaprites</i> cf. <i>nebrascensis</i> using μ CT and neutron tomography
11:45–12:00	Pohle et al.: The missing F: Form, formation and function of cephalopod cameral deposits
12:00–12:15	Schulbert & Korte: Carbon and Oxygen isotope trends of Upper Toarcian to Lower Aalenian belemnite rostra from the Mistelgau clay pit, Franconia, Germany
12:15–12:30	Chiari et al.: A first insight into Mid-Piacenzian Warm Period seasonality: Clumped isotope analysis of bivalve shells
12:30–13:30	<i>Lunch break</i>
13:30–14:30	Round table discussion: Future of Paleontology
14:30–15:30	Closing Ceremony with award ceremony

Room: D1.01

09:45–10:45	S8: Fossil fishes (chair: Werner Schwarzhans)
09:45–10:00	Grabensteiner et al.: Palaeobiogeography of Early Cretaceous hybodontiform chondrichthyans during the breakup of Pangaea
10:00–10:15	Stumpf et al.: Revisiting a classic: The visceral skeleton of the Early Jurassic chondrichthyan <i>Hybodus hauffianus</i>
10:15–10:30	El Fassi El Fehri et al.: A transoceanic ray-finned fish reveals a high diversity of macropredatory vertebrates in the latest Devonian
10:30–10:45	Sánchez-Villagra et al.: Unsuspected diversity and ghost lineages in the fossil record of Cenozoic neotropical fishes
10:45–11:15	<i>Coffee break</i>
11:15–12:45	Workshop CRITIS

12:45–13:30 *Lunch break*

Room: D1.02

09:45–10:45 **S7: Faunal Responses to Late Pleistocene Climate Change in Europe**

09:45–10:00 **Indelicato et al.:** The "Alpine cave bear period" in Northern Italy: morphometric and morphodynamic analyses paint the most complete evolutionary picture available.

10:00–10:15 **Loddi et al.:** Maximizing the data of dental microwear analysis in fossil carnivores: the giant wolf *Canis lupus maximus* from Jaurens cave (Late Pleistocene, France)

10:15–10:30 **Nagel et al.:** "Exotic" mammals as climate marker in the Late Pleistocene

10:30–10:45 **Pacher:** Audited evidence of cave bear and additional faunal elements in the Alpine region

10:45–11:15 *Coffee break*

11:15–12:30 **S7: Faunal Responses to Late Pleistocene Climate Change in Europe**

11:15–11:30 **Sabol et al.:** Man and bears - preliminary results from fossil bear research at the palaeolithic sites of Čertova pec Cave and Velká ružínska jaskyňa Cave.

11:30–11:45 **van Heteren & Villalba de Alvarado:** Functional morphology of Pleistocene and Holocene brown bears (*Ursus arctos*): a 3D geometric morphometric approach to masseter biomechanics and evolutionary ecology

11:45–12:00 **Villaluenga et al.:** Cave bears and humans, inhabitants of the Western Pyrenees caves

12:00–12:15 **Vincenzi et al.:** Palaeoecological insights into the giant deer (*Megaloceros giganteus*): the Italian Peninsula as a glacial refuge

12:15–12:45 **Lunch break**

Poster

S1

- Bindellini et al.:** Integrated methods for the preparation, conservation and interpretation of new ichthyosaurian remains from the Saltrio Formation (Early Jurassic, Southern Alps, Lombardy)
- Della Giustina & Fischer:** Derivative landmarking corroborates convergence in Mesozoic marine reptile skulls and their feeding performance
- Dieminger & Böhmer:** Regionalization in the flipper of Cetacea
- Dworczak et al.:** New research opportunities for stromatoporoid studies using fluorescence microscopy
- Ghezzo et al.:** Broken but not defeated: CT evidence for survival after juvenile forelimb trauma in a cave lion from Kanegra
- Giuliani et al.:** A complete skull and mandible of an anhanguerid pterosaur from the Araripe Basin: morphological and photogrammetric analysis
- Heischmann et al.:** Preservation and diagenesis of horseshoe crab fossils in different depositional environments
- Jung et al.:** A fossil a day keeps the doctor away – what other disciplines can learn from paleontology
- Nobile et al.:** Taphonomy of marine mammal remains from the Lower Miocene deposits of the Colle della Croce quarry (Feltre, Veneto, Italy)
- Pagliuzzi et al.:** Pleistocene fish remains from the Aalat Formation, Dandiero Basin, Eritrean Danakil Depression
- Rocchi et al.:** Recurrent pedal paleopathologies affecting small bipedal herbivorous dinosaurs provide novel insights into the evolution of ornithopod locomotion
- Weidtke et al.:** Digitization of Fossils at the SNHM in Brunswick, Germany as part of the project DigiVerS

S2

- Baucon et al.:** Were the Snorks real? Ichnological evidence for snorkel-bearing bilaterians from the Cambrian Explosion (Sardinia, Series 2)
- Camanni et al.:** Digitizing Avian Osteology: A 3D reference collection to support AI-based bone identification
- Di Franco et al.:** From collections to computation: building structured paleontological datasets for AI-ready workflows

S3

- Conedera et al.:** The fossils of the Crystalline Basement from Agordo (Belluno Dolomites): a challenging opportunity for interdisciplinary research on the Paleozoic of the Southern Alps
- Dimitrijevic et al.:** BIOFORCE: Biological Forcing of Earth System Evolution
- McCormack:** Reconstructing marine vertebrate dietary ecology through time using zinc isotopes

S4

- Deines et al.:** A window into the past: Arthropod diversity preserved in Colombian copal
- Maruca et al.:** Quantitative mapping of coralligenous bioconstructions: a case study from the Lamezia Terme CARG sheet
- Sanhueza et al.:** Comparison of mollusc living-dead assemblages: a case study from the northern Tyrrhenian Sea

S5

Camanni et al.: A diverse avifauna from the Pleistocene of Botswana – Bone Cave

Iannucci et al.: Revising Bethlehem suids and implications for chronology and paleobiogeography

Pfaff et al.: Something new, something old – ‘Martes’ efferens spec. nov. (Carnivora, Mammalia) from the late Middle Miocene (MN 7/8) of Gratkorn (Styria, Austria)

S7

Mongiovì et al.: Life of a dwarf giant: preliminary results on dental analysis of the Sicilian dwarf hippo *Hippopotamus pentlandi*

Villaluenga et al.: Bears and humans: an approach to the interactions between cave inhabitants through ichnology

S8

Amadori et al.: *Ostenoselache stenosoma* revisited: Key Morphological Traits of the Enigmatic “Eel-like” Shark from the Early Jurassic of Osteno, Italy

Feichtinger et al.: Facing the truth- the sample size matters! Contrasting responses of bony and cartilaginous fishes to the end-Cretaceous extinction event

Perlini et al.: An embryonic tooth of a Great White Shark (*Carcharodon carcharias*) from Pliocene deposits of Orciano Pisano, Italy

Reichenberg et al.: Elasmobranch diversity across a newly identified Cretaceous-Paleogene boundary in the Tethyan Realm (Bavaria, Germany)

Bracchi et al.: Study of micro-structures and isotopic signatures of cold-seep-associated bivalve shells from the Arctic Ocean

S9

Conti et al.: Breaking Two Decades of Silence: New Data on Barremian Ammonites from Dysoxic Layers of the Maiolica Fm. (Umbria–Marche Basin, Central Italy)

Cresta: Middle Jurassic ammonites of Monte Nerone (Umbria-Marche Apennines, Italy)

D'Arpa et al.: Ammonite biostratigraphy and paleobiogeographic signals in a condensed Jurassic succession from the Sciacca area (western Sicily, Western Tethys)

Pavia & Pavia: The Lower Jurassic in the Morona-Santiago Province (south-eastern Ecuador)

Vitón & De Baets: Ammonoid ecospace occupation in the upper Sinemurian (Lower Jurassic)

Wieneke: Towards a Complete Phylogeny of the Superfamily Stromboidea

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Caredda & Romano: Anatomic description and taxonomic attribution of an ichthyosaur specimen from the Jurassic deposits of Holzmaden (Germany)

Dreyer et al.: Hymenoptera from Miocene Randeck Maar: A new Cimbicidae and further honey bee records

Franke et al.: Extraordinary high diversity of crinoids and their attachment structures from the Lower Devonian Hunsrück Slate, Germany

Gašparič et al.: Exceptional preservation in a deep-marine setting: The *Konservat-Lagerstätte* of Meljski hrib (Early Miocene, Slovenia)

Hagdorn et al.: Silicified echinoderm ossicles from the upper Ladinian Pelsa-/Vazzoler Lagerstätten of the Agordo Dolomites (Italy, Belluno Province) and their bearing on post-Palaeozoic recovery

Haude et al.: The “king-crinoid” in echinoderm Lagerstätten of the Lower Devonian Talacasto Formation (Argentine Precordillera)

Liu et al.: 3D morphology of the Cambrian bivalved arthropod *Sunella* informs about head segmentation, arthrodization, and arthropodization

S11

Keiling et al.: Decay and preservation potential of the keratose sponge *Lendenfeldia chondrodes* under simulated Lagerstätten conditions

Linhart et al.: The riddle of the 100-million-year-old “beak larva” has been solved

Pasinetti: The palaeobiology of two crown group Cnidarians: *Haootia quadriformis* and *Mamsetia manunis* gen. et sp. nov. from the Ediacaran of Newfoundland, Canada

Voigt et al.: Arrowhead-shaped structures in late Paleozoic sedimentary rocks: Organic or inorganic origin?

S12

Altieri et al.: Benthic foraminiferal assemblages from shallow tropical submarine canyon settings: habitat heterogeneity, sediment remobilization and taphonomic mixing

Arena & Briguglio: Biostratigraphic and biometrical studies of Nummulites in the Rupelian succession of the Tertiary Piedmont Basin (NW Italy)

Briguglio et al.: The new biochronostratigraphic chart of the Paleogene and Neogene with updated larger foraminifera Biozones.

Calner et al.: Major stratigraphic incompleteness in the latest Ordovician and Silurian of the Arbuckle Mountains, Oklahoma, USA – result of deep time climate variability

Consorti et al.: Benthic foraminiferal response to anthropogenic pressure in the Gulf of Trieste: Preliminary insights

Ferretti et al.: Genus-level $\delta^{88}\text{Sr}$ signatures in Late Devonian conodonts from Kowala, Poland

Glioti et al.: Biostratigraphy and paleoenvironmental reconstruction of Neogene Cetacean-bearing deposits in Piedmont (NW Italy): a micropaleontological approach

Kolomaznik & Frenzel: Testing salinity reconstructions based on data from recent Baltic Sea Ostracoda

Leu: When imperfection survives: developmental malformations in an Early Triassic conodont from Kashmir

Lozar et al.: Synsedimentary nannofossil assemblages in laminar gypsum gives a glimpse on the water column structure during the Messinian Salinity Crisis.

Margaritelli et al.: Post-Glacial recolonization of *Globorotalia truncatulinoides* across the Western and Central Mediterranean Sea

Martinello et al.: Preliminary results of the paleontological/stratigraphic study at the “Cava Bergamasca” quarry, in Bevera di Ventimiglia (IM)

Petersen et al.: Reconstructions of monsoonal activity in a deglacial context

Pint et al.: Foraminifers in soil habitats of inland salt meadows in Germany

Zaza et al.: Benthic foraminifera assemblages in the Grotta Lu Lampiune Cave (Adriatic coast of Apulia, southern Italy): environmental significance

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Giovanelli et al.: Why Unsupervised Vision Transformers outperform Supervised Models in trace fossil recognition?

Macaluso et al.: Disarticulating *Salamandra*: limits and potential of isolated bones of the three Italian species of “true salamanders”

Moreau et al.: Morphological osteoderms variation in extant and extinct *Pseudopus* (Reptilia, Squamata, Anguillidae)

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- Barreiro et al.: *Lueckisporites virkkiae*: chronostratigraphical and palaeogeographical distribution of a key Permian pollen
- Branz et al.: The Neuwelt (Switzerland) plant fossil assemblage reveals insights into Carnian subtropical vegetation
- Da Conceição et al.: Permian petrified forests from the Parnaíba basin: stem anatomy and insights into responses to environmental changes in Pangea
- Foggetti et al.: Is *Acitheca isomorpha* De Stefani a younger synonym of *Acitheca polymorpha*?
- Kustatscher et al.: The plant fossils from the Middle Triassic (Ladinian) *Fossil-Lagerstätte* of Pelsa/Vazzoler (Dolomites)
- Perednis et al.: The Carnian ginkgophytes of Neuwelt (Switzerland)
- Tavilla & Wellstein: Ecological niche modelling of *Fagus sylvatica* L. in Italy at the Last Glacial Maximum: climatic potential and microrefugial landscapes

S15

- Buratti et al.: Thermal maturity assessment using a Machine-Learning workflow: automated Palynomorph Darkness Index (PDI) determination
- Mulas et al.: The paleoenvironment of Sardinia between the 6th and 5th millennium BC: preliminary results of palynological analyses

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- Carniti et al.: SST-seasonality recorded in *Gigantoproductus* brachiopod shells from the middle-upper Mississippian of Guizhou, South China
- Pomella et al.: Project presentation: CRITIS - Critical tipping points in the Earth System
- Prinot et al.: The “*Claraia wangi-griesbachii*” problem in the Mazzin Member
- Pulsinelli et al.: Origin and Dispersal of Messapicetiformes and Vomeroziphii (Ziphiidae): A Paleobiogeographic perspective

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- Cornet et al.: Feeding capabilities of thalattosuchians through the lens of biting performance
- Delfosse-Allain et al.: Wing venation intra-specific variability and sexual size dimorphism assessed in the Permian Orthoptera *Thuringoedischia trostheidei* (Insecta)
- Faltoni et al.: Cenomanian-Turonian calcareous nannofossil biostratigraphy of the Mudurnu section (Turkey)
- Gigliotti et al.: Procoelous vertebrae and the effect of different centre of rotation on Range of Motion analyses in sauropod tails from the Late Jurassic of Tendaguru (Tanzania)
- Ittner et al.: Dating the growth hormone gene duplication event in passerine birds
- Izzo et al.: Dive into Deep Time: exploring ancient ecosystems with Virtual Reality
- Koelewijn & Holmes: *Redlichia* needs revision: cranial measurements show substantial overlap between trilobites of the genus *Redlichia*
- Pacelli & Romano: Sex determination of a new specimen of *Keichousaurus hui* (Sauropterygia: Pachypleurosauria)
- Prino et al.: Virtual 3D dataset of temnospondyl pectoral girdles
- Zazzera et al.: The discovery of a new dinosaur tracksite as an opportunity for the regeneration, valorization, and educational development of the peripheral urban district of San Paolo (Bari, Italy) towards a community-based strategy.

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Dojen et al.: Advanced sensor-integrated solutions in paleontological 3D-Prints as a link between paleontological research and museology

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Falk et al.: An ichnology treasure box: Current progress on the trace fossil excavation in the Upper Hornburg Formation (Middle Permian, Germany)

Festi et al.: Triassic steps in the Northern Calcareous Alps: potential new track evidence from the Raibl formation

Granata et al.: Supernumerary digits in fossil footprints: three questions for confident diagnosis

Marchitelli et al.: Burrowing in Langebaanweg: amphisbaenians and snakes from the Early Pliocene of South Africa

other topics

Fabbi et al.: Deep vs. shallow: Corals in pelagic environments. Current understanding and new data from the Umbria–Marche Basin (N-Appennines - Italy)

Franceschi et al.: Vertebrate remains from the Rotzo Formation (Pliensbachian, Trento Platform, NE Italy): a diverse Early Jurassic embayment

Ghezzi: Ontogenetic patterns in large felids: lessons from modern skeletal collections

Isasmendi et al.: The enigmatic mid- to large-bodied ziphodont avetheropod (Dinosauria, Theropoda) from the Lower Cretaceous Iberian Peninsula: New insights into the non-spinosaurid theropod record of Europe

Mathes et al.: Dental morphology of *Glis sackdillingensis* from two Early Pleistocene localities

Matteoni et al.: Anatomy, histology and phylogeny of a new titanosaur from Patagonia: a preliminary integrative study

Messina et al.: New preliminary data on crocodylomorphs and anurans from the early Eocene Lignitifero Formation (SW Sardinia, Italy)

Pauly et al.: Phylogeny and evolution of the Palaechinidae (Echinodermata: Echinoidea)

Velasco & Martinez-Melo: Fossil echinoids from Cuba: a hidden legacy housed at the Academy of Natural Sciences in Philadelphia.

Unlocking fossil bone archives: advanced visualization and extraction protocols to study vertebrate trabecular bone

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Trabecular bone - the lattice of bony struts occupying specific internal skeletal regions - potentially records animals' ecology, e.g. being shaped by biomechanical loads associated with body weight support and locomotion. When preserved in fossilized remains, it represents a unique archive enabling key palaeobiological reconstruction in extinct species and, by extension, the interpretation of ecological diversification and adaptive strategies. Unlocking this archive demands advanced visualization and characterization techniques capable of handling the complexity and fragmentary nature inherent to fossil material. High-resolution imaging techniques, epitomized by computed tomography, have dramatically expanded analytical opportunities while simultaneously exposing significant methodological challenges. Examples are the precise isolation of trabecular bone from surrounding tissues and the removal of fossilization-related infill, including sedimentary and diagenetic material obscuring internal architecture. Semi-automated algorithms offer promising solutions. We review current protocols across proprietary and open-source platforms and present case studies implementing pipelines combining GUI software and coding environments for trabecular bone isolation and virtual cleaning of fossil specimens. These include applications of the *indianaBones* R package (Veneziano et al., 2021), effective across taxonomically disparate groups such as mammals and birds. Theoretical and practical advantages and limitations are critically discussed. While these techniques hold considerable potential for maximizing data extraction and reducing workload, expert supervision remains indispensable given the natural variability of fossil material.

References:

Veneziano A., Cazenave M., Alfieri F., Panetta D., & Marchi D. (2021). Novel strategies for the characterization of cancellous bone morphology: Virtual isolation and analysis. *American Journal of Physical Anthropology*, 175(4), 920-930.

Keywords: Vertebrate, Inner bone microstructure, Micro-computed tomography, Semi-automation, *IndianaBones* R package

Abstract (Oral communication)

Symposium: S4

Spatial variability of benthic foraminiferal assemblages along a coast–offshore gradient: insights from the Gulf of Tigullio (NW Mediterranean Sea)

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Benthic foraminifera are widely recognized as sensitive indicators of environmental variability in coastal and transitional marine systems. This study investigates the spatial variability of foraminiferal assemblages along a coast–offshore gradient in the Gulf of Tigullio (NW Mediterranean Sea, Italy), an area characterized by the interaction between natural sedimentary processes and multiple anthropogenic pressures.

Four sediment cores were collected along a transect ranging from 10 to 40 m water depth and subdivided into vertical intervals to explore both lateral and stratigraphic variability. The analysis focuses on species-level taxonomic composition, abundance patterns, and assemblage structure in relation to environmental gradients.

Preliminary results reveal a clear increase in benthic foraminiferal abundance from nearshore to offshore settings, suggesting a progressive shift in ecological conditions and sedimentary regimes along the transect. Changes in assemblage composition indicate the coexistence of taxa typically associated with shallow carbonate environments and forms linked to more distal or finer-grained conditions. Ongoing analyses aim to refine the vertical distribution patterns within individual cores and to assess potential temporal variations in assemblage structure. The integration of faunal data with sedimentological and environmental constraints will contribute to a better understanding of benthic ecosystem responses in Mediterranean coastal systems. These findings highlight the value of benthic foraminifera as proxies for interpreting spatial environmental gradients and for supporting environmental monitoring in complex transitional marine environments.

Keywords: Foraminifera, Anthropogenic impacts, Diversity

Benthic foraminiferal assemblages from shallow tropical submarine canyon settings: habitat heterogeneity, sediment remobilization and taphonomic mixing

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This study presents a preliminary investigation of benthic foraminiferal assemblages from shallow sectors of three canyon-head settings within a large tropical submarine canyon system. Samples were collected between approximately 53 and 71 m water depth and analysed in the 125 µm fraction, while the coarser fraction is being examined to better characterize the larger benthic component and its environmental significance.

Data from the 125 µm fraction indicate that the assemblages are strongly dominated by benthic foraminifera, with limited planktonic contribution, but show clear compositional differences among samples. Two assemblages are characterized by relatively high proportions of porcellaneous taxa and by abundant autotrophic benthic and other shallow-water forms, including miliolids and taxa such as *Amphistegina*, *Pararotalia*, and *Asterigerina*, indicating a strong influence from adjacent shallow tropical carbonate-producing environments. In contrast, a third sample shows a higher proportion of hyaline taxa and a comparatively more open-marine signature.

The coexistence of taxa associated with shallow tropical carbonate habitats and taxa typical of finer-grained or more distal settings suggests that these assemblages do not represent discrete *in situ* habitats. Instead, they reflect the integration of neighboring benthic environments across canyon-head domains, likely enhanced by sediment remobilization, hydrodynamic reworking, and post-mortem transport. The coarser fraction may provide further evidence of sediment redistribution and help distinguish *in situ* production from lateral input derived from nearby shallow tropical carbonate habitats.

Overall, these preliminary results indicate that shallow tropical submarine canyon-head environments may preserve mixed benthic signals recording both habitat heterogeneity and sediment redistribution, providing integrative records of local processes and broader environmental conditions across the canyon-margin system.

Keywords: Benthic foraminifera, Tropical submarine canyon, Canyon-head environments, Sediment remobilization, Shallow-water carbonate habitats

***Ostenoselache stenosoma* revisited: Key morphological traits of the enigmatic “Eel-like” shark from the Early Jurassic of Osteno, Italy**

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Early Jurassic elasmobranchs provide critical insights into the origin and early diversification of modern shark lineages. Exceptionally preserved fossil skeletons from *Konservat-Lagerstätten* are particularly valuable for resolving morphological disparity and testing phylogenetic hypotheses. Among these, the enigmatic shark *Ostenoselache stenosoma* Duffin, 1998 from the Sinemurian of northern Italy represents one of the most unusual elasmobranch fishes described to date. Despite being known from multiple articulated specimens, its morphology and systematic position have remained poorly understood and largely overlooked. Here we present a preliminary redescription of *Ostenoselache stenosoma* Duffin, 1998 based on the best-preserved material available. We show that this taxon possesses a unique combination of characters, including an elongate, flattened rostrum and a highly modified axial skeleton with no dorsal fins, distinguishing it from all other known neoselachians. These results help to refine the original diagnosis and clarify previously ambiguous morphological features, particularly in the cranial and postcranial skeleton. More broadly, our results further emphasize that rare exceptionally preserved fossils from *Lagerstätten* play a key role in reconstructing the early evolutionary history of elasmobranchs and refining the boundary between stem and crown group. Furthermore, placing this enigmatic taxon within a solid phylogenetic framework will be essential to resolve its systematic position. This study also underscores the importance of revisiting historically described taxa in a more modern perspective and contributes to a growing recognition of an unexpected morphological diversity among Early Jurassic elasmobranchs.

References:

Duffin C.J. (1998). *Ostenoselache stenosoma* n.g. n.sp., a new neoselachian shark from the Sinemurian (Early Jurassic) of Osteno (Lombardy, Italy). *Paleontologia Lombarda*, 9: 3–27.

Keywords: Holomorphic skeletons, Neoselachii, Konservat-Lagerstätten, Sinemurian

Neighbors but strangers: late Paleocene-early Eocene chondrichthyan assemblages from northeastern Italy

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The Spilecco site (Lessini Mountains, Verona) and the Euganei Hills (Padova) represent two poorly known but scientifically significant localities of northeastern Italy yielding chondrichthyan remains from the upper Thanetian–lower Ypresian (~56–54 Ma). Spilecco is situated near the Bolca Fossil-*Lagerstätte*, globally celebrated for its exceptional Eocene fish assemblages, yet its chondrichthyan fauna remains largely understudied and warrants thorough reappraisal. Spilecco is characterized by lowermost Eocene periplatform deposits resedimented in a basinal setting, recording the early initiation of nearby shallow-water carbonate sedimentation, while the Euganei Hills document a nearly coeval pelagic environment represented by hemipelagic Scaglia Rossa facies. This palaeoenvironmental framework provides a unique opportunity to compare chondrichthyan paleodiversity across two distinct yet broadly coeval western Tethyan basinal depositional settings. The chondrichthyan assemblage from Spilecco includes *Ginglymostoma* cf. *serra*, *Hypotodus verticalis*, *Striatolamia macrota*, *Otodus obliquus*, "*Mustelus spileccensis*", *Notorynchus serratissimus*, and possibly additional previously unidentified or misidentified taxa. The Euganean assemblage, by contrast, is dominated by pelagic and deep-water forms, including *Otodus*, *Hexanchus*, *Heptranchias*, *Isurolamna*, and the poorly known chlamydoselachid *Proteothrinax/Rolfodon*. The primary aim of this study is to comprehensively revise both assemblages by applying updated systematic criteria, and to refine their stratigraphic attribution through micropaleontological analysis of available data and newly processed embedding matrix samples. The results will contribute to reconstructing paleodiversity patterns and elucidating faunal relationships across the Paleocene–Eocene Thermal Maximum (PETM) interval within a western Tethyan context.

Keywords: Sharks, PETM, Western Tethys, Paleodiversity

Multiproxy insights into the initial stage of the Oligocene transgression of the central-eastern Tertiary Piedmont Basin (NW Italy)

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This study reconstructs the Oligocene transgression in the central-eastern Tertiary Piedmont Basin (NW Italy) through an integrated lithostratigraphic, paleontological, and Spectral Gamma-Ray (SGR) analysis of four sections of the Molare Formation: Sottovalle, Bric Rive, Lemme, and Bosio.

Larger benthic foraminifera and scleractinian corals provide the main paleoenvironmental and biostratigraphic constraints, assigning the successions to the middle-upper Rupelian and indicating shallow-marine settings within the photic zone. Strontium isotope stratigraphy data supports chronostratigraphic assessments. SGR data, based on K, U, Th, and Th/U ratios, were used to evaluate terrigenous input and redox conditions.

The integrated dataset reveals strong lateral variability over a limited area, consistent with deposition in a tectonically active basin affected by localized fan-delta systems and fluctuating sediment supply. Bric Rive records the most proximal and unstable conditions, interpreted as an inner fan-delta setting characterized by coarse-grained sedimentation, scarce fossil preservation, and only brief phases of coral colonization. Lemme documents the evolution from high-energy delta-influenced conditions to a more stable shallow-marine setting, interpreted as an inactive outer fan-delta. Sottovalle represents a relatively stable outer fan-delta environment, with abundant and diversified fossil assemblages and moderate terrigenous input. Bosio shows a distinct sedimentological and paleoecological signature, including greater lithological heterogeneity, higher SGR values, and more diverse microfaunal assemblages, suggesting deposition in a distal fan-delta system fed by a different fluvial source.

The results demonstrate the value of integrating paleontological proxies with SGR data to resolve paleogeographic organization, sediment-routing patterns, and environmental instability in tectonically influenced shallow-marine systems.

Keywords: Rupelian, Val Lemme, Molare Formation, Paleoenvironment, Fan-delta, Spectral Gamma Ray

Biostratigraphic and biometrical studies of *Nummulites* in the Rupelian succession of the Tertiary Piedmont Basin (NW Italy)

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This study examines the biostratigraphy and biometric variability of Larger Benthic Foraminifera (LBF) in the central-eastern sector of the Tertiary Piedmont Basin in NW Italy.

Paleontological analyses were performed to characterize fossil assemblages and define their stratigraphic distribution. Samples were collected from all investigated sections, treated with hydrogen peroxide to disaggregate the sediment, and wet-sieved through meshes of 2 mm, 500 µm, 250 µm, 125 µm, and 63 µm. The coarser fractions (2 mm, 500 µm, and 250 µm) were analyzed under a custom-made Optech GZ808 optical stereomicroscope to assess the LBF content. Equatorial sections were prepared to support taxonomic identification.

The fossil assemblages are dominated by LBF, particularly by representatives of the genus *Nummulites*. The most abundant species are *Nummulites fichteli*, *N. vascus*, and *N. kecskemetii*. Their known stratigraphic ranges, SBZ21 to SBZ22A for *N. fichteli*, SBZ21 to SBZ22B for *N. vascus*, and SBZ22B to SBZ23 for *N. kecskemetii*, indicate a middle to upper Rupelian (Oligocene) age for the studied sections. To date, no other Oligocene species, such as *N. bouillei* or *N. bormidiensis*, have been reported. Their absence is a key element in both the biostratigraphic interpretation and the refinement of paleoenvironmental reconstructions.

The results reveal marked variations in biometric parameters along the sections, possibly reflecting either shifts in paleoenvironmental conditions or evolutionary changes across successive chronospecies. Several questions remain open, particularly concerning the autoecology of *N. kecskemetii*, which appears to thrive under deeper, oligophotic conditions, and its potential competition with other Oligocene autotrophic foraminifera. Possible competition with *Operculina complanata* should also be considered.

Keywords: Larger Benthic Foraminifera, Biostratigraphy, Biometry, Oligocene, Val Lemme

Abstract (Oral communication)

Symposium: S10

40 years of conservation in the Southern Alps (South East France): Progress, feedbacks, and prospects

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The Haute-Provence national natural Geological Reserve (RNNGHP) was established in 1984 with the aim of protecting, studying, and promoting the region's rich geological heritage. Among the major sites that led to the Reserve's designation are two iconic paleontological sites: the Ammonite Slab gathering thousands of fossiles and the Robine Ichthyosaur displaying the first marine vertebrate discovered in the area. Today, these sites belong to the 18 sites classified as nature reserve in the southern French Alps. Acting like true open-air educational showcases, equipped sites serve both as a tool for public outreach and as a challenge for the *in situ* preservation of these major sites. With 40 years of experience in the protection of the geological and paleontological heritage of this territory, we pursue the development of new equipped sites by leveraging methodological advances and feedbacks from the evolution of previous equipment through time with the goal of promoting this geoheritage while ensuring its long-term sustainability.

We therefore present here the evolution of methods for the protection and development of geoheritage within the RNNGHP, as well as our thoughts on the future of geoconservation in this area.

Keywords: Geoheritage, Conservation, RNNGHP

Abstract (Oral communication)

Symposium: other topics

The Late Miocene Accipitridae (Aves, Accipitriformes) from the Gargano Terre Rosse, southern Italy

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Red soil deposits (Terre Rosse) fill most of the extensive paleokarst network within the Mesozoic limestone on the northwestern slopes of Mount Gargano (Apulia, southern Italy). Several fissure fillings have yielded a highly diverse assemblage of vertebrate fossils dated to the latest Miocene. The rich Terre Rosse fauna includes all classes of terrestrial vertebrates: Amphibia, Reptilia, Aves and Mammalia. However, it is highly unbalanced and exhibits all the characteristics of insular populations. The fossil birds from the so-called *Mikrotia*-Fauna after the most common rodent taxon, have been analyzed in two papers (Ballmann, 1973, 1976), where the author described 16 taxa, almost all of which were new to science and show strong character of endemism. Among the Accipitridae, in his first paper the author described two species of the new genus *Garganoaetus*: *G. freudenthali* and *G. murivorum*, together with two ungual phalanges attributed to an indeterminate vulture. The analysis of new material collected since the Ballmann's papers is still in progress and the preliminary data reveal the presence of at least 15 taxa of various groups, most of them belong to new species yet to be described. The study of the new Accipitridae remains allows to better define the osteology and phylogenetic relationships of the two already described species of *Garganoaetus* and to detect two other taxa new to science and still to be described and preliminary referred to the recent genera *Buteo* and *Circus* respectively. No other vulture remains have been found and their taxonomic affinities remain uncertain.

References:

- Ballmann, P., 1973. Vögel aus dem Neogen der Halbinsel Gargano (Italien). Scripta Geologica 17, 1–75.
- Ballmann, P., 1976. Vögel aus dem Neogen der Halbinsel Gargano (Italien) zweiter teil. Scripta Geologica 38, 1–59.

Keywords: Birds, *Garganoaetus*, Neogene, insular endemics

Middle–Late Miocene Nutrient Cycle changes and their impact on Indian Ocean productivity: Insights from nannoplankton assemblages

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Today, nutrient availability in mid- to low-latitude oceans is modulated by Antarctic Intermediate Water formation within the Antarctic Divergence. Projected climate change scenarios indicate that warming and sea ice retreat may significantly reduce nutrient fluxes into the lower latitudes. To assess nutrient flux changes in a warmer world, we use the Middle–Late Miocene as an analog for near-future climate trajectories. To analyze primary productivity changes over the selected time frame, two Ocean Drilling Program sites (ODP Site 722 and Site 752) in the Indian Ocean were studied using assemblage-based methods (nannofossils, diatoms) within a multi-proxy framework.

At Site 722, an increase in cool, eutrophic nannoplankton taxa (*Coccolithus pelagicus*, *Reticulofenestra pseudumbilicus*) marks the onset of SST cooling at ~13.4 Ma. By ~12 Ma, rare diatom frustules coincide with maxima in *Reticulofenestra haqii* and *R. antarctica*, indicating enhanced upwelling-derived nutrients, yet without coeval high-latitude cooling. By 11 Ma, diatom abundance rises sharply, with blooms of upwelling-sensitive *Thalassionema* spp. and abundant eutrophic nannoplankton (*R. pseudumbilicus*). Parallel increases in $\delta^{15}\text{N}$ (> 6‰) and high C/N ratios confirm high productivity and denitrification.

At Site 752, assemblages document a growing influence of Southern Ocean waters in the mid-latitude eastern Indian Ocean after the Middle Miocene Climate Transition. The nannofossil community shifts toward high-nutrient, cold-water taxa (*C. pelagicus*, *Calcidiscus leptoporus*). By 10.67 Ma, assemblages indicate a return to low-nutrient, warm-water conditions until 9.88 Ma, coincident with Pacific water influx inferred from ϵNd at Sites 752 and 707. High-nutrient, cold-water conditions resume after 9.88 Ma and persist to ~7.34 Ma.

Together, our data reveal dynamic changes in intermediate-water nutrient cycling, paced by high-southern-latitude cooling and associated nutrient trapping in the Antarctic Divergence.

Keywords: Nanoplankton, Nutrient cycling, Cooling, Antarctic Divergence

The fragmentary fossil record of echinoderms: reconstructing Holocene communities based on isolated elements

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We investigated the Holocene record of echinoderm communities from skeletal fragments and ossicles in a sediment core from the Po Delta in the northern Adriatic Sea. This setting provides an ideal archive because it combines a well-constrained stratigraphic framework, a documented history of human impact and existing high-resolution palaeoecological data from mollusks. The latter demonstrated a significant ecosystem regime shift over the past century. We analyzed echinoderm remains across multiple echinoderm classes, ossicle types, grain-size fractions, and depositional settings to assess which skeletal elements are preserved, what their stratigraphic distribution is, and whether they can be used for reconstructing temporal shifts in taxonomic composition and biomass of echinoderm assemblages. As the studied sediment cores offer a relatively continuous temporal record, they help overcome the patchy spatial and temporal distribution that is typical for echinoderm populations. However, interpreting the record requires separating ecological signals from taphonomic and sedimentological controls, an objective achievable by including all fragmented material.

The echinoderm community composition differs significantly between habitats, and first results indicate pronounced variation in relative abundance related to grain size fraction, echinoderm class and ossicle type. Yet these patterns do not straightforwardly mirror trends observed in mollusk assemblages, suggesting that echinoderms provide an independent and potentially complementary perspective on ecosystem change. By comparing different processing and abundance-estimation approaches, we developed a practical framework for using fragmented echinoderm ossicles in paleoecological research. Our data indicate that even highly fragmented remains can provide valuable information on long-term community dynamics, preservation potential and ecological change in soft-bottom marine habitats.

Keywords: Echinoderms, Paleoecology, Holocene, Sediment cores

Abstract (Oral communication)

Symposium: S17

Investigating misconceptions in Paleontology for education and science communication: design and preliminary results of the PaleoConcept questionnaire

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In the context of geoscience education and communication, Paleontology is a discipline with high potential, as it is a historical science based on inference and retrodiction, supporting the development of critical thinking. However, like many scientific disciplines, it is affected by widespread misconceptions, related both to the complexity of key topics such as evolution and geological time, and to their popular media representation. These misconceptions, which often persist at the university level and beyond (Yacobucci, 2018), highlight gaps in earlier stages of formal education and make their identification essential for developing effective strategies in paleontology education and communication across different contexts.

This contribution presents PaleoConcept, a questionnaire designed to investigate common misconceptions in paleontology, currently targeting upper secondary school students. The instrument was developed through a literature review and consultation with experts, following established validation criteria. It was administered in several Italian schools across different regions, involving students from different grades, to analyze differences across educational levels. Preliminary results highlight the persistence of key misconceptions, such as confusion with archaeology or linear evolution, and limited understanding of specific topics such as deep time. Differences were also observed across different grade levels.

PaleoConcept can serve as a tool for designing targeted educational pathways both in secondary schools, using paleontology as a cross-disciplinary subject, and in discipline-specific university courses to identify students' misconceptions. It is also adaptable to non-formal education and science communication contexts, supporting outreach and public engagement activities by actively engaging and challenging audiences.

References:

Yacobucci, M. M. (2018). Confronting prior conceptions in paleontology courses. Cambridge University Press.

Keywords: Paleontology misconceptions, Geosciences education, Communication strategies, Students, Survey questionnaire

Analysis of the endocranial anatomy of the Miocene European crocodylian *Diplocynodon ratelii* with phylogenetic, ecological and ontogenetic implications

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Diplocynodon is typically recovered as one of the earliest diverging taxa within Alligatoroidea. Although its extant relatives today can only be found in the Americas and China, *Diplocynodon* was seemingly endemic to Europe, being the last known alligatoroid taxon to have inhabited the continent. Spanning the late Paleocene to the Middle Miocene, the fossil record comprises several occurrences from all over the continent, with eleven currently recognized species. *Diplocynodon* specimens are typically recovered from freshwater environments; however, remains of one species have been found in a marine setting, potentially indicating a degree of salt tolerance. This would differ from extant alligatoroids and might have been an important factor facilitating the dispersal of early members of the clade. Additionally, some phylogenetic analyses have recently cast doubt on the monophyly of these species and have even suggested that *Diplocynodon* might instead lie outside of crown-group Crocodylia. One possible avenue to address these questions is to evaluate the endocranial anatomy of *Diplocynodon*, which can potentially reveal important ecological information, as well as provide a source of currently neglected anatomical features that can be incorporated into phylogenetic analysis. Here we present new results based on CT scans of two specimens of the type species *D. ratelii*, both from the Miocene of France. The high level of internal preservation has permitted a detailed reconstruction of their endocranial anatomy, comprising almost every main internal cavity of the crocodylian skull. Through detailed description and comparative analysis with closely related eusuchian groups, we provide new insights into the phylogenetic relationships, ecology, and ontogeny of this taxon.

Keywords: Diplocynodon, Alligatoroids, CT Scan, Endocast, Endocranial Anatomy

The Cisuralian of the Southern Alps: A supervolcano complex key for Permian palynostratigraphy

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The lower Permian of the Southern Alps (N Italy) represents one of the largest and best-preserved volcanic successions of the upper Cisuralian in Europe, including the Athesian Volcanic District (AVD), the Collio Basin, and the Orobic Alps. The AVD, in particular, provides an exceptionally high-resolution chronostratigraphic framework based on detailed geological mapping and U–Pb zircon geochronology. Continental sedimentary sequences intercalated within volcanic units were deposited during phases of reduced volcanism, typically in alluvial–lacustrine environments and yield abundant and diverse paleobotanical remains. Palynological assemblages from ten stratigraphic sequences belonging to the Monte Luco, Verano, Guncina, and Tregiovo formations have been studied spanning a middle to upper Kungurian age interval. Two palynozones were differentiated: the *Vittatina* and *Protohaploxypinus* palynozones. Moreover, the comparative analysis of these assemblages allows refinement of the stratigraphic ranges of key Permian palynological taxa, including *Falcisporites stabilis*, *Gigantospores aletoides*, *Jugasporites delasaucei*, *Lueckisporites virkkiae*, *Nuskoisporites dulhuntyi*, *Taeniaesporites noviaulensis*, and *Vestigisporites* spp. The new AVD records of these taxa, traditionally considered typical of younger (Guadalupian to Lopingian) intervals, have implications for their chronostratigraphic ranges, at least within the southeastern Euramerican phytoprovince. These results highlight the value of the AVD as a radiometrically calibrated reference for Cisuralian continental palynostratigraphy and provide a framework for future interbasinal correlations across the Southern Alps.

Keywords: Palynology, Kungurian, Biostratigraphy, Southern Alps

***Lueckisporites virkkiae*: chronostratigraphical and paleogeographical distribution of a key Permian pollen**

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Lueckisporites virkkiae Potonié et Klaus 1954 emend. Clarke 1965 is a distinctive Permian taeniate bisaccate pollen. It is characterized by a smooth corpus, two well-developed sacchi, and two prominent proximal taeniae associated with a monolete-like sulcus. Its botanical affinity, historically linked to several conifers, is consistent with Majonicaceae. Since its original definition, the genus *Lueckisporites* has undergone multiple emendations. While early studies proposed several species and morphotypes, later works emphasised a broad morphological continuum within *L. virkkiae*, leading to the definition of variants and palynodemes (e.g., Clarke, 1965). Recent ultrastructural analyses (Gibson et al., 2020) support the interpretation that this variability reflects intraspecific plasticity, probably driven by hydration–dehydration processes (harmomegathy).

From a chronostratigraphic perspective, *L. virkkiae* has long been regarded as a key taxon for the late Permian, particularly within Euramerican palynoassemblages. However, earlier occurrences in the lower Permian and its debated global synchronicity have led to increasing uncertainty regarding its chronostratigraphic range. A comprehensive revision of the stratigraphic and palaeogeographic distribution of *L. virkkiae* is based on published occurrences across multiple basins and phytogeographic provinces. By critically reassessing taxonomic criteria and integrating updated age constraints, we aim to refine its chronostratigraphic range and evaluate its significance as a potential interregional correlation tool in late Palaeozoic successions.

References:

- Clarke, R.F.A. (1965). British Permian saccate and monosulcate miospores. *Palaeontology*, 8(2): 322-354.
- Gibson, M.E., Taylor, W.A., & Wellman, C.H. (2020). Wall ultrastructure of the Permian pollen grain *Lueckisporites virkkiae* Potonié et Klaus 1954 emend. Clarke 1965: evidence for botanical affinity. *Review of Palaeobotany and Palynology*, 275: 104169.

Keywords: Palynology, Permian, Biostratigraphic marker, Palynostratigraphy

Shedding new light on the preservation of the enigmatic hydrozoan medusae from the Grès à Voltzia Lagerstätte

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The Middle Triassic Grès à Voltzia Lagerstätte represents a rare window into recovery after the P-T mass extinction and is an exceptional archive of soft tissue preservation. *Progonionemus vogesiacus* (Grauvogel & Gall, 1962), a limnomedusae hydrozoan, exhibits the upper limits of fossilization fidelity. Previous work attributed their ultrastructural preservation to rapid microbial growth, resulting in iron oxide enrichment and mineralization via phosphatization; however, this has not been validated using modern analyses. To test this hypothesis, we applied synchrotron-based micro X-ray fluorescence (μ XRF) and SEM-EDX. Our results show that the soft tissues are preserved as aluminosilicate films enriched with trace elements, particularly copper; there is no evidence for phosphatization. Iron oxides appear localized to the gastrovascular cavities pointing to internal microbial processes, specifically sulfate reduction. The recognition of these soft tissues as Cu-enriched aluminosilicate films and potentially mediated by internal microbial processes redefines their taphonomic pathway, offering new insights into soft tissue preservation mechanisms in the Grès à Voltzia biota.

Keywords: Taphonomy, Soft tissue preservation, Lagerstätte, Medusae, Triassic

Ecosystem dynamics in the Permian Bolzano Supervulcano (Italy): an integrated ichnological and artificial intelligence approach

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Volcanic settings host some of the most extreme continental ecosystems on Earth, yet the infaunal paleoecology of caldera lakes and streams remains poorly understood. Here we use the Bolzano Supervulcano, the largest and best-exposed Permian supervulcano of Europe, as a natural laboratory to investigate how life copes with recurrent volcanic disturbance, integrating paleoichnological and sedimentological analysis with artificial intelligence and neoichnology across multiple sites within the paleocaldera and its surroundings.

Three broad ecological patterns emerge. First, infaunal life was structured by transient colonization windows. At Silberhof, straight burrows record substrate exploitation by r-strategic organisms, likely insects, during volcanic stasis, when seasonal streams opened favorable colonization windows. Second, microbial communities thrived where metazoans could not: microbially-induced sedimentary structures (gas domes, wrinkle marks) at Monte Luco and Tregiovo indicate that extreme conditions (e.g., low-oxygen porewater, alkaline settings) suppressed metazoan competition. Third, disturbance acted as a biodiversity-promoting force: the Gocciadoro alluvial fan supports a three-stage succession model in which debris flows generated nutrient-rich habitats colonized by opportunistic deposit feeders, while the absence of K-selected taxa indicates recurrent stress.

Artificial intelligence sharpens these signals: generative AI produced the first visualization of a bioturbated paleoecosystem, and Vision Transformers at Sesto autonomously discriminated bioturbated from non-bioturbated ichnofabrics. Far from being lifeless wastelands, supervolcanic ecosystems emerge as vibrant arenas of ecological innovation — landscapes in which life persisted, adapted, and diversified in the face of recurrent disturbance.

Keywords: Ichnology, Artificial intelligence, Permian, Caldera, Disturbance ecology

Were the Snorks real? Ichnological evidence for snorkel-bearing bilaterians from the Cambrian Explosion (Sardinia, Series 2)

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The Cambrian Explosion arguably represents the most significant episode of body-plan diversification in the history of life. Among its most iconic ichnological signatures are horizontal burrows displaying a longitudinal dorsal furrow — architectural features that have long intrigued paleontologists with respect to both functional morphology and tracemaker affinity. Here we describe a large psammichnitiid burrow from the Cambrian Stage 3 (Series 2) of Sardinia (Italy) that exhibits this general architectural organization and expands the known diversity of snorkel-bearing tracemakers in the early Phanerozoic. The Sardinian burrow is unbranched and horizontal, with a central meniscate fill and a thick marginal wall ornamented by transverse ridges and a longitudinal dorsal furrow.

Palaeontological data and actualistic analogues indicate that the producer was a bilaterian possessing either a hydrostatic or rigid skeleton, and equipped with a dorsal, snorkel-like structure that maintained contact with oxygenated bottom waters. Generative artificial intelligence was employed to develop a visual reconstruction of both the tracemaker body plan and the tracemaking mechanism. Comparison with the holotype of *Psammichnites gigas* reveals a comparable behavioral program, although the Sardinian tracemaker appears to have invested more heavily in burrow-wall reinforcement, exploiting the endobenthic realm for both shelter and feeding while maintaining aerobic respiration.

The shared architecture of *Mattaia*, *Psammichnites*, *Plagiogmus*, *Dictyodora*, and the Sardinian burrow suggests a common lineage of snorkel-bearing tracemakers that flourished from the latest Ediacaran to the Ordovician — a key clade in the early Phanerozoic diversification of bilaterian behaviors and body plans.

Keywords: Ichnology, Cambrian explosion, Psammichnitiids

Abstract (Oral communication)

Symposium: S10

A highly diverse Asterozoan ichnofauna from the Famennian Aoufilal *Lagerstätte* of the eastern Anti-Atlas of Morocco

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The Hangenberg sandstone equivalent of the Famennian Aoufilal *Lagerstätte* of the Eastern Anti-Atlas yielded an exceptional record of asterozoan ichnoassemblages, offering rare insight into the behavior of ancient sea stars after one of the most severe biological crisis (Frasnian-Famennian) and during the Hangenberg event. This study documents a highly diverse assemblage of star sea trace fossils referred to the two known ichnofamilies of the informal Asterichnidii group, which are: Asteriacitidae and Biformitidae. These ichnoassemblages are providing new perspectives on asterozoan paleobiology and paleoethology in the Devonian. Morphometric analysis distinguishes several morphotypes, reflecting variability in trace morphology and tracemaker behavior. While traditionally interpreted as resting traces, these structures reveal a broader behavioral spectrum, including locomotion, feeding and crawling activity across the seafloor, as well as responses to environmental stress. Rather than isolated impressions, this assemblage captures dynamic interactions between organisms and substrate, preserving a continuum of behaviors rarely documented in the fossil record. These findings highlight the ecological complexity of the latest Devonian shallow-marine environments after the Frasnian-Famennian biological crisis and during the Hangenberg Event, thus, they demonstrate how trace fossils can significantly refine our understanding of organism–substrate interactions. The exceptional preservation further indicates episodic sedimentation under well-oxygenated, moderate-energy conditions.

Keywords: Upper Devonian, Asterozoan, Anti-Atlas, Morocco

Introducing the Central Mediolateral Line: quantification of sauropod footpad complexity

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Sauropodomorph footprints provide essential indirect evidence for pedal soft-tissue pads, which were critical adaptations for supporting their immense body mass. Although osteologically digitigrade, sauropods maintained a functionally plantigrade dynamic foot posture through the development of a complex multi-pad system. A recurring transversal feature in sauropodomorph pes tracks, which separates the distal digital pads from the proximal rear area, has been frequently noted in the literature; we formally introduce the term Central Mediolateral Line (CML) to identify it.

Here, we present the result of our observation of seventy tracks from eleven ichnogenera spanning the Late Triassic to the Late Cretaceous, and we introduce two new morphometric parameters to quantify distal-to-proximal foot proportions and standardize descriptions: the PPL/PL and PPL/PW ratios, i.e., the proximal pad length relative to overall pes length and pes width, respectively.

Results demonstrate that the CML occurs in 75% of the analyzed tracks. This prevalence suggests the feature reflects underlying functional anatomy rather than taphonomic artefacts. Statistical analyses indicate that proximal pad length varies significantly among ichnogenera, with *Breviparopus* and *Galinhapodus* displaying the largest relative values. Furthermore, elongate and narrow tracks exhibit proportionally longer proximal pad impressions, suggesting that narrow-footed sauropods relied more heavily on the posterior heel pad for load distribution. These findings establish the Central Mediolateral Line as a potential new diagnostic proxy for ichnotaxonomical identification, offering vital insights into the evolutionary adaptations that facilitated sauropod gigantism.

Keywords: Ichnotaxonomy, Pes morphology, Pedal soft-tissue, Heel pad, Sauropod

Shark feeding traces on Eocene archaeocetes from the Pisco Basin Lagerstätten (Peru)

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The emergence of marine mammals introduced a novel, lipid-rich resource into marine ecosystems, potentially influencing shark ecology. Following the extinction of marine reptiles at the end of the Cretaceous, a 20–25-million-year gap preceded the radiation of fully aquatic mammals during the Eocene, marking a major ecological transition.

New fossil evidence from the East Pisco Basin (Peru) provides insight into early shark–cetacean interactions. Archaeocete remains, including Protocetidae and Basilosauridae from the Paracas and Otuma formations (ca. 43–35 Ma), exhibit recurrent shark bite marks on cranial elements. These traces are consistently concentrated above the orbital region, particularly on the frontal bones. More than ten specimens from different localities and depositional settings display comparable patterns, indicating that these interactions are not isolated but represent a recurring feature in the fossil record. Most affected individuals correspond to adult, small-sized specimens.

The morphology of the traces indicates feeding activity by sharks, although no specific taxonomic attribution can be made. Comparable evidence has been reported from other regions, including North America and Europe, suggesting a broader geographic distribution, although the global extent of this pattern remains unresolved.

These findings may represent some of the earliest direct evidence of trophic interactions between sharks and marine mammals. While not tested here, the temporal coincidence between the rise of marine mammals and diversification trends in sharks raises the possibility of an ecological link. Ongoing work aims to better characterize these interactions and their implications for the evolution of marine megafaunal ecosystems.

Keywords: Pisco basin, Cenozoic, Sharks, Archaeocetes

New sauropod and theropod specimens from the Turonian Portezuelo Formation (southern Neuquén Basin, Patagonia, Argentina) and their phylogenetic implications on the Late Cretaceous clades Titanosauria and Megaraptora

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The Portezuelo Formation (southern Neuquén Basin, Argentina), dated to the late Turonian – early Coniacian transition (~90–88 Ma), represents a key interval for understanding South American saurischian evolution following the Turonian faunal turnover. Here, we describe and comparatively analyze new sauropod and theropod specimens from the Los Bastos locality (Neuquén Province, Patagonia), investigated using computed tomography, 3D photogrammetry, and phylogenetic analyses to obtain the most comprehensive possible morphological documentation. The results document a significant example of a post-Turonian assemblage characterized by high titanosaur diversity, including both basal and derived forms of various sizes, likely radiating after the extinction of Rebbachisauridae from South America. Concurrently, we observe an increase in the megaraptorid fossil record following the extinction of large-bodied theropods from the continent (e.g., carcharodontosaurids and spinosaurids). This pattern is associated with increased skeletal pneumaticity and body size within Megaraptoridae. Furthermore, phylogenetic results support their potential placement within basal Tyrannosauroidae.

Keywords: Titanosauria, Megaraptora, Turonian faunal turnover, Portezuelo Fm., Patagonia

A Late Triassic fossil mud trap from Switzerland reveals sauropodomorph dinosaurs surrounded by pterosaurs and rhynchocephalians

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The Late Triassic (Norian) Gruhlade Member of the Klettgau Formation from Frick, northern Switzerland, forms part of the Central European Basin (CEB). This Member comprises a succession of terrestrial playa-lake deposits (i.e., ephemeral lakes with intermittent sheetfloods) that, along with other contemporaneous German localities such as Trossingen and Halberstadt, have in the past predominantly yielded numerous fossils of the sauropodomorph dinosaur *Plateosaurus trossingensis*. These *Plateosaurus* ‘bonebeds’ from across the CEB led to the formulation of a size-biased ‘mud-trap’ hypothesis, whereby animals became mired in mud during droughts and only the largest animals that were too heavy to escape were preserved. However, here we describe a new fossil site from Frick that comprises a pair of almost complete and articulated *Plateosaurus* skeletons surrounded by numerous pterosaurs (extinct flying reptiles) and rhynchocephalians (tuatara relatives) – the first instance in which dinosaurs and microvertebrates have been found together in a single CEB mudtrap. The dinosaurs are preserved holding hands and are thus inferred to have died together after becoming mired in mud. The microvertebrates are somewhat complete and articulated and thus also inferred to have died after miring. We identify at least two new species of pterosaur from the site that, consequently, represent the oldest European terrestrial pterosaurs and sets back the playa-inhabiting pterosaur record approximately 130 million years. We also identify at least two distinct rhynchocephalian taxa, doubling the number known from the Klettgau Formation, making Frick hugely important for understanding Late Triassic rhynchocephalian biogeography. This new site thus adds a new layer of complexity to the CEB mudtrap hypothesis and provides new insight into the compositions of terrestrial Triassic European ecosystems.

Keywords: Triassic, Pterosauria, Rhynchocephalia, Taphonomy

Integrated methods for the preparation, conservation and interpretation of new ichthyosaurian remains from the Saltrio Formation (Early Jurassic, Southern Alps, Lombardy)

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Here we report on new ichthyosaurian remains from the Saltrio Formation (Sinemurian, Early Jurassic) of Lombardy (Northern Italy). The specimen was recovered in 2004 during quarrying operations in the “Cava Salnova” of Saltrio (Varese province), reported to the competent Superintendency, and deposited in the labs of the Museo di Storia Naturale di Milano. Preparation was carried out recently with mechanical and chemical methods, enabling complete extraction of the bones from the matrix. The specimen was then scanned with an Artec Spider structured light 3D scanner, and replicas of it are presented herein.

The Saltrio Formation consists of calcarenites deposited in an open subtidal environment. These marine sediments are known for abundant marine invertebrate fossils, chondrichthyan teeth, rare marine reptiles, and the ceratosaurian dinosaur *Saltriovenator zanellai*.

The specimen consists of 16 caudal vertebrae, two caudal ribs, one neural arch, and one limb bone. Two groups of six vertebrae were found preserving the original intervertebral space. Comparison with published data allowed to determine the anatomical position of the vertebrae: eight vertebrae belong to the tail stock and are located around the mid-length of the vertebral column; six vertebrae are positioned posteriorly, closer to the tail fluke. By comparing relative proportions of dorso-ventral height and transverse width of the centra with SMNS 15950 *Temnodontosaurus trigonodon*, we estimate the Saltrio ichthyosaur to measure 5–6 m in absolute length.

The integrated workflow — preparation, 3D scanning, and physical replication — served complementary purposes: preparation allowed complete bone extraction from a hard calcarenitic matrix; digitisation provided a “digital twin” of the specimen, a permanent record for conservation, and reduced handling risks; replicas enabled comparative analysis without stressing the original material. Together, these steps made the interpretive results presented here possible.

Keywords: Ichthyosauria, Saltrio Formation, Early Jurassic, 3D scanning, Integrated digitization workflow

Covariation in the craniomandibular system of seals

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During the land-to-sea transition, pinnipeds underwent an evolutionary shift in emphasis of craniomandibular function from prey processing to prey capture. Additionally, pinnipeds are opportunistic feeders and show flexibility in feeding strategy. They capture prey as efficiently as possible, which may require them to switch between prey types depending on their availability. This challenges the identification of form-function relationships and the reconstruction of the feeding strategy in fossil seals.

Here, we investigated the covariation in the craniomandibular system of the Harbor seal (*Phoca vitulina*) and the Grey seal (*Halichoerus grypus*) to reveal the relation between muscles, bones, teeth and feeding behavior in living phocids. These sympatric species are classified as pierce feeder which represents the plesiomorphic condition in pinnipeds, but our analyses showed that *P. vitulina* primarily consumed hard structures, whereas *H. grypus* primarily fed on softer food particles. Despite interspecific differences in morphology and behavior, we identified coordinated variation between cranium, mandibula and bite force. Next, we included the remains of a fossil specimen that is also classified as pierce feeder to quantitatively infer the anatomy of the extinct relative. Our results indicate that the fossil seal is more like *P. vitulina* suggesting that it had a more diverse diet than *H. grypus*.

In pinnipeds, morphological features of the feeding apparatus often correlate poorly with feeding behavior because many species exploit similar prey despite considerable morphological variation. Consequently, relying solely on single traits can be misleading, and a holistic approach quantifying the craniomandibular system is necessary to reliably reconstruct feeding strategy.

Keywords: Mammals, Skull, Functional morphology, Foraging

Pollen record of the Last Interglacial Complex from Valle di Castiglione Paleolake (Central Italy): Vegetation Dynamics and Climate Variability

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A 131.2 m long composite section derived from sediment cores extracted in 2021 from the Valle di Castiglione paleolake (Colli Albani volcanic complex, 20 km southeast of Rome). It preserves a continuous sequence spanning ~365 ka and represents one of the longest continuous pollen records in Italy. Dated through tephra stratigraphy (Macri et al., 2023). It has the potential to refine the previous palynological study of Follieri et al. (1988) and overcomes the scarcity of well dated and high-resolution terrestrial archives in the central Mediterranean. This deficit has limited the precise reconstruction of vegetation dynamics and paleoclimate changes during the Last Interglacial Complex (MIS 5, ~130–70 ka BP), a period characterized by the alternation of warm/wet interstadials and cold/dry stadials that mirrors the Holocene in terms of climatic and vegetation patterns.

Our data document a rapid increase of arboreal taxa at the onset of MIS 5e, signifying the establishment of full interglacial warm and wet conditions. The interstadial phases feature mesophilous deciduous forests elements (e.g. *Quercus*, *Carpinus*) alongside with Mediterranean evergreen elements (e.g., *Olea*, *Quercus ilex* type) and montane species (e.g. *Abies*, *Betula*, *Fagus*), intermittently interrupted by stadial periods marked by the expansion of herbaceous vegetation. Progressing into late MIS 5, a gradual increase in non-arboreal taxa reveals landscape opening, forest retraction, and the incoming dry conditions of the Last Glacial (MIS 4).

The Valle di Castiglione pollen record emerges as reference for the definition of timing, amplitude, and internal structure of MIS 5 in the central Mediterranean in terms of vegetation and climate trend. In addition, it provides a critical highlight for assessing pre-anthropogenic climate dynamics and environment responses in the entire Mediterranean region.

Keywords: Pollen, Last Interglacial Complex, Vegetation dynamics, Valle di Castiglione

Bioconstructions in Conservation Paleobiology near-time perspective

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In conservation paleobiology, near-time perspectives focus on the relatively recent (sub)fossil record to understand how extant species and ecosystems have responded to environmental change in the long term, and to reconstruct historical baselines prior to the onset of anthropogenic impact.

The mesophotic benthic zone, which is home to algal reefs and nodule beds that have developed since at least the last glacial maximum, is of particular interest. These habitats are extremely important for their biodiversity and because they are the result of the interplay between biological and geological processes over time. They are an expression of geo-biodiversity and have an important fossil legacy, thus providing abundant material for research.

Analyzing these structures enables us to reconstruct environmental and climatic changes over time, how species adapted to these changes and the processes that led to constructive or destructive phases or the alternation of bioengineers in response to environmental and anthropogenic variations. For this reason, they represent a potential archive for conservation paleobiology studies.

In this talk, we will explore several case studies focusing on the use of mesophotic bioconstructions, particularly those made of calcareous algae, such as Coralligenous build-ups and rhodalgae nodules, as a tool for Conservation Paleobiology studies. We will examine how to interpret the information they provide as an archive of environmental changes and anthropogenic impact. We will also address the limitations of using such geobiological materials. We finally consider possible further research in this field, such as their role in the carbon cycle as organic carbon storage.

Keywords: Bioconstructions, Coralligenous, Rhodoliths, Near-time, Archives

Study of micro-structures and isotopic signatures of cold-seep-associated bivalve shells from the Arctic Ocean

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This research investigates the efficacy of the Arctic bivalve shells *Thyasira capitanea* Åström & P. G. Oliver, 2017 as biogeochemical archives for reconstructing the history of methane emissions in cold seep environments. By analyzing dead and subfossil specimens from three distinct Arctic locations - Vestnesa Ridge (VR), Svyatogor Ridge (SR), and the Polaris Mud Volcano Complex (PMVC) - this study was conducted within a multidisciplinary framework including petrography, electron backscatter diffraction, and stable isotope analysis ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$).

Petrographic examinations revealed that *T. capitanea* has a two-layers shell structure, composed of an inner nacreous layer and an outer prismatic layer. Electron BackScatter Diffraction successfully confirmed an entirely aragonitic composition. Sclerochronological analysis further revealed that these organisms are surprisingly long-lived, with *T. capitanea* reaching ages between 11 and 23 years.

The isotopic analysis showed that shells from all sites display $\delta^{13}\text{C}$ values significantly more negative than those of a typical non-chemosymbiotic marine bivalve, confirming that the analyzed organisms lived in an environment influenced by methane emissions. The isotopic values in shells from PMVC are slightly more negative than those from VR, indicating the incorporation of more CH_4 -derived carbon or a gas-source inherited signature (PMVC gas is purely microbial with $\delta^{13}\text{C}$ as low as -85‰).

Additionally, the study validated the use of *T. capitanea* as a paleotemperature archive based on $\delta^{18}\text{O}$ data. At the VR site, the calculated water temperatures of 2.6°C to 4.3°C align with instrumental measurements, whereas anomalous higher temperatures as reconstructed for the PMVC site indicate a requirement for deeper investigation.

Keywords: *Thyasira capitanea*, Sclerochronology, Biogeochemistry, Cold-seep, Arctic Ocean

Fish evolution in the Serbian Lake System during from the late Early Miocene to the Sarmatian

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The Serbian Lake System (SLS) is situated along the southern margin of the Pannonian Basin between the Dinarides and the southern Carpathians and developed independently from the Paratethys Sea during the Early and Middle Miocene. The SLS represents a key yet still underexplored freshwater center of endemism and fossil fish evolution in Southeast Europe.

Fish assemblages of the Serbian Lake System are documented from several key localities spanning the Late Early to Middle Miocene, revealing a clear temporal and ecological succession. The oldest record originates from the Klinci locality (late Early Miocene), where otoliths *in situ* of Gobiidae indicate the presence of early freshwater gobiid assemblages which are now extinct. Middle Miocene (Badenian) deposits from the Vračević locality yield otolith assemblages composed of Gobiidae and Cyprinodontidae, suggesting increased faunal diversity. Slightly younger deposits from the Radobić locality (late Badenian?, study in progress) are characterized by Cyprinidae-dominated assemblages, pointing to further ecological differentiation. The youngest record, from the Sarmatian of the Zmajevac locality, is marked by the occurrence of Ambassidae (*Neodapalis haraldahneli*), representing the latest known record of this group in Europe, extending the known temporal range of the group beyond previous records.

In contrast to earlier representatives of the genus *Dapalis*, which are mainly known from the Eocene to Early Miocene with a peak in diversity during the Oligocene, *Neodapalis* indicates a prolonged persistence of freshwater- and brackish-adapted lineages in the SLS. The survival across the Middle Miocene Climate Transition (MMCT) suggests that the SLS may have acted as a refugium, enabling the survival of warm-climate fish faunas for a certain period in time under changing environmental conditions.

Together with the observed turnover of gobiid assemblages around 14 Ma, following the Miocene Climatic Optimum, these patterns indicate a major ecological reorganization of freshwater ecosystems in the region. Our observations emphasize the role of the SLS as a key evolutionary and biogeographic node within Neogene freshwater ecosystems of Europe.

Keywords: Serbian Lake System, Miocene, Ambassidae, Gobiidae, Cyprinidae

Fungal colonization of plant fossils: implications for preservation and conservation strategies

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Fungal colonization of fossils represents a potentially significant but still under-researched problem that affects our understanding of the fragility of paleontological collections. Its effects on plant fossils can compromise both their state of preservation and their suitability for scientific analysis. The aim of this study is to investigate the occurrence and characteristics of fungal colonization on plant fossils and to explore its potential implications for conservation strategies. A total of 666 specimens of plant fossils from the paleobotanical collection of the Museum of Nature South Tyrol (Bolzano) were systematically examined using stereomicroscopy. Fungal infestation was documented in terms of morphology, color, and substrate. Selected samples were additionally analyzed using microbiological cultures and DNA-based identification. Moreover, various cleaning methods (mechanical, chemical, and gel based enzymatic cleaning) were tested. Fungal infestation was detected in 139 specimens (~21%). Colonization occurs primarily on rock substrates, rather than on the plant fossils themselves and typically manifests as whitish, reticulate to cotton-like mycelia. Preliminary observations suggest a possible correlation between the frequency of infestation and storage duration, indicating the importance of long-term storage conditions. Microbiological analyses indicate the presence of various fungal taxa, including both storage-related and plant-associated forms. These results provide an initial overview of fungal colonization in paleobotanical collections and highlight the need for further investigation into its extent and effects. The durability of fungal structures and their interaction with the substrate could have implications for fossil preservation and conservation strategies.

Keywords: Fungi, Plant fossils, Biodeterioration, Fossil conservation

The Neuwelt (Switzerland) plant fossil assemblage reveals insights into Carnian subtropical vegetation

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The Carnian Pluvial Episode (CPE) represents a major climatic perturbation of the Late Triassic, associated with significant changes in terrestrial ecosystems and vegetation dynamics. However, subtropical plant communities along the northwestern Tethyan margin remain poorly constrained.

The historical collection of Neuwelt (near Basel, Switzerland) provides an important opportunity to improve our understanding of the vegetation composition at low paleolatitudes. The Neuwelt plant fossil assemblage is currently reassessed through an integrated approach combining taxonomical revision and cuticular analyses of selected taxa. Macromorphological and cuticular studies will be used to refine the taxonomic framework of the assemblage, with epidermal features providing insights into plant ecological strategies. The integration of these datasets is expected to enhance taxonomic resolution and allow a more robust reconstruction of plant diversity and community structure in the low latitudes during the CPE and provide new data for regional comparisons within the northwestern Tethyan realm.

Keywords: Neuwelt, Carnian Pluvial Episode, Cuticles, Paleovegetation

Abstract (Poster)

Symposium: S12

The new biochronostratigraphic chart of the Paleogene and Neogene with updated larger foraminifera Biozones.

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This contribution showcases the newly published Biochronostratigraphic chart with the updated biozonation for shallow water - symbiont bearing - larger benthic foraminifera. It provides a complete update for both Shallow Benthic Zones (SBZ) and Orthophragminid zones (OZ), including the recently proposed SBP for the Paleocene. The proposed zonation considers the time span from Danian to Tortonian, thus including the entire Paleogene and part of the Neogene. According to the most recent literature, a correlation proposed of shallow water biozones with the established planktonic biozones, geomagnetic chronozones, and standard chronostratigraphy using the most recent Geological Time Scale (GTS), available from 2020. This study considers all those bioevents retrieved along stratigraphic succession within the Tethyan realm and does not consider yet the Letter Zonation for the Indo-Pacific bioprovinces. This study highlights several new considerations regarding both the Paleocene/Eocene and the Eocene/Oligocene boundaries. the newly presented data are only partially in agreement with the previous version of the chart and add significant revisions also considering the most recent modifications of the chronostratigraphic chart.

Keywords: Paleocene, Eocene, Oligocene, Miocene, Biostratigraphy

Giant *Bathysiphon* (Foraminiferida) and associated ichnodiversity in the Building Stones of the Priamar Fortress in Savona (Italy)

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Very large and well-preserved specimens of agglutinated foraminifer *Bathysiphon palachei*, have been identified in the building stones of the Priamar Fortress located in Savona, Liguria, NW Italy. These specimens, with test lengths extending to 120 mm, are among the largest foraminifera documented to date. We identified the source of the building stone as the Costa Quarry, located near Bedonia, where the Monte Zuccone Sandstone (Chattian-Aquitania) is exposed. Together with this giant foraminifer, a large diversity of deep water, flyschoid type ichnoassociation occurs, such as: *Halopoa imbricata*, *Paleodictyon minimum*, *Spirorhaphe involuta*, *Desmograptus? ichthyiforme*, *Ophiomorpha annulata*, *Helminthopsis? labyrinthica*, and *Scolicia strozzii*.

Considering the ichnological association, alongside taphonomic and sedimentological observations, it is suggested that the studied *Bathysiphon* were deposited in a deep-sea fan environment after experiencing minimal transport. Beside peculiar paleoenvironmental reconstruction, it seems interesting the use of a flyschoid unit from the Tuscan nappe as paving stone for a Ligurian historical building surrounded in the region by equivalent flyschoid material, with indeed less diverse ichnoassociation.

Keywords: Building stone, Quarry, Bedonia, Ichnofossils, Biodiversity

Approaches to trackmaker evolution

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Since the 1970s, evolutionary inferences from tetrapod trackway producers of tetrapod trackways have been systematically approached through quantitative analysis of fossil trackway data, but also by using extant model animals in actuopaleontological research on track production. Congruent with other fields of vertebrate paleontology, these studies often aim at the inference of evolution in trackmaker locomotion through comparison of samples from successive time slices (i.e., stratigraphic approaches) or by considering samples of different track types in a phylogenetic framework (phylogenetic approaches), or both. Either way of inference usually involves the assignment of a trackmaker group to an ichnotaxon or at least the delimitation of a set of similar track types which share a higher-level producer group (e.g. “tridactyl theropod tracks”). Especially for trackmaker groups with a relatively conservative foot morphology, large available samples of trackways, and only slight differences between individual types of footprints, time slice approaches – that are nowadays widely used in paleodiversity and disparity studies – might be the method of choice. For cases of more rapidly evolving foot morphology and locomotion and/or a well-defined ichnotaxonomy, the concept of synapomorphy-based correlation of trace fossil taxa (ichnotaxa) and trace-producing animal taxa (orthotaxa) has been introduced, potentially enabling us to map trackway features on a phylogenetic tree and interpret trace fossil data phylogenetically. In practice, however, this method of inference is often limited by the relative paucity of diagnostic features that are recorded by both the autopodial skeleton and the tracks, as well as the extramorphological variation in the tracks. Additional problems include the scarcity of complete articulated autopodia, evolutionary convergence, and unclear phylogeny of the trackmakers. Here we reconsider methodological approaches used to infer trackmaker evolution to suggest best practices for future studies.

Keywords: Ichnology, Phylogenetics, Ichnotaxonomy, Mesozoic, Paleozoic

Thermal Maturity Assessment Using a Machine-Learning Workflow: Automated Palynomorph Darkness Index (PDI) determination

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Estimation of organic-matter thermal maturity is fundamental for basin analysis, hydrocarbon exploration, and geological reconstructions. Palynomorph Darkness Index (PDI) provides a quantitative, cost-effective optical proxy for maturity assessment (Goodhue & Clayton, 2010; Buratti et al., 2024). However, its workflow remains time-consuming and partly operator-dependent. In this study, we present a machine-learning assisted system designed to automate major steps of the PDI workflow. The approach integrates a RetinaNet object-detection model, an EfficientNet-V2 classifier, and an OpenCV-based segmentation workflow optimized to identify homogeneous measurement areas within images of individual palynomorphs. The model was trained and validated using 12,542 images from 367 samples covering a wide range of stratigraphic ages, thermal maturities, and preservation states. Automated PDI values show strong agreement with conventional microscope-based measurements ($r^2 = 0.95$), with a mean absolute difference of 3.1% and a root mean square error of 4.0% after expert-guided revision of outliers. At sample scale, the agreement increases further ($r^2 = 0.99$; mean deviation = 1.4%). The tool performs robustly on both subsurface and outcrop samples, significantly reduces operator bias, and markedly accelerates the analytical workflow. Overall, this method represents a major step toward fully automated optical maturity assessment, with direct applications in research, basin modelling, and exploration.

References:

- Buratti N., De Luca R., Garuti L., Sorci A. & Spina A. (2024). Thermal maturity evaluation on mildly artificially oxidised sporomorphs: A comprehensive calibration of palynomorph darkness index (PDI) with vitrinite reflectance. *Marine and Petroleum Geology*, 162.
- Goodhue R. & Clayton G. (2010). Acritarch Palynomorph Darkness Index (PDI) as an indicator of thermal maturity in Silurian sections from Saudi Arabia. *Palynomorph darkness index (PDI) - a new technique for assessing thermal maturity*. *Palynology* 34: 147–156.

Keywords: Thermal maturity, PDI, Organic matter, Artificial intelligence

Major stratigraphic incompleteness in the latest Ordovician and Silurian of the Arbuckle Mountains, Oklahoma, USA – result of deep time climate variability

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Highly time-resolved stable carbon isotope data ($\delta^{13}\text{C}_{\text{carb}}$) from the latest Ordovician (Hirnantian) Keel Oolite and the Silurian Cochrane, Clarita, and lowermost Henryhouse formations in the Arbuckle Mountains of Oklahoma (USA), in combination with conodont biostratigraphy of the studied sections, reveal a series of extensive stratigraphic gaps in this part of the Laurentian succession. We present a first $\delta^{13}\text{C}_{\text{carb}}$ analysis of the Keel Oolite, which reveals only a fragmentary carbon isotope record, making any detailed chemostratigraphic correlation of the local Hirnantian difficult. This type of marine oolites is known from different paleocontinents and represents a time specific facies within the Hirnantian Stage. In the classical Highway 77 road-cut section, our $\delta^{13}\text{C}_{\text{carb}}$ stratigraphy reaches nine metres into the Silurian succession immediately overlying the oolite, corroborating previous interpretations of an extremely discontinuous stratigraphy with major stratigraphic hiatuses. Above the Keel Oolite at this locality, the latest Hirnantian, the entire Rhuddanian and most of the Aeronian ages are missing. Based on a combination of conodont biostratigraphy and $\delta^{13}\text{C}_{\text{carb}}$ record above this hiatus, we identify the overall position for preserved parts of Silurian $\delta^{13}\text{C}$ excursions. The recognized $\delta^{13}\text{C}_{\text{carb}}$ events include the Late Aeronian Carbon Isotope Excursion (LACIE), the Valgu Carbon Isotope Excursion (Valgu CIE), Early Sheinwoodian Carbon Isotope Excursion (ESCIE), the Mid Homerian Carbon Isotope Excursion (MHCIE), and the Mid Ludfordian Carbon Isotope Excursion (MLCIE). Substantial parts of all these excursions are missing. Thus, our geochemical data reflect a highly modest stratigraphic completeness of the strata. We argue that the erosion and hiatuses developed as a response to eustatic sea level fluctuations likely forced by global climate variability causing expansion and contraction of Gondwanan ice-sheets well into the Silurian.

Keywords: Ordovician, Silurian, Chemostratigraphy, Conodont biostratigraphy

Abstract (Oral communication)

Symposium: S8

The Chiavon *Lagerstätte* (Vicenza, N Italy): A forgotten tropical ichthyofauna of the Veneto Region

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The Paleogene *Lagerstätten* of northeastern Italy preserve a remarkable diversity of exceptionally well-preserved fossil fishes, including the famous Ypresian shallow-water Bolca sites (Verona and Vicenza provinces), the bathyal Solteri (Trento) and Monte Solane (Verona Province) assemblages, as well as the Rupelian coral-reef deposits of Perarolo (Vicenza Province). These sites play a pivotal role in documenting the early Cenozoic radiation of teleosts, a time marked by the major evolutionary expansion of acanthomorphs and other teleost lineages. Within this framework, the Chiavon site (Vicenza Province) represents a historically important, yet still understudied *Lagerstätte*. First reported in the mid-nineteenth century, Chiavon yielded a diverse and distinctive ichthyofauna that, in some respects, parallels that of Bolca. Although several taxa were described in early studies, a modern revision and an accurate paleoenvironmental reconstruction of the assemblage is still lacking. Fossil material collected during the nineteenth and twentieth centuries is dispersed across several Italian museums and the Naturhistorisches Museum in Vienna. These collections have remained largely neglected for more than a century, as the last comprehensive study dates to 1889, with the first known collection from this site being housed in Vienna and last examined in 1863. Additional specimens are known but were never studied in detail. The ongoing taxonomic revision has revealed an assemblage dominated by clupeiforms, gonorynchiforms and percomorphs (e.g. Carangidae, Sparidae). Furthermore, its lower Oligocene assignment, proposed by Fabiani in 1915, requires modern biostratigraphic reassessment. More refined and robust chronological constraints for the Chiavon assemblage are essential to assess the significance of its ichthyofauna within the broader evolutionary history of Paleogene Tethyan fish communities, especially in a critical period such as the Eocene/Oligocene boundary.

Keywords: Teleostei, *Lagerstätte*, Paleogene, Northern Italy

A diverse avifauna from the Pleistocene of Botswana – Bone Cave

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Most studies on the palaeoecological context of hominin evolution during the Plio-Pleistocene have focused on investigating the *Cradle of Humankind*, an area covering less than 0.009% of the total surface of South Africa, which may not adequately represent this context. The Homini'Karst project, started in 2020, aims to propose a new 'Southern Africa' palaeoecological model by integrating the data on ecosystem diversity from new fossil assemblages outside South Africa. In particular, Botswana seems to have some interesting areas to explore, such as the newly discovered fossil sites in the Koanaka and Gcwihaba hills in the North-West. The fossil bird remains analyzed in this study come from Bone Cave, located in the eastern Koanaka Hills. This preliminary work uncovers a well-differentiated diversity of this site, that includes at least 25 taxa across 18 families, in addition to several Passeriformes. The most abundant species is a *Tyto*, which, together with the found Falconidae, is the evidence of the rocky outcrops in which the cave was opened. The occurrence of Anatidae, a small grebe, Ardeidae, Threskiornithidae and a high diversity among the Charadriiformes (at least eight taxa in four different families) indicates the presence of permanent water bodies. The existence of open grassy areas is supported by the discovery of several species of Phasianidae, Pteroclididae and Otidae, while the only evidence of riparian forest until now is a single humerus of Psittaciformes. Among these fossil remains is the oldest known record of *Scopus umbretta*, represented by six bones of at least two individuals. The avifaunal diversity suggests a heterogeneous paleoenvironment which highlights the importance of Botswana in reconstructing Plio-Pleistocene ecosystems and contributes to refine a broader model of environmental variability during the Southern African Pleistocene.

Keywords: Aves, *Scopus umbretta*, *Tyto*, Southern Africa, Quaternary

Abstract (Oral communication)

Symposium: S5

The Early Pliocene Accipitridae (Aves, Accipitriformes) from Langebaanweg, south-western Cape Province, South Africa

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The fossiliferous Upper Varwater Formation at Langebaanweg (South Africa) produced one of the largest pre-Pleistocene bird bone accumulations worldwide, which is still insufficiently known despite the numerous studies reported in the literature. According to latest estimates, more than 37 bird families with around 100 species have been recorded, mostly representing the earliest family records for the African continent. The analysis of the remains of Accipitridae reveals a great diversity in the guild of the diurnal birds of prey. In fact, the most abundant species is the extinct vulture *Aegypius varswaterensis*, whose abundance is probably linked to the plentiful supply of large mammal carcasses carried by river floods. Five other species have been identified in the fossil bird assemblage: two species of eagle (*Aquila*), one species of kite (*Milvus*), and two species of hawk (*Accipiter*), three of them representing taxa new to science and still to be described. In particular, the morphological and phylogenetic analyses confirm that: a large extinct species of *Aquila* shows affinities with the recent *Aquila verreauxi*; the extinct kite from Langebaanweg is similar to the extant *Milvus migrans*, but with longer legs; and the second most common Accipitridae is an extinct species of the genus *Accipiter* similar in size and proportions to *Accipiter melanoleucos*, but with more primitive characters than all the other analyzed species of the genus.

From the palaeobiogeographical point of view, we confirm that the Early Pliocene African avifauna is characterized by extinct forms of Palearctic affinities, as none of the taxa detected at Langebaanweg so far belongs to African endemic lineages. In addition, these results confirm the great importance of Langebaanweg as an archive to understand the paleobiodiversity of South Africa during the Early Pliocene, just before the beginning of the hominin evolution in this part of the African continent.

Keywords: Langebaanweg, Neogene, Fossil birds, Accipitridae, Palaeobiogeography

Digitizing Avian Osteology: A 3D Reference Collection to Support AI-Based Bone Identification

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Birds are a fundamental component of human environments. Interactions between people and birds date back to the Middle Paleolithic. However, many aspects of how this relationship unfolded remain unclear. The AviArch project aims to answer some of the questions about the tempo and modes of human-avian interactions, including early management and domestication of some species and the consequences of anthropization on bird communities. Part of this project addresses the challenge of improving the identification of bird remains in archaeological contexts through the development of an AI-based tool for avian bone recognition. This system is trained on ad-hoc photographic, tabular and 3D data collections.

The 3D database was built by acquiring scans of modern bird skeletons from the collection housed in the Department of Earth Sciences at the University of Turin. This expanding collection, established in 1995, has grown to include more than 3,000 specimens from around 900 species. The digitizing workflow required extensive and accurate preliminary work aimed at choosing the best-preserved skeletons and cleaning them when needed. The scans were then acquired using the Artec Space Spider and the Artec Micro II scanners and processed with Artec Studio 18.

One specimen for each of approximately 100 European or African bird families was selected and the result is a digital reference collection composed of over 1000 models of long bones, skulls, pelvises, sternums, mandibles, carpals and phalanges. This digital resource will soon be freely available, incorporating additional datasets from the AviArch project (e.g., protein marker sequences), to enable consultation and reuse by interested researchers. Furthermore, it will support the training of the AI classification algorithms, by providing 3D model-based data augmentation.

Keywords: 3D models, AviArch, Bird bones, AI

Total-evidence tip-dating reveals macroevolutionary dynamics in deep-sea squaliform sharks

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Squaliform sharks (Chondrichthyes: Squaliformes) represent about a quarter of the extant shark diversity and are a key component of modern deep-sea ecosystems. Their tooth morphology is extremely diversified within the group, allowing for the identification of several features that are diagnostic at family or genus level. This makes squaliforms an ideal candidate group among sharks to apply state-of-the-art phylogenetic methods that integrate neontological and paleontological data, as the fossil record of sharks is stratigraphically dense but consists mostly of teeth. Here, we analyze a newly assembled total-evidence (DNA + morphology + chronostratigraphy) dataset consisting of 104 extant and 50 extinct species of squaliforms in a Bayesian phylogenetic framework with a fossilized birth-death model. Furthermore, we use the resulting time-calibrated phylogeny to reconstruct environmental occupation, diversification dynamics, and body size evolution of squaliforms over deep time. Our study reveals that the initial radiation of squaliforms in the deep sea happened in the Early Cretaceous, significantly predating the global Cenomanian–Turonian anoxic event that has been previously proposed as a key abiotic trigger for the colonization of deep-sea environments by this group. Moreover, our analyses fail to recover any phylogenetic signal for an increase in extinction rates around the Cretaceous–Paleogene (K–Pg) boundary, suggesting a potential role of the deep sea as a refugium during major mass extinction events.

Keywords: Tip-dating, Squaliformes, FBD, Phylogenetics, Chondrichthyes

Anatomic description and taxonomic attribution of an ichthyosaur specimen from the Jurassic deposits of Holzmaden (Germany)

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This study presents the anatomical description and taxonomic attribution of the fossil specimen MSP441, an ichthyosaur preserved within the collection of the Municipality of Serrapetrona (Marche, Italy). The specimen, lacking an identification label, most likely originates from the Jurassic (Toarcian) deposits of the Posidonienschiefer in Holzmaden, Germany. The analysis was conducted by integrating traditional morphometric measurements with the use of photogrammetry to generate a 3D model. From a taphonomic perspective, the fossil lies on a matrix of dark marls and shales, indicating a low-energy, anoxic marine environment. The carcass was deposited in a prone position; it shows excellent articulation in the anterior half and progressive disarticulation in the post-flexural caudal region and the left limbs, a dynamic suggesting limited exposure on the seafloor before burial. The probable presence of gastric contents is also noted. Morphologically, the specimen features a slender and elongated rostrum (longipinnate condition) and large orbits with a distinct scleral ring. The vertebral column consists of 102 vertebrae characterized by discoid centra. The fundamental diagnostic element for classification was identified in the anterior appendicular skeleton, where the humerus shows a peculiar facet on the leading edge. Based on these diagnostic cranial and appendicular characters, the specimen MSP441 is formally attributed to the genus *Leptonectes* (Family Leptonectidae, Clade Parvipelvina).

Keywords: Descrizione anatomica, Ittiosauro, Holzmaden

Abstract (Oral communication)

Symposium: S8

A new marine otophysan fish (Teleostei: Ostariophysi) from the Eocene of Bolca, Italy

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With more than 260 currently recognized species-level taxa, the Eocene (Ypresian) fish fauna of Bolca represents one of the most diverse vertebrate assemblages in the fossil record. It comprises sharks and batoids, some of the last representatives of the neopterygian order Pycnodontiformes, and a considerable number of teleosts. The teleost assemblage includes more than 240 species, the vast majority of which pertains to the Acanthomorpha, the spiny-rayed teleosts. Non-acanthomorph teleosts are represented by less than 30 taxa, including a putative pachyrhizodontid, three osteoglossiforms, 16 elopomorphs, five clupeomorphs, a single aulopiform, two possible gonorynchiforms, and the basal otophysan *Chanoides macropoma*. Otophysans currently represent about 68% of the living freshwater fish species, being represented in the marine biosphere only by the members of the catfish families Ariidae and Plotosidae. Two partially complete articulated skeletons pertaining to a new marine Eocene otophysan fish from Bolca were discovered in the collection of the Carnegie Museum, Pittsburgh. This new otophysan exhibits a suite of peculiar features, including the presence of peripheral ctenoid scales. These are characterized by a distinctive single marginal row of cteni that are well separated from the main body of the scale, very similar to those of the extant African citharinoid family Distichodontidae (Vari, 1979).

Financial support for the research was provided by the European Union – NextGenerationEU, Mission 4, Component 2, CUP I53D23002070 006, Project Title: BIOVERTICES (BIOdiversity of VERTEbrates In the CEEnozoic Sea).

References:

Vari R.P. (1979). Anatomy, relationships and classification of the families Citharinidae and Distichodontidae (Pisces, Characoidea). *Bulletin of the British Museum (Natural History) Zoology series*, 36: 261–344.

Keywords: Otophysi, Teleostei, Eocene, Bolca

SST-seasonality recorded in *Gigantoproductus* brachiopod shells from the middle-upper Mississippian of Guizhou, South China

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High-resolution oxygen isotope sampling across the growth lines of well-preserved brachiopod shells can reveal intra-annual, seasonal, variations of sea-surface temperature (SST). The amplitude of intra-annual $\delta^{18}\text{O}$ oscillations ($\Delta\delta^{18}\text{O}$) is a proxy for SST-seasonality intensity, with increases linked to climatic cooling and ice-sheet expansion. Seasonality fundamentally regulates marine physical, chemical and biological processes, and understanding its dynamics related to global climate change is fundamental for studies on the resilience of modern marine environments; yet, deep-time paleoseasonality data, useful for model training, remain scarce, especially for the Paleozoic.

Here we investigate SST-seasonality variation across the upper Visean and Serpukhovian, a critical interval coinciding with the onset of the main phase of the Late Paleozoic Ice Age (LPIA), based on a stratigraphically ordered collection from the Shangsi and Baizuo formations at Yashui Section in Guizhou (South China). The fauna is dominated by large linoproductids such as *Gigantoproductus*, *Datangia*, *Latiproductus* and *Striatifera*.

Cathodoluminescence, SEM microstructural screening and elemental analyses revealed that specimens of species of *Gigantoproductus* possess a well-developed, pristine tertiary prismatic layer suitable for isotope analysis. Oxygen isotopes were sampled across growth lines in the tertiary layer of six *Gigantoproductus* spp. specimens spanning the entire section. Mean $\delta^{18}\text{O}$ values range from -3.16‰ to -4.02‰ ; intra-specimen $\Delta\delta^{18}\text{O}$ ranges from 2.05‰ to 3.65‰ . Both parameters peak around 80 m, near the Visean–Serpukhovian boundary, suggesting a distinct glacial pulse in the late Visean at the onset of sustained icehouse conditions.

These data from South China provide rare high-resolution evidence of sustained SST seasonality during the LPIA's main phase in the eastern Paleo-Tethys.

Keywords: Sclerochemistry, Oxygen isotopes, Palaeoclimate, Late Paleozoic Ice Age, Seasonality

Application of Large Language Models to palaeontological taxonomy: test cases with palynomorphs and brachiopods

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The identification of fossils collected in the field, palaeontological taxonomy, is the first step for any study in biostratigraphy, palaeobiogeography, paleoecology and evolution. However, taxonomy requires years-long training, and it is based on textual descriptions of fossil taxa within a heterogeneous set of books, monographs and papers, often difficult to access online. As a result, the discipline is progressing slowly and it is in the hands of a shrinking pool of experts.

As the discipline mainly relies on published textual diagnoses and descriptions, we explored the application of Large Language Models (LLMs) to paleontological taxonomy, by developing two pilot LLM-augmented taxonomic systems (LATS) to support identification of palynomorphs and brachiopods. The palynology LATS is trained with the Jansonius & Hills catalogue (1976) of >4500 fossil spore and pollen genera, while the brachiopod LATS is based on the revised Treatise on Invertebrate Paleontology, Part H (Brachiopoda) (Williams et al., 1997–2007), covering ~4000 genera. Preparation of the palynomorph LATS faced several challenges including variable description quality and inconsistent use of terminology, whereas the main issue of the Brachiopod Treatise LATS was the synthetic nature of the diagnoses.

The LATS work as chatbots providing a list of possible candidate genera based on a prompt description; these systems assist rather than replace taxonomists, speeding up the identification work, promoting access to original taxonomic data, and potentially providing a tool for the education of the future generation of taxonomists. Beyond identification, LATS can be used for research application, such as analyse genus distribution in morphological space, potentially reshaping many fields of palaeontological practice.

References:

- Jansonius J., Hills V. (1976). Genera file of fossil spores and pollen. Univ. Calgary.
- Williams A. et al. (1997–2007). Treatise on Invertebrate Paleontology, Part H (Brachiopoda), Revised. GSA & Univ. Kansas.

Keywords: Taxonomy, Artificial intelligence, Brachiopods, Palynomorphs, Large language models

Abstract (Oral communication)

Symposium: S19

New dinosaur tracks in the Late Jurassic Cañadón Calcáreo Formation (Argentina): the first evidence of *Deltapodus*

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The Cañadón Calcáreo Formation (Chubut, Argentina) is one of the few units in Gondwana with a rich Late Jurassic dinosaur record. The formation is composed of a thick succession of fluvial and lacustrine terrestrial sediments and has been dated as Oxfordian-Kimmeridgian. Dinosaur remains include abundant sauropods (basal macronarians, dicraeosaurids and possible brachiosaurids) whereas other groups (e.g. theropods and ornithischians) are scarce. Among ornithischians, the recent identification of a stegosaur humerus represented the first evidence of plated dinosaurs in the Late Jurassic of South America. Despite the rather rich osteological record in the unit, ichnological evidence for dinosaurs has not been reported so far. Recent paleontological fieldwork in the Puesto Almada area has allowed the discovery of the first dinosaur ichnological remains. Different outcrops distributed across three different ravines have been discovered. The tracks have been identified as concave hyporeliefs at the base of sandstone levels or as fallen casts. Interestingly, among the tracks, several specimens show the characteristic subtriangular pes with three short, rounded, anteriorly positioned blunt digits of the stegosaur ichnogenus *Deltapodus*. This ichnotaxon has been mainly identified in the Middle Jurassic–Early Cretaceous of the Northern Hemisphere. Thus, the discoveries represent not only the first dinosaur ichnological evidence of the Cañadón Calcáreo Formation but also the first evidence of *Deltapodus* in the Late Jurassic of South America, thus reinforcing the occurrences of stegosaurids in this unit. This new discovery provides new data for the understanding of the Late Jurassic faunas of the Southern Hemisphere.

Keywords: Ichnology, Oxfordian-Kimmeridgian, Dinosaur casts, Stegosauria

The fishes of St. Margarethen: an overview of the biodiversity of fishes from a Middle Miocene marine ecosystem

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The Kummer quarry in St. Margarethen, Burgenland is among the most well known *Konservat-Lagerstätten* in Austria. This Middle Miocene locality is located at the Langhian/Serravallian boundary (14–13.5 Mya). It was a shallow water heterogeneous environment, containing both rocky reefs and seagrass meadows with an open water influence. This has led to a diverse and abundant faunal assemblage, particularly in fishes. These fossils are extraordinarily preserved owing to them being formed in hypoxic water with limited to no water mixing which prevented organisms being destroyed by scavengers. However, compared to other more famous fossil fish *Lagerstätten* such as Bolca and the Late Cretaceous Lebanese limestones, the fish fauna of St. Margarethen is quite understudied. A recent donation of 60 tons of fossil material from this site by the late paleontologist Herbert Schaffert to the Upper Austrian State Cultural Organization (OÖ Landes-Kultur GmbH) has now allowed for the opportunity for researchers to research this incredible *Lagerstätte* in great detail. A preliminary investigation of this material has uncovered a substantial increase to the diversity of fishes from this site. While previously known fossil taxa such as the scorpionfish *Scorpaena prior*, the round herring *Spratelloides* and the pipefish *Nerophis zapfei* are still found in great abundance, new taxa belonging to Labridae, Tetraodontidae and Scorpaenidae have also been discovered. Previously known specimens which were known only from fragmentary specimens are now found in complete condition. Lastly, taxa representing clades previously unknown from St. Margarethen are here represented for the first time including damselfishes (Pomacentridae) and cusk eels (Ophidiiformes). These new findings add more data to what a diverse fish fauna is, representing forms from both temperate and subtropical waters which lived during the Middle Miocene Climate Transition, a time of profound ecological change.

Keywords: Actinopterygii, Miocene, Biodiversity, Climate, Taxonomy

Unravelling biomineralization processes in modern brachiopods: integrating structural analyses with high-resolution elemental mapping and ecology

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Brachiopod shells provide a unique biomineral archive of Phanerozoic environmental and climatic changes owing to their exceptional preservation potential (low-Mg calcite) and widespread presence in the fossil record. However, significant uncertainties remain in the interpretation of their geochemical signals, as biomineralization processes and the influence of vital effects—including the debated relationship between shell fabric and geochemistry—remain poorly understood.

Addressing these uncertainties requires an interdisciplinary approach integrating structural analyses, with high-precision geochemical techniques, and detailed ecological and biological understanding. Applied to modern brachiopods, this integrated approach offers potential to disentangle the influence of vital/growth effects from environmental controls. Here, we combine mesostructural characterization (SEM) with high-resolution elemental analyses (LA-ICP-MS and TOF-MS) to investigate biomineralization processes in modern two- and three-layered brachiopod species from different geographic and bathymetric settings.

Our results show that shell microstructure is not the primary driver of intra-shell geochemical variability, contrary to previous interpretations. Consistent geochemical differences between fibrous and columnar fabrics were observed only in *Liothyrella neozelanica*. Statistical analyses of elemental compositions across species and fabrics reveal a significant Sr–Li–Na–B cluster, suggesting paired incorporation pathway associated with active biomineralization and rapid shell growth. Conversely, Mg incorporation appears paired with Mn, with both elements apparently enriched in specific shell regions, potentially reflecting reduced exclusion efficiency during late ontogenetic stages or physiological stress.

These findings reveal previously unknown pairings of trace elements during incorporation and point towards at least two different incorporation pathways that vary with growth stage.

Keywords: Brachiopods, Biomineralization, Shell geochemistry, Trace elements, Vital effects

The Piesberg in Osnabrück (NW Germany) – a window of exceptional preservation into the Pennsylvanian (upper Moscovian, Westphalian D) biodiversity of palustrine and lacustrine palaeoenvironments

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The Pennsylvanian (Upper Moscovian, Westphalian D) outcrops of the 188 m high Piesberg in the north of Osnabrück (Lower Saxony) belong to the northernmost occurrences of coal-bearing Carboniferous strata in Germany. At the locality, an active quarry exposes approximately 135 m of cyclically deposited fluvial to palustrine sediments, consisting of conglomerates, sandstones, mudstones, claystones and coal seams. The succession is characterized by fining-upwards cycles with conglomerates, arenites and quartzitic and lithic sandstones at their base. The cycles are usually capped by coal seams with beds of rhizolitic mudstone at their base and layers of highly fossiliferous mudstones at their top. The mudstones are interpreted as mire- and floodplain deposits of an ancient braided-river system. The recent discovery of an approximately 1.5 m thick lens of in part finely laminated dark mudstone, exhibiting varve-like stratification, is interpreted as a lacustrine freshwater deposit, a palaeoenvironment rarely recorded in the Moscovian (Roscher & Schneider, 2006).

Fossil preservation in the lacustrine and palustrine sediments is frequently exceptional, due to the anoxic depositional environment, lack of bioturbation and small grain sizes. Exceptionally well-preserved fossil specimens feature minute anatomical details or even record colour patterning, such as in rare cases of insect wings.

With the common preservation of originally organic elements such as chitinous exoskeletons or ligninous leaves, as well as large accumulations of parautochthonous plant fossils, the Piesberg locality constitutes a “mixed-mode” *Lagerstätte*, possessing properties of both *Konservat-* and *Konzentrat-Lagerstätten*.

References:

Roscher M., Schneider J.W. (2006). Permo-Carboniferous climate: Early Pennsylvanian to Late Permian climate development of central Europe in a regional and global context. Geological Society, London, Special Publications, 265, 95–136.

Keywords: *Lagerstätte*, Pennsylvanian, Palaeo-lake, Coal mires, Arthropoda

A first insight into Mid-Piacenzian Warm Period seasonality: Clumped isotope analysis of bivalve shells

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Clumped isotope thermometry (Δ_{47}) is a technique that is being increasingly applied to biogenic carbonates, as it provides a powerful tool for reconstructing seawater palaeotemperatures without requiring past $\delta^{18}\text{O}_{\text{sw}}$ value assumptions. Bivalve shells are recognized as one of the most valuable archives for its application, as they often live in settings affected by changes in $\delta^{18}\text{O}_{\text{sw}}$ values. Here, we perform for the first time clumped isotope analyses to bivalve shells from an Italian Pliocene succession, using a sclerochronological approach to reconstruct seasonal variations. We analyze four pristine shells belonging to taxa with different growth rates: two slow-growing *Glycymeris bimaculata* (Poli, 1795) and two fast-growing pectinids, *Aequipecten opercularis* (Linnaeus, 1758) and *Perapecten scabrellus* (Lamarck, 1819). The combination of species with contrasting growth rates allows reconstruction of seasonality of different record lengths: 2-3 years (Pectinidae) to more than 10–15 years (Glycymerididae). These taxa come from the Rio Vaccaruzza section (Villalvernia, Piedmont, Italy), deposited in the Tertiary Piedmont Basin and attributed to the Mid-Piacenzian Warm Period (3.3–3.0 Ma). Specimens were collected from Bed 3 of the Rio Vaccaruzza section, characterized by muddy sand deposits of the Sabbie di Asti Formation. The depositional environment is interpreted as an infralittoral setting influenced by hyperpycnal flows, leading to bottom-water instability and salinity fluctuations. Under this depositional setting, clumped isotope analysis is crucial as it enables independent reconstruction of seasonal seawater temperatures and $\delta^{18}\text{O}_{\text{sw}}$ variability recorded in bivalve shells. Preliminary Δ_{47} and $\delta^{18}\text{O}$ data indicate higher mean annual water temperatures compared to the modern Northern Adriatic Sea, along with seasonal $\delta^{18}\text{O}_{\text{sw}}$ value fluctuations consistent with a shallow-marine environment affected by variable freshwater input.

Keywords: Sclerochemistry, Bivalve, Seasonality, Clumped isotope, Paleotemperature

Dawn of a dynasty: the origin and early evolution of the Afro-Eurasian hipparion three-toed horses

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Hipparion three-toed horses originated in North America during the early Middle Miocene and subsequently dispersed into Eurasia and Africa. This dispersal event is known as the Hipparion Datum, originally formalized as a geochronological instantaneous event at 12.5 Ma, but currently dated to the early Late Miocene (≥ 11.2 Ma). The oldest accurately-dated Eurasian records of hipparion horses (~ 11.3 – 11.0 Ma) are currently referred to as *Hippotherium*, considered to have locally evolved in Eurasia from *Cormohipparion* following the dispersal of the latter from North America. Here we report the oldest well-dated hipparion remains from Europe and North Africa, demonstrating the presence of *Cormohipparion* in Europe, North Africa, and Anatolia, and its co-occurrence with *Hippotherium* in Europe for the first time. Our results, based on morphometric and phylogenetic analyses, coupled with body mass estimates and paleodietary inferences, fill a gap in the evolutionary history of the Afro-Eurasian hipparion horses and help to characterize their early diversification and evolution. We conclude that *Cormohipparion* rapidly dispersed across Eurasia and Africa at ~ 11.3 – 11.2 Ma before giving rise to *Hippotherium* and other genera. We also re-conceptualize the Hipparion Datum as the *Cormohipparion* Dispersal Event from North America into Afro-Eurasia, owing to a sea-level lowstand during the early Late Miocene. Our results have far-reaching implications for Late Miocene biochronology in Afro-Eurasia (particularly, the definition of the Vallesian European Land Mammal Age) and provide a new starting point for disentangling the complex evolutionary history of one of the most emblematic horse lineages during the Neogene and Quaternary.

Keywords: Hipparion Datum, Paleobiogeography, Late Miocene, Vallesian, Equids

Abstract (Oral communication)

Symposium: S1

A new ornithopod dinosaur species and theropod-rich egg assemblage from the mid-Cretaceous of Aphaedo, Korea

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The Mesozoic record of the Korean Peninsula is striking in the abundance, preservational quality and diversity of footprints from an array of remarkable localities. In contrast, egg fossils attributable to small theropod dinosaurs have not previously been reported, and skeletal remains of dinosaurs are also exceedingly rare. Our research on new specimens from the mid-Cretaceous Ilseongsan Formation of Aphae Island (Aphaedo) has yielded the first avialan egg and a new small ornithopod dinosaur species known from a partial skeleton, including the first studied cranial remains of a dinosaur from Korea. X-ray micro-computed tomography (micro-CT) revealed the anatomy of the new neornithischian species and a new avialan oospecies. Phylogenetic analyses recover the new species as a thescelosaurid and further support Asia a potential ancestral area for this clade. The new tiny avialan theropod egg taxon is based on multiple eggs. These eggs lack surface ornamentation and, in thin section, show three distinct layers, characteristics uniquely observed within Avialae, including in crown birds. It is one of the earliest records of an egg showing these characteristics. The Aphaedo site, which preserves a total of five ootaxa attributed to theropods, is unique among Korean Cretaceous egg sites and most closely resembles select theropod-rich egg assemblages reported from other parts of Asia and North America. Such assemblages may reflect nesting preferences and/or preservational biases. One of Aphaedo egg types is preserved in an intact nest structure and two others are known from largely intact eggs, suggesting limited or no transport prior to deposition in overbank deposits of a floodplain environment.

Keywords: Dinosauria, Avialae, Eggs, Ornithischia, Asia

Abstract (Oral communication)

Symposium: S9

The d'Orbignys and their mollusks

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During a career of less than 30 years, French 19th century scholar Alcide d'Orbigny became one of the most prolific malacologists of all times. He named more than 5,000 new mollusc taxa, including 92 genera and 16 families. His numerous large, influential works include the 'Histoire naturelle, générale et particulière des céphalopodes' (with André de Férussac), the (unfinished) 'Paléontologie française' and the 'Cours élémentaire de paléontologie', which, besides their taxonomic and systematic achievements, helped establishing biostratigraphy as a science and laying the foundations of the geological timescale. His father and brother, Charles Marie and Charles Henry d'Orbigny, also studied mollusks, but described less than a dozen new species each. We assessed the malacological contributions of the three d'Orbignys and, listing all the new names, for the first time reveal the actual magnitude of Alcide's malacological work. For each species, information on type localities, type ages, type material and, where possible, the latest scientific opinion has been established. Precise publication dates were researched, and numerous nomenclatorial issues clarified. Alcide d'Orbigny coined hundreds of replacement names for junior homonyms, thus contributing greatly to a stable nomenclature. The resulting data can be analyzed in various ways, showing the impact of Alcide's research. For example, more than 60% of the new mollusk species he described are Mesozoic, while only 15% are Recent. A remarkably high number of genus- and species-level names coined by the d'Orbignys are still valid, and many of them represent type species or genera of valid genus- or family-level taxa. Thus, while Alcide d'Orbigny's work has not been received without criticism by his peers, it has aged well and remains a source of inspiration for further studies. Without the seminal contributions of taxonomists like Alcide d'Orbigny, today's palaeobiological research would be unthinkable.

Keywords: Taxonomy, Nomenclature, Cephalopoda, Gastropoda, Bivalvia

Weighing a Pleistocene giant: digital body mass estimation in *Palaeoloxodon antiquus*

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In this contribution, we estimate the body mass in two specimens of *Palaeoloxodon antiquus* from the Middle Pleistocene site of Grotte Santo Stefano (Italy), housed at the Museo Universitario di Scienze della Terra (MUST), Sapienza University of Rome, and the Giacomo Doria Civic Museum of Natural History. Body mass estimates for extinct tetrapods are commonly based on allometric equations derived from long bones of extant taxa. However, these methods are often problematic for extinct proboscideans, whose proportions differ markedly from those of modern elephants. To test this issue, traditional osteometric estimates were compared with a volumetric approach based on three-dimensional reconstruction. Digital models were produced through photogrammetry, using a micro-drone to capture otherwise inaccessible areas, improving reconstruction accuracy. Models were subsequently digitally refined through postural corrections and soft-tissue reconstruction. Calculated body volumes, combined with proboscidean-specific density values, yielded estimates of 10470 kg for the Rome specimen and 13290 kg for the Genoa specimen. Comparison with allometric results revealed marked discrepancies, highlighting the limits of methods derived only from extant analogues. Beyond research applications, high-resolution digital models are also valuable for conservation and museum outreach, reducing the need for direct handling while providing permanent digital archives. The results support volumetric reconstruction as a more reliable method for estimating body mass in extinct megafauna and demonstrate the growing importance of digital technologies in paleontology.

Keywords: *Palaeoloxodon antiquus*, Body mass, Digital models, Middle Pleistocene, Grotte Santo Stefano (Italy)

Late Ladinian (Middle Triassic) Alpine ichthyofaunas compared

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The Pelsa/Vazzoler (PV) *Lagerstätte* (Agordo Dolomites, Italy) is the richest vertebrate assemblage in the Dolomites. Recently, small fieldworks have yielded ~400 fish specimens (~20 species). The slightly older Kalkschieferzone (KSZ) (Italy-Switzerland) is the youngest fossiliferous unit of the Monte San Giorgio *Lagerstätte*. Since the 1980s, systematic field campaigns have unearthed several thousands of fishes (~27 taxa). Although both sites were in a tropical climate, PV was a small intraplateau basin within a carbonate build-up, surrounded by a rich reef-like biota, whereas the KSZ was a muddy shallow lagoon with periodical freshwater inputs, lacking marine benthic life.

PV and KSZ ichthyofaunas include mostly miniature and small actinopterygians but show contrasting assemblage structures. Apart from ubiquitous genera (*Peltopleurus*, *Saurichthys*), possibly other shared taxa are few (*Caelatichthys*, *Perleidus*). The KSZ is dominated by *Prohalecites*, a miniature advanced neopterygian that makes up to 95% of the fish specimens and is known only from KSZ and the Perledo area. Contrarily, PV is rich in *Marcopoloichthys* and *Placopleurus*, also advanced neopterygians, with a wide geographic and stratigraphic distribution across Tethys. Coelacanths and sharks are relatively common in PV, but much rarer in the KSZ. PV also includes the peltopleuriform *Thoracopterus wushaensis*, a flying fish originally described from China, and abundant *Habroichthys*, again as in the Xingyi Fauna.

About trophism, PV includes several suspension feeders (*Habroichthys*, *Marcopoloichthys*, *Placopleurus*), whereas in the KSZ active predators dominate also in the small taxa (*Prohalecites*, *Allolepidotus*, *Peltopleurus*, *Perleidus*, *Caelatichthys*). Top predators are medium-sized *Saurichthys* and coelacanths in both assemblages. Durophages are rare: *Felberia* in the KSZ, *Stoppania* and hybodontids in the PV, the latter possibly linked to the very rich benthic invertebrate fauna.

Keywords: Fish, Ichthyofauna, Triassic, Dolomites, Monte San Giorgio, Trophism

The fossils of the Crystalline Basement from Agordo (Belluno Dolomites): a challenging opportunity for interdisciplinary research on the Paleozoic of the Southern Alps

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The Lower Paleozoic lithostratigraphic sequence of Agordo remarkably preserves three distinct fossil assemblages in weak metamorphism: the Col di Foglia acritarchs in dark metapelites, the Ponte Alto graptolites with muellerisphaerids in nodules within dark phyllites, and corals in metalimestone boudins.

The acritarch assemblage dates to the late Cambrian; these microfossils represent the oldest biostratigraphic record in the Alpine region and peninsular Italy.

Graptolites and corals are preserved within nodules and boudins in a shear zone cutting low-grade metapelites. Graptolites indicate the early Aeronian '*Demirastrites*' *triangulatus* Biozone (Llandovery, Early Silurian). The massive rugose corals were tentatively assigned to the Middle Devonian by comparison with the Paleozoic succession of the Carnic Alps.

This association of different rocks, fossils, and ages raises key unresolved questions: 1) What were the paleoenvironments of northern Gondwana where acritarchs, graptolites, and corals lived? 2) How can Devonian corals be enclosed within Silurian metasediments? 3) Are they true coral colonies and really Devonian in age?

The Agordo phyllites and their fossil content offer potential for integrated paleontological, petrological, and structural studies. The use precise biostratigraphic data, perhaps accompanied by geochronology, could better constrain the pre-metamorphic stratigraphy and help unravel the complex structural history of the Paleozoic lithologies of Agordo during the Variscan Orogeny.

References:

Dieni I., Giordano D., Loydell D.K., Sassi F.P. (2005). Discovery of Llandovery (Silurian) graptolites and probable Devonian corals in the Southalpine Metamorphic Basement of the Eastern Alps (Agordo, NE Italy). *Geological Magazine* 142: 1–5.

Vecoli M., Dieni I., Sassi F., Servais T. (2008). Cambrian Acritarchs from the Col di Foglia (Agordo) southalpine metamorphic basement, Italian Eastern Alps: the oldest biostratigraphic record in the alps. *Rendiconti Lincei* 19: 45–55.

Keywords: Acritarchs, Graptolites, Corals, Metamorphick rocks, Crystalline Basement

Benthic Foraminiferal Response to Anthropogenic Pressure in the Gulf of Trieste: Preliminary Insights

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The Gulf of Trieste is a shallow, semi-enclosed bay located in the northernmost part of the Adriatic Sea. Given its peculiar climate, geography, and oceanography, the Gulf has experienced recurrent and severe bottom-water oxygen depletion events. These episodes, greatly documented during late summers of the 1980s, have been linked to anthropogenic nutrient inputs and water column stratification. Although intense, they were relatively short-lived, typically lasting 1–2 months. Further events impacting seabed oxygenation were related with recurrent, widespread mucilage blooms, documented from the 1990s through the 2000s. To assess the long-term impact of these environmental perturbations on the benthic communities, we analyzed the foraminifera retrieved within a sediment box core collected in 2012 from the deepest site of the Gulf of Trieste (about 25 m depth). Age of the core bottom is established at 1980 through ²¹⁰Pb and ¹³⁷Cs radionuclides, with a depositional rate of around 0.7 cm per year. TOC values increase from 0.7 at the bottom to 1.10% in the upper core. Foraminiferal ecological associations shift from epiphytic dominance in the lower interval (pre-1990) to infaunal dominance in the upper interval (1990–2012). These preliminary results appear consistent with the upward trend in TOC, suggesting a coupled influence of seasonal bottom-water oxygen depletion during the 1980s and the subsequent mucilage events of the 1990s and 2000s. These environmental changes likely forced benthic foraminifers to adapt to progressively organic-rich environment through time. Faunal density decreases towards the top core, where a reduction in size of some taxa (*Ammonia beccarii*, *Asterigerinata adriatica*, *Porosononion granosum* and *Bulimina* spp.) may reflect a decline in growth capacity, or phenotypic responses to environmentally stressful conditions.

Keywords: Benthic Foraminifera, Bottom Anoxia, Gulf of Trieste

Abstract (Oral communication)

Symposium: S1

RTI a new tool for imaging fossil tracks

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Ichnology is a relatively new science, starting in 1836 when Professor Edward Hitchcock first recognized and described dinosaur footprints from Massachusetts. Since then, one of the main challenges that ichnologists had to face was the representation of the tracks. For years, footprints representation in scientific papers have been limited to tracks outlines, which are already subjective interpretations. The advent of 3D modelling was a great improvement: digital data can be plotted in standardized ways to compare footprints and trackways worldwide, but light conditions are still mostly important to detect true anatomical details.

Here we investigate the combination of 3D technologies with Reflectance Transformation Imaging (RTI), an imaging technique widely used in cultural heritage, to enhance the readability of artifacts and specimens through dynamic lighting. Starting from models acquired via scanning technologies, we assess the impact of both RTI and VRTI (Virtual Reflectance Transformation Imaging) on the readability of paleontological footprints.

We further present a scalable Blender-based workspace designed to generate renderings comparable to those obtained through traditional RTI acquisition, while streamlining the visualization process. This approach is not intended to replace field-based RTI, but to provide paleontologists with a flexible and accessible alternative for re-examining track morphology. By enabling systematic variation of lighting conditions, it may reveal features otherwise overlooked and support more robust interpretation of track outlines.

Keywords: Footprints, Ichnology, RTI, 3D, Virtual Heritage

Breaking two decades of silence: New data on Barremian ammonites from dysoxic layers of the Maiolica Fm. (Umbria–Marche Basin, Central Italy)

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The Umbria–Marche Basin has long represented a cradle of ammonite research. Already the first generation of pioneers (e.g., Fucini, Canavari, Zittel, Meneghini) focused on the fossil-rich Jurassic successions while the Lower Cretaceous deposits (Maiolica Fm.) remained comparatively neglected due to the general rarity and poor preservation of the specimens. A turning point came in the late 1980s, when the ammonite-based biozonation spanning the Berriasian–Barremian was established by Cecca, Pallini, Faraoni and Marini. From the early 2000s onward, research activity progressively ceased, leaving the Lower Cretaceous ammonite knowledge of the Umbria–Marche area largely stagnant until the 2020s. Renewed investigations have enhanced our understanding of distinctive dysoxic layers (Conti et al., 2025 and unpublished data), providing new insights into their origin and significantly advancing the study of the ammonite assemblages that distinctly characterize them. The most significant results include: a) The discovery of abundant Leptoceratoididae in several horizons spanning the *N. pulchella*–*T. vandenheckii* Zones (lower/upper Barremian), across multiple sections; b) The first report of the genera *Deitanites*, *Moutoniceras* and *Euptychoceras* as well as of the species *Leptoceratoides ternbergense*, *Karsteniceras* cf. *hohenneggeri*, *Holcodiscus decorus* *H. nodosus*, *H. cf. diversecostatus*, *H. aff. cadoceroides* and *Kotetishvilia sauvageau*.

The recognition of several Leptoceratoididae-rich horizons demonstrates that this family was locally abundant also on the Adria microplate. Comparable occurrences in Austria (Lukeneder, 2005) and Hungary (Göggös & Szives, 2024), together with their proposed ecological significance (Conti et al., 2025), provide key constraints for regional paleoecological considerations. Moreover, the identification of previously unreported taxa in the Umbria–Marche Basin provides robust biostratigraphic and paleobiogeographic links with major European reference areas (e.g., Vocontian Basin, Subbetic and Prebetic domains, Transdanubian Range), suggesting that this basin preserve an integral component of the Early Cretaceous Mediterranean Tethyan paleobiogeographic mosaic.

References:

- Conti, C., Faraoni, P., Mancini, A. M., Martire, L., Negri, A. (2025). Unusual mass-occurrence of small, uncoiled ammonites in a Barremian black shale of the Maiolica Formation in the Umbria-Marche Basin (Central Italy). *Bollettino della Società Paleontologica Italiana*, 64(3): 517–543.
- Göggös G. & Szives O. (2024). First report of the Mid Barremian Event from the Transdanubian Range (Hungary) and associated Leptoceratoididae (Ammonoidea) fauna. *Hungarian Geological Society*, 154: 199–238.
- Lukeneder A. (2005). An equivalent of the *Karsteniceras* level within the Vienna woods (Sparbach section, Lunz nappe, northern calcareous Alps, Lower Austria). *Geologica Carpathica*, 56: 307–315.

Keywords: Maiolica, Ammonites, Barremian, Paleoecology, Paleobiogeography

Feeding capabilities of thalattosuchians through the lens of biting performance

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Thalattosuchia is an extinct group of aquatic crocodylomorphs globally distributed from the Early Jurassic to the Early Cretaceous. Most species possessed elongated snouts capable of delivering a rapid bite, comparable to those of extant longirostrine crocodilians. However, some lineages evolved more robust skulls and dentition, interpreted as hypercarnivorous such as *Dakosaurus*. While several studies have investigated the biomechanics of thalattosuchian crania, few have focused on mandibular biomechanical performance. Here, we compared biting performance in numerous thalattosuchians and extant crocodilians using high-definition 3D models. This study aims to quantify thalattosuchian feeding capabilities using realistic bite simulations, performed via muscle-driven finite element analyses (FEA). Muscle attachment sites were mapped on the skull and mandibles to reconstruct three-dimensionally the jaw adductor musculature and estimate muscle forces. Biting simulations were performed considering a bilateral bite at mid-dentigerous length with a 10° gape angle. In parallel, an artificial intramandibular fenestra was added to metriorhynchids to determine whether the loss of this feature benefited biting performance. Our results reveal a diversity in biting performance across Thalattosuchia. Elevated internal energy values in teleosauroids and basal metriorhynchoids suggest that maximal muscle force was not recruited during biting, pointing toward a predatory strategy suited to small, soft prey items. In contrast, extant longirostrine crocodilians exhibit significantly lower internal energy values despite similar bite forces. Derived, unrelated taxa such as *Machimosaurus* and *Dakosaurus* evolved jaws generating powerful bites with high mechanical efficiency, while differences in stress patterns suggest distinct feeding niches. Our findings offer practical insights into the feeding habits of thalattosuchians and biomechanical constraints that characterized their evolution.

Keywords: Thalattosuchia, Finite element analysis, Feeding biomechanics, Biting performance, Mechanical efficiency

Abstract (Poster)

Symposium: S9

Middle Jurassic ammonites of Monte Nerone (Umbria-Marche Apennines, Italy)

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The poster illustrates a selection of Middle Jurassic ammonite species from the nodular limestones of the Bugarone Group. These species, cited in many biostratigraphic and chronostratigraphic contributions (Cecca et al., 1990; Cresta et al., 1995; 2002; Cresta 2025), have never been the subject of an illustrated paleontological study. Each of the 27 species was chosen for its bio-chronostratigraphic value, functional for chronostratigraphic correlations with other areas of the western Tethys.

References:

Cecca F., Cresta S., Pallini G. & Santantonio M. (1990). Il Giurassico di Monte Nerone (Appennino marchigiano, Italy centrale): biostratigrafia, litostratigrafia ed evoluzione paleogeografica. Proceedings 2nd Pergola International Symposium "Fossili, Evoluzione, Ambiente" (Pergola, 1987): 63–139.

Cresta S., Basilici G., Bussoletti A., Comas M.J., Elmi S., Fernandez Lopez S., Ferretti A., Goy A., Henriques M.H., Kalin O., Jimenez A., Martinez G., Sandoval J., Ureta S., Venturi F. (1995) – Relazione sul workshop "Paleontologia e biostratigrafia dei sedimenti ammonitiferi toarciano-bajociani in successioni di alto morfostrutturale dell'Appennino umbro-marchigiano: l'area di Monte Nerone. Correlazioni con altre regioni della Tetide occidentale". Bollettino Servizio Geologico d' Italy, vol.CXII (1993): 129-139.

Cresta S. Coccioni R., Diligenti A., Di Pietro D., Duronio F., Grippo A., Marini A., Marinucci D., Ureta S. (2002). The Paleontological Monument of Monte Nerone (Umbria Marche Apennines). Field trip guide of 6th International Symposium on Jurassic Stratigraphy, 221–247.

Cresta S. (2025) Ammoniti e Biostratigrafia del Toarciano superiore - Bajociano inferiore (Giurassico) di Monte Nerone (Appennino Marchigiano). Paleodays 2025, Catania

Keywords: Jurassic, Aalenian, Bajocian, Apennines

No heroic “Out-of-Africa” dispersal, just a passive Afrotropical realm extension follow-up

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We reassess the “Out of Africa” Early Pleistocene hominin dispersal paradigm using new faunal, paleoenvironmental, and paleobiogeographic data from the Olteț River Valley (Valea Grăunceanului, Romania), dated to ≥ 1.95 Ma. The mammalian assemblage includes thermophilous and African-affiliated taxa (giraffids, pangolins, large cercopithecids), while stable isotope data indicate mild winters and hydroclimatic seasonality at $\sim 45^\circ\text{N}$. Cut-marked bones demonstrate hominin presence within this ecological context. Together with the hominin record from Dmanisi, these data support a new hypothesis explaining the presence of early hominins in the Black Sea basin.

Paleoclimatic and biogeographic evidence indicates episodic reductions in Saharo-Arabian aridity, facilitating connectivity between Africa and Southwest Asia and enabling the northward expansion of African-derived faunas. The fauna of Bethlehem ($>3\text{--}2.5$ Ma) exemplifies an early stage of this reorganization, reflecting the expansion of the Afrotropical realm into the Levant. Although Anatolia, the Caucasus, and southeastern Europe remained outside this realm, episodic incursions of African taxa into these regions are well documented.

Subsequent climatic shifts associated with intensification of Northern Hemisphere glaciation fragmented Afrotropical ecosystems in the Levant and caused their southward retreat. Relict populations of African-affiliated taxa, including hominins and *Smutsia*, persisted in Southwest Asian and southeastern European refugia. We propose that the Early Pleistocene hominin record in Europe reflects passive biome tracking within a temporarily expanded Afrotropical system, followed by dispersal into refugial regions such as the Lower Danube Plain. This Biome-Tracking Model supersedes the traditional anthropocentric “Out of Africa” framework by viewing hominins as components of a broader faunal shift involving taxa such as *Smutsia* and *Theropithecus*, rather than exceptional agents of dispersal.

Keywords: Hominin dispersal, Early Pleistocene, Paleobiogeography, Lower Danube Plain

Ammonite biostratigraphy and paleobiogeographic signals in a condensed Jurassic succession from the Sciacca area (western Sicily, Western Tethys)

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The Middle–Upper Jurassic succession exposed at Contrada Nadorello (southwestern Sicily), along the outermost sector of the Sicilian–Maghrebian fold-and-thrust belt, represents a highly condensed pelagic record developed on a structural high along the southern margin of the Western Tethys.

Following the completion of bed-by-bed sampling, microfacies analyses, and taxonomic and taphonomic investigations of the ammonite assemblages, this study provides a refined reconstruction of the depositional dynamics and paleobiogeographic significance of the succession. The investigated sections, spanning from the Upper Bajocian to the Lower Tithonian, are characterized by nodular to pseudonodular limestones (Petrella et al, 2025), recurrent Fe–Mn crusts, and pronounced lateral thickness variations, reflecting persistent sediment starvation and strong bottom-current activity as confirmed by the ammonite taphonomic features.

Integrated ammonite biostratigraphy and microfacies analyses reveal a markedly discontinuous stratigraphic record interrupted by several hiatuses, including a major gap across the Callovian–Oxfordian interval. The ammonite fauna displays a predominant Mediterranean character, including typical Tethyan Phylloceratina, but also taxa less commonly reported from Sicilian Jurassic successions, suggesting intermittent faunal exchanges with Submediterranean and NW European domains. The integration of biostratigraphic, taphonomic, and sedimentological data demonstrates that condensed ammonite-bearing successions are highly selective records in which sedimentary dynamics, paleoceanographic processes, and faunal distribution patterns are closely interconnected.

References:

Petrella, F., D'Arpa, C., Morticelli, M.G., Todaro, S., Rizzo, G.F., Gennuso, M. & Sulli, A., 2025. Preliminary biostratigraphic data from the Upper Bajocian–Kimmeridgian succession of the Contrada Nadorello section (Sciacca area, SW Sicily, Italy). *Paleodays 2025*, Catania: 37.

Keywords: Ammonite biostratigraphy, Jurassic, Western Tethys

Permian petrified forests from the Parnaíba basin: stem anatomy and insights into responses to environmental changes in Pangea

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During the late Paleozoic, continent-scale tectonic processes culminated in the formation of Pangea and led to increased seasonality and aridity in continental interiors. These changes had a significant impact on terrestrial paleoecosystems. Abundance of spore-producing vascular plants adapted to humid habitats have been significantly reduced, whilst seed plants, which are better adapted to more dynamic conditions, have spread widely. Adaptive strategies, including anatomical modifications of the wood, may have played an essential role in the spreading, persistence and survival of these plants under unstable paleoenvironmental conditions. This study analyzes fossil wood anatomy from the lower Permian of the Parnaíba Basin (Brazil, central Pangea), focusing on the pith and secondary xylem to explore relationships with plant responses to environmental changes. Approximately 25 gymnosperm samples were examined using standard thin sections. The specimens exhibit heterogeneous anatomy, including irregular tree rings, reduced tracheid diameters, piths with canals, ducts, septa or lacunae, and axial parenchyma. Taken together, all these features, supported by various geological evidence and coeval anatomical characteristics from spore-producing vascular plants, indicate functional responses to paleoenvironmental variability and increasing ecological stress. The occurrence of axial parenchyma, relatively uncommon in Paleozoic gymnosperms, further supports interpretations of tolerance to water stress and nutrients storage under fluctuating paleoclimatic conditions. As an outlook, a forthcoming comparison with other early Permian localities, such as the Chemnitz Petrified Forest in central Germany, will test whether the anatomical features recognized in plants from the Parnaíba Basin reflect local conditions or broader patterns across the Pangea supercontinent.

Keywords: Brazil; Gymnosperms; Paleozoic woods; Subtropical paleoclimate

First record of dinosaur footprints in Lombardy (Italy): the exceptionally rich Stelvio megatracksite (Late Triassic, Austroalpine Domain)

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On September 15th 2026, several steeply-dipping bed surfaces bearing large fossil tracks of terrestrial vertebrates were reported to the Italian authorities by one of us (EDF) from the Fraele Valley, within the Stelvio National Park (Lombardy, Northern Italy). Tracks are preserved in dolomitized shallow-water carbonate facies of the Dolomia Principale cropping out along the slopes of Cime di Plator and Cima Doscopa, overlooking the Cancano Lakes. The Dolomia Principale, Norian in age, testifies a wide carbonate platform that can be traced from the Southern Alps to the Austroalpine units, locally preserving dinosaur tracks.

Preliminary analyses, based on *in situ* observations, photographs, and aerial (UAV) imagery allowed the mapping thousands of footprints, likely produced by bipedal sauropodomorph dinosaurs. Despite weathering at high altitudes, many tracks preserve diagnostic features, including elongate heels and tetradactyl digit impressions, suggesting a possible attribution to the ichnogenus *Pseudotetrasauropus*.

Many tracks are deeply impressed, indicating water-saturated carbonate muds, later dolomitized. These facies were likely deposited on a low-energy carbonate platform, characterized by depositional conditions from subtidal to intertidal. Footprints preserving well-defined natural casts, infilled by darker sediments that blanketed the lighter carbonate mud shortly after track formation, point to a cyclic facies organization. Several palaeosurfaces are heavily “dinoturbated”, due to extremely high track density.

Although discontinuous due to erosion, the track-bearing surfaces are exposed along seven different ridges across at least six stratigraphic levels. To date, at least 26 track-bearing outcrops have been identified over approximately 4.5 km. The Plator–Doscopa area thus represents the largest ichnosite in the Alps and one of the most extensive dinosaur tracksites worldwide for the Triassic. More investigations are ongoing.

Keywords: Dinosaur footprints, Megatracksite, LateTriassic, Stelvio National Park, Northern Italy

Abstract (Oral communication)

Symposium: S18

A new archosaur (Reptilia, Diapsida) from the Triassic of Austria

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The marine Partnach Formation (Ladinian-earliest Carnian) near Jadersdorf (Gitschtal, Hermagor) in the Gailtal Alps of Carinthia (Austria) yielded the remains of sauropterygian reptiles (the nothosaur *Carinthiasaurus kandutschii* and still undescribed pachypleurosaurs; Klein et al., 2025) and a still undescribed *Macrocnemus*-like tanystropheid. A partial skeleton of a small reptile with a distinctive maxilla, dentition, caudal vertebrae and osteoderms, represents a new taxon from this formation and locality. It is an archosaur diagnosed by autapomorphies in the anterior process and subnarial foramen of the maxilla, accessory articular processes in the neural arches of mid-distal caudal vertebrae, and shape and arrangement of the caudal osteoderms. It also shows a unique combination of features regarding the extent of the antorbital fossa in the maxilla and the morphology of its ventral margin, dentary shape, dentition, and the elongation and shape of the caudal vertebrae. The segment of 16 mid-distal caudal vertebrae is one of the better articulated tail segments ever found in Triassic archosaurs, showing the arrangement of the dorsal osteoderms and the presence of accessory processes in the neural arches stiffening the posterior termination of the tail. Phylogenetic analysis recovered the specimen as a pseudosuchian in a basal position within the Poposauroidae. Terrestrial habits for this archosaur reptile are suggested by the absence of swimming adaptation in the tail and the presence of terrestrial plant remains in the same outcrop.

References:

Klein N., Furrer H., Dojen C., Lukeneder A. & Scheyer T.M. (2025). A new nothosaurid taxon from the Middle Triassic of Carinthia, Austria. *Austrian Journal of Earth Sciences*, 118(1): 141–155.

Keywords: Reptilia, Archosauria, Poposauroidae, Alpine Triassic, Austria

Molluscan biodiversity in the Mediterranean Sea during the Last Interglacial

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The Last Interglacial (LIG, 129–116 ka) is considered an excellent climate analogue for forecasted moderate warming scenarios, as global temperatures were around 1.5 °C higher than pre-industrial levels. The Mediterranean Sea has an excellent fossil record of LIG marine mollusks. Some species, known as “warm guests” (WGs), such as the iconic gastropod *Tethystrombus latus*, are of clear palaeoclimatic and paleobiogeographic significance, as they are tropical Atlantic species that during the LIG underwent a northern range expansion and temporarily colonized the basin due to warming. Although LIG mollusks have been studied extensively over the last two centuries, a review of the available literature was needed to contextualize the data within a modern framework. We compiled a dataset comprising over 100 fossil sites across the basin. For the first time, we documented a west-to-east decline in mollusk biodiversity, similarly to that observed in the present day. Revising the list of WGs, which now includes 23 species, we found that they were more prevalent in the eastern part of the basin, mirroring seawater palaeotemperatures. No WGs were reported in colder regions such as the Gulf of Lyon, the Adriatic Sea, and the northern Aegean Sea. Our results are relevant to our understanding of possible, future biodiversity scenarios for the Mediterranean Sea. If future warming recreates a climatic connectivity along north-west Africa, as predicted under intermediate warming scenarios, tropical Atlantic species will recolonize the Mediterranean. Alongside the ongoing Indo-Pacific invasion through the Suez Canal, this would irreversibly transform the entire Mediterranean Sea.

Keywords: Climate Change, Pleistocene, Warming, Tropicalization

Assessment of Notosuchia phylogenetics through tip-dating Bayesian inference

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Notosuchia is a diverse group of predominantly terrestrial crocodyliforms that inhabited Gondwana during the Cretaceous Period spanning until the Middle Miocene, as evidenced by the fossil record of South America. The combination of fossil discoveries, reassessment of historical taxa and comprehensive dataset refinement marks progress in Notosuchia systematics. Phylogenetic analyses of Notosuchia predominantly rely on maximum parsimony, although few studies have included notosuchians in Bayesian analyses of broader crocodyliforms. The monophyly of Notosuchia and major lineages (e.g. Baurusuchia, Sebecidae) is commonly well-supported, whereas constant expansion of data matrices is inevitably accompanied by contentious internal clade support depending greatly on the dataset used. Nevertheless, studies still elaborate on the nomenclature and evolution of internal clades, leading to potentially misleading discussions on evolutionary and biogeographical patterns. Here, we use two comprehensive Notosuchia-centered datasets accounting for differences in taxon coverage and character composition to provide a robust assessment of Notosuchia systematics under a tip-dating Bayesian inference using RevBayes. Our time-calibrated trees strongly support the abovementioned major notosuchian lineages, whereas many internal clades show extremely poor posterior probability support (e.g. Peirosauridae, Pepesuchinae). Specifically, ambiguity on the phylogenetic position of lineages crossing the Cretaceous-Paleogene (KPg) boundary (i.e. sebecids) complicates precise divergence age estimates. Hence, our results demonstrate inherent limitations of the fossil record and complexity of elaborating on the evolution of Cenozoic notosuchian lineages. Our results emphasize that assessing Notosuchia systematics through integrative methodological approaches is key to investigate Notosuchia evolutionary history and paleobiology, transcending terminology delimitations.

Keywords: Notosuchia, Bayesian inference, Tip-dating, Macroevolution, Systematics

Paleoparasitological potential of Permian-Triassic vertebrate coprolites

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The Permian-Triassic extinction, a major biodiversity crisis driven by climate stressors, coincides with helminth diversity shifts in bromalites and inferred host switches in modern phylogenies. While tapeworms were previously found in a Permian coprolite, the oldest ascaridoid and oxyurid nematodes date to the Triassic. Prior focus on only Paleozoic shark bromalites and Mesozoic tetrapod coprolites has limited understanding of diversity dynamics and host switching within and between parasitic lineages.

We analyzed inclusions in additional fish and tetrapod coprolites. Three new tapeworm types in Permian Rio do Rasto Formation spiral coprolites raise total abundance to 6%, reconstructing life cycles involving paleonisciform fishes as intermediate hosts and sharks as final hosts. Among 32 thin sections of fish coprolites, no ascaridoid nematodes were found, consistent with their inferred post-Permian colonization of sharks and teleosts. Ascaridoids remain restricted to Triassic coprolites previously tentatively attributed to archosaurs and therapsids, while oxyurids are known only from two putative therapsid coprolites at a single Triassic locality.

Further analysis of Permian-Triassic localities and phylogenetic modeling are needed to clarify parasite extinction and host switching. Polish sites like Miedary, yielding over 800 coprolites from diverse vertebrates, are crucial. Preliminary dissolution of a non-spiral coprolite found no parasitic remains, yet organic material in the 20–80 µm range highlights suitable preservation for discovery through analysis of more material.

This research was supported by the National Science Centre, Poland (grant no. UMO-2024/53/B/NZ8/03528, OPUS 27) to KDB.

Keywords: Paleoparasitology, Macroevolution, Extinctions, Helminths, Co-evolution

Not what they eat, but where they live: habitat, not diet, drives cranial evolution in living and fossil odd-toed ungulates (Perissodactyla)

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In this project, we investigate cranial modularity and integration across the order Perissodactyla, which includes three extant families: Equidae, Rhinocerotidae, and Tapiridae; together with 15 fossil taxa spanning approximately 55 million years. Using three-dimensional geometric morphometrics on 48 specimens (22 fixed landmarks and two semilandmark curves), we test seven hypotheses of cranial modularity and build a supertree based on published molecular phylogenies (Álvarez-Carretero et al., 2022) and Bayesian tip-dating (BEAST2). Both the Covariance Ratio and EMMLi methods, with and without phylogenetic correction, consistently support a five-module organization comprising the nasal, palatine, zygomatic, vault, and basicranial regions (CR = 1.050, $p = 0.001$). The palatine module exhibits the highest within-module integration ($p = 0.77$), suggesting strong functional constraint likely linked to mastication. Yet, despite this strong integration of the feeding apparatus, feeding strategy does not significantly predict cranial shape. Habitat type, however, significantly influences cranial morphology ($R^2 = 0.19$, $p = 0.003$), challenging the expectation that cranial modularity in perissodactyls primarily reflects dietary adaptation. Phylogenetic signal, when assessed through eigenanalysis (Mitteroecker et al., 2024), reveals significant signal concentrated in few shape dimensions (traceK $p = 0.005$), a pattern masked by conventional Kmult ($p = 0.113$). Our results suggest that high modularity in the perissodactyl cranium facilitated independent evolutionary responses to habitat shifts rather than dietary specialization across the history of this clade.

References:

- Adams D.C., Collyer M.L. (2024). *Methods in Ecology and Evolution*, 15: 2234–2246. Álvarez-Carretero S. et al. (2022). *Nature*, 602: 263–267.
- Mitteroecker P. et al. (2024). *Systematic Biology*, 74: 215–229.

Keywords: Geometric morphometrics, Cranial modularity, Perissodactyla, Integration, Phylogenetic comparative methods

Abstract (Oral communication)

Symposium: S13

Resizing the predators: estimation of body mass and in-vivo reconstruction of two Sphenacodontidae family members

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Body mass (BM) is a key biological trait in animals, closely linked to ecological and physiological processes (Brassey, 2016). However, its estimation remains challenging in early amniotes such as basal non-therapsid synapsids. Here, we present the first volumetric body mass estimates and *in-vivo* reconstructions of two basal synapsids of the family Sphenacodontidae, *Dimetrodon* and *Sphenacodon*, based on composite-mounted skeletons on display at the Field Museum of Natural History, Chicago. Sphenacodontids are regarded as apex predators of the early Permian, making them essential for understanding the evolution of large body size in tetrapods and their ecological role. Using 3D photogrammetric models, we estimated body mass ranges by applying a range of density values representative of living tissues to the *in-vivo* reconstructions. Comparison with classical regression-based methods shows that traditional formulas yield broader and less reliable estimates, often over- or underestimating body mass. These discrepancies likely reflect differences in limb proportions between extinct and extant taxa, particularly those related to sprawling posture. Our results highlight the limitations of regression equations when applied to early tetrapods and support the use of volumetric approaches as more reliable tools for estimating body mass.

References:

Brassey, C. A. (2016). Body-mass estimation in paleontology: a review of volumetric techniques. The Paleontological Society Papers, 22, 133–156.

Keywords: “Pelycosaurs”, Non-therapsid synapsids, Sphenacodontidae, Permian, Photogrammetry, Body mass

A window into the past: Arthropod diversity preserved in Colombian copal

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Copal is considered a subfossil resin with a maximum age of about 2.58 Ma. Due to its comparatively young age, copal has received far less scientific attention than amber. Nevertheless, it represents an important link between the fossil record preserved in amber and modern ecosystems.

Colombian copal has been dated to approximately 70 to 10.600 years before present, making it particularly suitable for studying biodiversity changes over relatively short timescales till recent. Resin inclusions can provide valuable insights into the composition of past ecosystems and may help to understand ongoing biodiversity change.

In this study, a remarkable piece of Colombian copal from the collection of the Museum für Naturkunde Berlin was documented. The specimen (128 × 79 × 8 mm) contains more than 130 arthropod inclusions belonging to several groups, including various dipterans, coleopterans and hymenopterans, and representatives of Archaeognatha, Mantispidae, Heteroptera, Dictyoptera, Lepidoptera, and Arachnida. This preservation of multiple organisms within a single piece reflects a part of the diversity of the past ecosystem, capturing representatives with a variety of ecological niches and life strategies, including predators and parasites.

Although copal represents only a short time window of a few thousand years, such assemblages provide insights into past community composition and allow comparisons with modern ecosystems, potentially also revealing shifts in taxonomic diversity.

Keywords: Copal, Biodiversity, Insects

Resilience and turnover of the reptiles in the Aldabra Atoll (Seychelles)

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The Aldabra Atoll in the Seychelles hosts the world's last reptile-dominated ecosystem, with over 150,000 giant tortoises (*Aldabrachelys gigantea*). Despite the exceptionally high density of this species, the present-day native reptile diversity is remarkably low, comprising only one gecko and one skink in addition to the tortoises.

Fossil evidence from the Late Pleistocene (Arnold 1976; Brochu 2006; Scheyer et al. 2018) reveals a substantially richer assemblage, including the extinct "miniature horned crocodile" (*Aldabrachampsus dilophus*), a relatively large oplurid "iguana", three gecko species, and a skink. At least two marine transgressions that submerged the atoll led to repeated extinction and recolonization events, driving significant faunal turnover. Among these taxa, only the giant tortoises appear to have shown marked resilience, being constantly present in all the assemblages.

Recent advances in our understanding of Aldabra's reptile fauna stem from the 2021 University of Zurich expedition, supported by SIF; which recovered new material of tortoises, crocodiles, "iguanas", and geckos. Of note are the first articulated and associated crocodile remains from the atoll. These findings indicate that the endemic crocodile was not a miniaturized species, as previously thought, and likely belonging to the genus *Crocodylus*. This large predator could have sustained a viable population by preying upon the giant tortoises, a hypothesis supported by the fossil record itself.

References:

- Arnold E.N., 1976. Fossil reptiles from Aldabra Atoll, Indian Ocean. Bulletin British Museum, 29: 85–116.
- Brochu C.A., 2006. A new miniature horned crocodile from Quaternary of Aldabra Atoll, Western Indian Ocean. Copeia, 2006(2): 149-158.
- Scheyer T.M., Delfino M., Klein N., Bunbury N.J., Fleischer-Dogley F. & Hansen D.M., 2018. Trophic interactions between larger crocodylians and giant tortoises on Aldabra Atoll, Western Indian Ocean, during the Late Pleistocene. Royal Society Open Science, 5: 171800.

Keywords: Insular ecosystems, *Aldabrachelys gigantea*, *Aldabrachampsus dilophus*, *Oplurus*, Extinction, Dispersal

The invertebrate Paleozoic–Mesozoic fossil record of pre-angiosperm palynivory

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Biotic pollination is a key mutualistic interaction in terrestrial ecosystems, yet its evolutionary origins remain uncertain. Palynivory, the consumption of spores and/or pollen, has been proposed as a precursor to insect-mediated pollination. Here, we review the fossil record of invertebrate bromalites (coprolites and gut contents) containing spores and pollen from non-angiosperm plants across the Paleozoic and Mesozoic, synthesizing data accumulated since earlier studies. Early records from the Silurian–Devonian are dominated by detritivorous consumption of a variety of spores, mixed to other organic and inorganic remains, indicating spore opportunistic feeding. During the Carboniferous, increasing plant and insect diversification coincides with greater dietary specialization, occurrence of herbivory and the first evidence of pollen consumption. In the Permian, a shift from sporivory- to pollinivory-dominated floras occurs, likely linked to environmental changes and the rise of seed plants. In contrast, the Mesozoic record is sparse, limiting its interpretation. The fossil record of palynivory is strongly biased by preservation, methodological limitations, and uncertainties in the botanical affinity of the spores and pollen. Although often considered a precursor to biotic pollination, direct links between pollen consumption and gymnosperms pollination mutualisms remain difficult to establish. Among the different non-angiosperm plants supposed to be involved in pollination, only cheirolepidiacean pollen grains have been found so far in bromalites. This review highlights the need for standardized and targeted methodologies to better document palynivory and clarify its role in the evolution of plant–insect interactions.

Keywords: Bromalites, Plant-insect interactions, Pollination, Palynology

Wing venation intra-specific variability and sexual size dimorphism assessed in the Permian Orthoptera *Thuringoedischia trostheidei* (Insecta)

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Consistent delimitation of fossil species is necessary to derive reliable abundance estimates. But a high level of intra-specific variability and/or strong polymorphism can lead to an overestimation of the number of species actually present in a sample. The extent of these phenomena can be difficult to assess, especially when the fossil sample is limited and when no closely related species, extant or fossil, can be used as a reference. Nonetheless, paired organs within a single individual, such as insect wings, can provide a means to estimate intra-specific variability based on the intra-individual variations; and a decently large sample may allow suspecting a case of sexual size dimorphism (SSD). Based on extant forms and a few well-documented fossil species, both variability and SSD are expected to occur at moderate levels in stem-relatives of crickets and grasshoppers (Orthoptera). We examined a sample composed of 31 specimens of stem-Orthoptera from the Cabarz and Sperbersbach localities (Asselian, Germany), presumed conspecific. Eight specimens preserve a complete forewing pair, revealing that the number of terminal branches of RP, MA and CuA+CuP α , as well as the length of the anastomosis between RP and MA, varies considerably. The distribution of wing sizes points towards a female-biased SSD. Altogether, these data indicate that the 31 specimens are indeed conspecific and can be assigned to *Thuringoedischia trostheidei* Zessin 1987. This contribution underscores the importance of accounting for morphological variability in taxonomic studies of Paleozoic Orthoptera and highlights the need for a critical reassessment of Oedischioidea systematics.

Keywords: Asselian, Thuringia region, Intra-individual variability, Wing morphology

Derivative landmarking corroborates convergence in Mesozoic marine reptile skulls and their feeding performance

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During the Mesozoic, several reptile clades independently radiated into the marine realm. Aquatic environments impose strong constraints on feeding and mobility, which, in turn, drove morphological convergence in their cranial anatomy. Studies of form-function relationships in these groups have often relied on continuous and discrete traits, largely due to preservation biases, such as the prevalence of slab specimens. Landmark-based geometric morphometrics offers a more transparent representation of shape, yet the gap between these two methods has rarely been bridged. Here, we propose 'derivative landmarking', a novel method to convert linear measurement datasets into fixed landmark coordinates that capture functionally relevant proportions of the skull and mandible. Using Mesozoic marine reptiles as a case study, we analyzed an extensive dataset of linear craniomandibular measurements. The resulting morphospaces reveal functional convergence among clades, notably among polycotylid plesiosaurians, slender-snouted pliosauroids, and ichthyosaurians. We then employed the R package *Morphoscape* to generate performance landscapes for key functional proxies, such as bite force and jaw-opening speed, to test for convergence in performance rather than in general shape. High bite force values align with morphospace regions occupied by mosasaurids, thalattosuchians, and short-snouted elasmosaurids, while elevated jaw-opening speed characterizes polycotylids and ichthyosaurians. A combined adaptive landscape helped visualize the morphospace through functional optimality, underlying convergent optimal morphologies across unrelated lineages, such as mosasaurids and derived metriorhynchids. Derivative landmarking is proposed as a practical, accessible method for (i) extensive taxonomic sampling and (ii) repurposing existing linear datasets, enabling confirmation of previous findings and expanding morpho-functional analyses for groups heavily affected by preservation biases.

Keywords: Mesozoic marine reptiles, Feeding performance, Geometric morphometrics, Derivative landmarking, Adaptive landscapes

Abiotic drivers of cranial functional disparity in Mesozoic marine reptiles

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The wide array of cranial shapes exhibited by Mesozoic marine reptiles reflects both the longevity of certain clades (e.g., Ichthyosauromorpha, Sauropterygia) and their capacity to adapt to diverse ecological roles throughout their evolutionary history. The Mesozoic saw profound environmental changes, including mass extinctions, anoxic oceanic events, and major regressions/transgressions. These profound events may have driven ecological selectivity among marine predators. However, testing these hypotheses has been challenging due to preservation biases that severely affect taxonomic diversity. Since disparity is often decoupled from species richness, quantifying the functional shapes of Mesozoic marine reptile skulls might reveal new connections with changes in environmental factors. In this work, we introduce the largest dataset of functionally informative craniomandibular traits of marine reptiles ever assembled, comprising measurements from over 600 taxa across 21 Mesozoic time bins. Analyses of functional disparity reveal peaks during the Mid Triassic and Early Cretaceous, driven by the substantial expansion of functional morphospaces by coastal durophagous groups (placodonts and sea turtles, respectively). Through generalized differencing, we detrended overall disparity and group-specific disparity curves, as well as fluctuations in abiotic factors such as sea level, continental flooding extension, and continental fragmentation. We then tested for correlations within the same time bin and with a one-bin lag between these datasets. While most clades only showed isolated relationships between disparity and abiotic factors, ichthyosauromorphs consistently exhibited significant negative correlations with both sea level and continental flooding, suggesting sensitivity to these environmental shifts. These findings provide initial insights into the evolutionary drivers influencing Mesozoic marine predators and suggest potential relationships with abiotic conditions.

Keywords: Mesozoic, Marine reptiles, Functional disparity, Ecological selectivity, Abiotic factors

From collections to computation: building structured paleontological datasets for AI-ready workflows

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The use of Artificial Intelligence (AI) in paleontology is limited by the availability of structured, accessible, and annotated datasets, as well as the incomplete and biased nature of the fossil record (Yu et al., 2023). Natural history collections represent a vast but underused resource that could help address these limitations.

Here, we present our ongoing efforts to digitize and standardize a major paleontological collection within the framework of the GeoSphere Austria initiative, comprising over one million specimens, and over 128,000 database records, including over 25,000 type specimens across vertebrates, invertebrates, microfossils and plants.

Our work focuses on transforming heterogeneous data into standardized, machine-readable formats, following methods such as Darwin Core. In doing so, we address key challenges such as inconsistent metadata, data completeness, and the need for standardized taxonomic and stratigraphic information. We also focus on visual documentation, including images of specimens and labels. Once openly accessible with structured metadata, these resources can support research and serve as training data for AI methods, especially for image classification and label information extraction. Tools such as Transkribus are also explored to support the transcription of historical collection data.

The broader aim is to prepare these data for publication through infrastructures such as the Open Scientific Collections Austria (OSCA), GBIF and a planned GeoSphere Austria collection portal, improving access and reuse. Although machine learning applications have not yet been implemented, this work provides a basis for future AI-driven analyses, while underlining the importance of taxonomic expertise, since the quality and consistency of both metadata and training data ultimately rely on expert identification and curation.

References:

Yu, C., Qin, F., Watanabe, A., Yao, W., Li, Y., Qin, Z., ... , Xu, X. (2023). AI in paleontology. *bioRxiv*, 2023–08.

Keywords: Database, AI, Collection, Darwin Core

Regionalization in the flipper of Cetacea

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The evolutionary transformation of cetacean forelimbs into flippers is accompanied not only by changes in external appearance but also by significant internal modifications of the skeletal structure, including alterations in digit number and phalangeal organization, such as hyperphalangy. While there is evidence showing that these structural adaptations are crucial in optimizing the hydrodynamic properties, we currently lack knowledge about evolutionary patterns.

Here, we quantified morphological variation in metacarpals and phalanges across extant cetaceans to identify patterns of modularity and integration within the flipper skeleton. The landmark-based 3D geometric morphometrics showed that shape primarily varies according to digit identity, indicating strong vertical patterning across the manus. Within digits, centroid size decreases from proximal to distal elements, reflecting consistent morphological gradients. Hierarchical clustering revealed greater similarity among phalanges within digits than between homologous elements, supporting a digit-centered modular organization. Hyperphalangy is linked to increased morphological similarity within affected digits, suggesting integration associated with shared developmental pathways. Our comparative analyses reveal taxonomic-specific differences between Mysticeti and Odontoceti, while species with broad flippers (e.g., *Orcinus orca*, *Delphinapterus leucas*) show convergent morphospace occupation, likely reflecting similar hydrodynamic constraints.

Expanding our data set with fossil relatives will enhance our understanding of the origin and evolution of cetacean flippers, unraveling the morphological pathways involved in the limb-to-fin transition.

Keywords: Mammals, Whales, Limbs, Evolutionary patterns, Convergence

BIOFORCE: Biological Forcing of Earth System Evolution

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Life has played a transformative role in shaping Earth's systems throughout deep time. Over the past 4 billion years, successive evolutionary innovations and the emergence of new biological groups have progressively "bioengineered" the planet, exerting increasing influence on the structure and function of the Earth system. From early microbial metabolisms that altered atmospheric composition to the expansion of terrestrial forests that restructured the carbon cycle, biological processes have acted as powerful drivers of environmental change. By influencing weathering rates, greenhouse gas concentrations, nutrient cycling, and surface albedo, the biosphere has not only responded to environmental shifts but has also created new boundary conditions that impact climate and geochemical dynamics on planetary scales.

Understanding the modern Earth as a bioengineered system requires examining key transitions in deep time, when evolutionary innovations or ecological expansions triggered cascading effects across ecosystems and the physical environment. Although paleontology and paleobiology have long explored evolutionary radiation, mass extinctions, and recoveries, the causal links between biological change and Earth system dynamics remain insufficiently quantified. Integrating fossil evidence with geochemical proxies, ecological reconstructions, and Earth system modelling offers a pathway towards testing these relationships and assessing the magnitude of biological forcing over time.

This contribution highlights the conceptual framework of BIOFORCE, a research initiative that aims to identify, understand, and quantify the long-term impacts of biological processes on other components of the Earth system across a wide range of temporal and spatial scales. BIOFORCE emphasizes interdisciplinary approaches that combine various methods ranging from detailed specimen-based research, actualistic experiments, big-data approaches, and cutting-edge computational modelling. By focusing on major evolutionary transitions, environmental disturbances, and biotic recoveries, this framework seeks to clarify how step-changes in the history of life have shaped Earth system dynamics and to provide insights into potential tipping points linked to ongoing biodiversity loss.

Keywords: Earth system, Biosphere, Evolution, Earth system engineers, Ecosystem engineers

Abstract (Oral communication)
Symposium: S3

Reef crises and marine biodiversity loss

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Metazoan reefs have experienced repeated crises throughout the Phanerozoic, marked by geologically rapid declines in reef carbonate production. While some of these crises coincided with major biotic turnovers, others left reef-building communities largely intact, and no simple relationship exists between crisis magnitude and ecological change. Consequently, the extent to which reef crises reshaped reef community composition and whether they triggered cascading extinctions among reef-dependent organisms remains unresolved.

Here, we use a global compilation of reef-related fossil occurrences over the Phanerozoic to test whether reef crises affected not only reef builders but also the wider marine biota. We distinguish four cohorts of reef affinity: (i) metazoan reef builders (i.e. colonial corals and sponges), (ii) reef dwellers, (iii) non-reef organisms, and (iv) generalists. By integrating these data with stage-level changes in reef volume, we evaluate extinction dynamics across four major Phanerozoic reef crises.

We find that reef builders and reef dwellers were tightly coupled over the last 500 million years. Although their background extinction patterns do not indicate simple, one-to-one cascading extinctions, extinction rates in both groups increased significantly during intervals of major reef loss. Interestingly, non-reef organisms and generalists show comparable responses to reef crises. Our findings highlight the fundamental ecological interdependence between reef-building organisms and the diverse communities they support, and they underscore that the collapse of reef frameworks likely entails the loss of far more biodiversity than reef-building organisms alone.

Keywords: Reef crises, Extinctions, Marine diversity, Phanerozoic

Exploring hamster diversification and diversity with Bayesian and deep learning approaches

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Understanding the variation of diversification rates through time and across lineages is essential for identifying evolutionary processes and assessing the influence of biotic and abiotic drivers on diversification. Fossils provide key information for reconstructing these dynamics, yet the incompleteness and biases of the fossil record pose major challenges for inference. We investigate diversification dynamics and paleodiversity in true hamsters (Cricetinae) by conducting analyses based on a recently reconstructed comprehensive total-evidence phylogeny and on an extensive fossil occurrence dataset, compiled for this study. We apply complementary phylogeny- and occurrence-based approaches, such as a Fossilized Birth-Death Diffusion model (FBDD), a birth-death neural network model (BDNN) and Deep learning Diversity estimation (DeepDive) to infer lineage-specific diversification rates, evaluate the influence of environmental and geographic predictors, and to reconstruct the true paleodiversity. Across methods, speciation rates show a generally stable to slightly declining trend through time, whereas inferred extinction dynamics vary among approaches. Lineage-specific extinction patterns suggest a relative resilience of hamsters to environmental fluctuations, which can potentially be linked to ecological buffering strategies such as burrowing and hibernation. Variation in speciation rates is mainly associated with geographic distribution. The reconstructed paleodiversity follows a hump-shaped trajectory, reaching its peak during the Messinian and Pliocene. Our results highlight both the potential and the limitations of current diversification models when applied to heterogeneous fossil datasets, emphasizing the importance in diversification analyses of comparing varying approaches and explicitly accounting for temporal, taxonomic, and spatial biases in the fossil record.

Keywords: Cricetinae, Paleodiversity, Diversification rates, Bayesian inference, Deep learning

Advanced sensor-integrated solutions in paleontological 3D-Prints as a link between paleontological research and museology

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In 2025 the new sauropterygian taxon *Carinthiasaurus kandutschii* from the Ladinian of Carinthia has been described by Klein et al. The specimens as well as several pachypleurosaur (most likely belonging to *Neusticosaurus*) are housed in the “Kärntens versteinerte Welten” at the Nockalmstrasse by geologist G. Kandutsch, who found most of the material after scientific prospection. The kaernten.museum (k.m.) at Klagenfurt on the other hand is in possession of some pachypleurosaurs including the holotype of *Neusticosaurus toeplitzschii* (Nopsca, 1928), some remains of *Lariosaurus* as well as some vertebra and rib bones of the large ichthyosauria *Shastasaurus “carinthiacus”* Huene 1925. More remains are scattered in other institutions of the area. In order to compile a single collection showing the biodiversity of marine reptiles which provides detailed replica for further scientific studies and offers at the same time additional benefits for the public a cooperation between the FH Villach and the k.m. has been established within the Enhanced Smart Materials and Application (ESMA) project.

As a first step *C. kandutschii* has been 3D-scanned and printed in life-size. This replica is intended for public display where visitors can interact with the model on different levels: they can both touch the model and get content wirelessly by embedded Near Field Communication (NFC) tags within the 3D print and a mobile device. When a visitor approaches the NFC tag at a certain area the tag triggers the display and show information e.g. about aquatic adaptations to marine lifestyle of extinct sauropterygia such as paddle-like limbs on the display of the readers device.

References:

Klein, N., Furrer, H., Dojen, C., Lukeneder, A., Scheyer, T.M. (2025). A new eosauroptrygian taxon from the Middle Triassic of Carinthia, Austria. *Austrian Journal of Earth Sciences*, 118: 141–155.

Keywords: Museology, Sauropterygian, 3D-print, Visitor-object-interaction

Environmental evolution of the U.S. Atlantic Coastal Plain from the late Paleocene into the Paleocene-Eocene Thermal Maximum (PETM)

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The Paleocene-Eocene Thermal Maximum (PETM) is the most pronounced global warming event of the Cenozoic. It is characterized by negative $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ excursions recorded in sedimentary archives, and a transient disruption of the biosphere. We investigated the regional paleoenvironmental evolution from multiple drill sites along the U.S. Atlantic Coastal Plain (New Jersey, Maryland), combining benthic foraminiferal assemblage and grains size data, to reconstruct environmental conditions across a late Paleocene-PETM shelf transect.

Late Paleocene foraminiferal assemblages were diverse and heterogeneous. The most proximal sites (south-west) were prone to river-influence, indicated by a typical opportunistic, low-diversity river outflow assemblage. The more open marine, south-eastern and northern sites are characterized by a higher assemblage diversity. The southern domain is strongly influenced by high food availability, which is comparatively reduced in the northern domain, while bottom waters are oxic throughout. In contrast, the PETM shelf assemblage is poorly diverse and shelf-wide more homogeneous. It indicates a river-dominated setting with reduced currents, resulting in the accumulation of fine-grained, silty-clayey sediments. Episodic low-oxygen conditions, caused by river-induced stratification allowed the less diverse, but opportunistic PETM fauna to thrive, while the Paleocene assemblages nearly vanish from the records. Despite their opportunistic lifestyle, some of the typical PETM taxa still show preferences regarding river influence and water depth for their habitat. Renewed vertical mixing during the PETM recovery phase led to increased oxygen availability on the sea floor. Late Paleocene taxa gradually reappear in the assemblage, while the dominant PETM taxa start to decrease in abundances. Despite the great environmental perturbation, no increased extinction rate is observed, hinting towards the presence of refugia along the shelf.

Keywords: Paleocene Eocene Thermal Maximum, Benthic foraminifera, Turnover, Shelf environment

Hymenoptera from Miocene Randeck Maar: A new Cimbicidae and further honey bee records

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The Randeck Maar (Swabian Alb, southwestern Germany) is one of Europe's most important Cenozoic insect *Lagerstätten*, yielding exceptionally preserved compression fossils formed under anoxic lacustrine conditions. Here we report new hymenopteran specimens, one from the suborder Symphyta (Cimbicidae) and two Apocrita (Apidae). The most interesting specimen, SMNS 64674/17, is a large-bodied sawfly with characteristic club-like antennae. Morphological examination confidently assigns it to the subfamily Cimbicinae. To refine its placement, we applied forewing vein angle analysis (FWVA), a geometric morphometric approach widely used in insect systematics. The comparative dataset included 23 Cimbicidae representing the most prominent extant genera and four fossil taxa. The obtained clusters reflect established taxonomic groupings well. SMNS 64674/17 grouped closest to the Palearctic genera *Pseudoclavellaria* and *Praia*, yet, was clearly diverged from all sampled taxa to justify the description of a new genus. The new taxon is diagnosed by larger body size, habitus, and a distinctive forewing venation pattern supported by its FWVA placement. We propose a new genus and species for the first Cimbicidae from Miocene Germany, which also represents one of very few European occurrences and a significant addition to the sparse fossil record of clubbed giant sawflies. Two additional fossil specimens from the Randeck Maar (SMNS-P-108001-1 and SMNS-P-108001-2) are assigned to *Apis armbrusteri* (Zeuner, 1931), a species previously documented from the *Lagerstätte*. FWVA places the better-preserved *A. armbrusteri* within morphotype CM (*ceramal mellifera*-like), adding to the documented intraspecific variability and supporting the existence of two distinct morphotypes at this locality. The occurrence of a new phytophagous Cimbicidae and corbiculate Apini in the Randeck Maar is consistent with reconstructions of a warm-temperate, vegetation-rich habitat during the Miocene Climatic Optimum.

Keywords: Hymenoptera, Fossil-Lagerstätte, Miocene, Geometric Morphometrics, Cimbicidae

New research opportunities for stromatoporoid studies using fluorescence microscopy

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Fluorescence microscopy (FL) is a rapid and non-destructive analytical technique used to visualise the distribution and redistribution of organic matter, solid inclusions within crystals, and crystal lattice defects (Dravis & Yurewicz, 1985). In palaeontology, this method is particularly useful for visualising bioerosion, skeletal structures, and growth banding. Hitherto, most studies on stromatoporoids have relied on transmitted light microscopy, whereas FL has been largely overlooked. In this study, we investigated Devonian stromatoporoids from the Osiny quarry in the Holy Cross Mountains (Poland) and Silurian specimens from Gotland (Sweden) using FL microscopy. Despite the low concentration of organic matter in the stromatoporoid skeletons, FL reveals structural features that may reflect their original or near-original skeletal composition, as well as high porosity (galleries and microgalleries). In contrast, under transmitted light (PPL and XPL), the skeletons commonly appear strongly altered and non-porous due to overprinting by fabric-retentive irregular calcite (FRIC) crystals. The application of FL microscopy to stromatoporoids from different stratigraphic intervals and palaeogeographic settings could provide valuable insights into the lifestyles of stromatoporoids. It could also contribute to resolving the systematic uncertainties within this group. Finally, FL microscopy does not require vacuum chambers, which allows analyses to be performed on very large thin sections, including those with cover glasses. Consequently, it is more universal than cathodoluminescence, which cannot be applied to covered samples, making historical collections, including museum material, accessible for fluorescence-based studies.

References:

Dravis J.J., Yurewicz D.A. (1985). Enhanced carbonate petrography using fluorescence microscopy. *Journal of Sedimentary Research*, 55: 795–804

Keywords: Stromatoporoids, Fluorescence microscopy, Devonian, Silurian

A transoceanic ray-finned fish reveals a high diversity of macropredatory vertebrates in the latest Devonian

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Up until the latest Devonian (approx. 359 ma), higher trophic levels in marine vertebrate ecosystems are occupied by large macropredatory arthrodire ('Placodermi') and chondrichthyan taxa. Actinopterygians, on the other hand, appear confined to lower trophic levels, only starting to fill macropredatory roles in the Carboniferous with emergence of new morphologies and feeding ecologies, and the diversification of so-called "macrodon'ts" (i.e. large-bodied, large-toothed species).

The earliest known "macrodon't" lineage is represented by only two taxa in the Devonian, one of which is merely known from the impression of an incomplete dentary. The other, *Tegeolepis clarkii*, is known from several specimens from the Famennian-aged Cleveland Shale (Ohio, USA). However, these remains are typically compressed and disarticulated. This preservation obscures many anatomical aspects of this taxon, thus masking its macroevolutionary significance. Furthermore, although *Tegeolepis* is recognized as the largest Devonian actinopterygian, little attention has been given to its ecology.

We present new *Tegeolepis* material from the latest Devonian of the Moroccan Anti-Atlas, including four specimens preserved largely in articulation and in three-dimensions. Using computed tomography, we bring new anatomical data to light, including internal components of the skull. We reveal previously unknown morphology, including traits with a restricted distribution among Paleozoic actinopterygians, and specializations for macropredation. These finds are congruent with recent evidence supporting a cryptic Devonian origin for many morphological innovations underlying the ecological diversity observed in the Carboniferous and beyond. Finally, we posit that the abundance of *Tegeolepis* specimens in two separate faunas across the Rheic ocean points towards a previously underestimated complexity within global trophic networks.

This work is supported by National Science Foundation award EAR 2219007 (MF).

Keywords: Actinopterygii, Devonian, Macropredator, CT

Decoding the Late Cretaceous Austroalpine palaeoenvironment: Evidence from vertebrate coprolites at Muthmannsdorf

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Coprolites, or fossilized faeces, are valuable trace fossils that can provide insights into the diet, digestion, and behavior of extinct vertebrates and their environment (Qvarnström et al., 2019). They display a wide variety of shapes, which can reflect the internal structure of the intestine or depositional conditions. Morphology, size, composition, inclusions, and abundance allow inferences about the potential producer, although these signals may be altered by diet, behavior, or preservation biases (Hunt et al., 2012). The oldest known vertebrate coprolites date back to the Ordovician at the latest and became increasingly abundant in the Mesozoic, in both marine and non-marine deposits worldwide (Hunt & Lucas, 2021). While vertebrate coprolites were documented from several Cretaceous sites in Austria (e.g., Hunt & Lucas, 2016; Ősi et al., 2021), none have been reported from the famous early Campanian dinosaur-bearing locality of Muthmannsdorf up to now (Giritzer et al., 2025). The present study is the first comprehensive analysis of vertebrate coprolites from Muthmannsdorf (Neunkirchen district, Lower Austria) of the “Neue Welt” basin (Grünbach Formation, Gosau Group) and re-evaluates historical material previously misidentified as skeletal remains. Twenty specimens were assigned to six morphotypes and analyzed using micro-CT, SEM–EDX, thin sections, and chemical decomposition. Most coprolites indicate carnivorous to omnivorous diets, while some imply herbivory. Preserved inclusions comprising remnants of arthropods, plants, pollen, fungal spores, cyst-like structures, and filamentous microbial hyphae offer unique palaeoecological insights. Morphological and compositional evidence points to diverse sauropsid producers, including crocodylomorphs and dinosaurs. Overall, this study expands the palaeobiological record of the Late Cretaceous Austroalpine region and highlights the value of coprolites for reconstructing terrestrial ecosystems.

References:

- Giritzer D.P.H., Staudenhirz V., Wallner B.P.L., Leimhofer J., Laaß M., Füby F.-S., Etzler P.A.D., Philipp S.A.L., Marx T.E., Weber S.D., De Rossi F., Pauker N.I., Kriwet J., Hofmann C.C., Seyfullah L.J., Neubauer T.A., Hyžný M., Páll-Gergely B., Schiel H. & Zesch L. (2025). Die vergessene Dinoinsel – Kreidezeitliche Ökosysteme der Neuen Welt (NÖ). Schriftenreihe des Städtischen Museums Neunkirchen, Band 5: 1–74.
- Hunt A.P., Lucas S.G., Milàn J. & Spielmann J. A. (2012). Vertebrate coprolite studies: Status and prospectus. *New Mexico Museum of Natural History and Science Bulletin*, 57: 5–24.
- Hunt A.P. & Lucas S.G. (2016). The record of vertebrate coprolites across the Cretaceous/Paleogene boundary. *New Mexico Museum of Natural History and Science Bulletin*, 74: 79–93.
- Hunt A.P. & Lucas S.G. (2021). The ichnology of vertebrate consumption: Dentalites, gastroliths and bromalites (Vol. 87). *New Mexico Museum of Natural History and Science*.
- Ősi A., Szabo M., Tóth E., Bodor E., Lobitzer H., Kvaček J., Svobodová M., Sente I., Wagneich M., Trabelsi K., Sames B., Magyar J., Makádi L., Berning B. & Botfalvai G. (2021). A brackish to non-marine aquatic and terrestrial fossil assemblage with vertebrates from the lower Coniacian (Upper Cretaceous) Gosau Group of the Tiefengraben locality near St. Wolfgang im Salzkammergut, Austria. *Cretaceous Research*, 127: 104938.
- Qvarnström M., Ahlberg P.E. & Niedźwiedzki G. (2019a). Tyrannosaurid-like osteophagy by a Triassic archosaur. *Scientific Reports*, 9(1): 925.

Keywords: Coprolites, Palaeoecology, Sauropsida, Cretaceous, Austria

Abstract (Poster)

Symposium: other topics

Deep vs. shallow: Corals in pelagic environments. Current understanding and new data from the Umbria–Marche Basin (N-Apennines - Italy)

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Deciphering paleodepth in pelagic basins is challenging due to the scarcity of depth-sensitive fossil assemblages. Corals are one of the few reliable proxies, and were used to try to constrain the depth of pelagic deposits associated with pelagic carbonate platforms (PCPs) in the Umbria–Marche Basin. PCPs are intrabasinal horsts produced by the Early Jurassic rifting, and host condensed pelagic successions. Colonial corals as long been regarded as zooxanthellate, making their occurrence in pelagic settings surprising, and indicative of shallow conditions. Since the 80s, However, also colonial corals have been shown to include azooxanthellate taxa. Consequently, corals in pelagic deposits were often reinterpreted as deep-water taxa, until some forms were recognized in the late 90s as being zooxanthellate pennular corals (e.g. *Kobya monteneronensis*), indicative of mesophotic conditions. The recent finding of a large colony of shallow-water, dome-shaped zooxanthellate coral *Ogilvinella jurassica* from the Mt Nerone PCP, further refines this framework, documenting episodes of very shallow conditions during PCP evolution.

Also azooxanthellate corals are recorded on and around PCPs in the Upper Jurassic. Most specimens are solitary, with ceratoid morphologies consistent with Caryophylliidae, but a significant new record is a large colony of *Cyathophora* sp. from the Mt Acuto PCP. These assemblages are oligotypic yet locally abundant, and their association with pennular corals suggests colonization of hard substrates within or just below the lower photic zone.

Overall, these data highlight the need to decouple lithofacies from fixed bathymetric interpretations in Tethyan pelagic systems. Corals provide key constraints for reconstructing paleobathymetry of pelagic basins, and suggest that the Umbria–Marche Basin, PCP tops likely remained relatively shallow (~30 to ~250 m) from the Sinemurian to the Tithonian.

Keywords: Jurassic, Paleodepth, Photic zone, Zooxanthellae

An ichnology treasure box: Current progress on the trace fossil excavation in the Upper Hornburg Formation (Middle Permian, Germany)

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The outcrops of the late Middle Permian Hornburg Formation (Saxony-Anhalt, Germany) unveil a complete fan and playa-system and its associated biota, which is rarely preserved in present-day central Europe. Since September 2022, ongoing annual excavations at the abandoned “Quarry Held”, Wolferode (Upper Hornburg Fm.), have yielded a variety of well-preserved trace fossils. To date, ca. 120 excavation boxes (ca. 6 m³) of Quarry Held scientific material have been stored in the collections of the “Museum für Naturkunde Magdeburg”.

In 2025, two adjacent excavation sites at the quarry edge were stratigraphically correlated, resulting in a cumulative excavation surface area of approximately 60 m². The succession includes ca. 7 meters of fossiliferous laminated siltstone and claystone, which were interpreted as dry evaporitic red beds. Approximately 6 meters of the section have been investigated for fossil content and sedimentary structures in mm- to cm-scale resolution. The rich fossil content includes tetrapod footprints of at least three morphotypes, tetrapod trackways, tetrapod scratch marks and abundant and diverse invertebrate traces. These invertebrate traces include putative medusoid impressions and a variety of arthropod trackways, that can be assigned to distinct morphotypes and producer groups. Additionally, there are insect body imprints (resting traces) that might be referred to some of the arthropod trackmaker groups. Microbially induced sedimentary structures are common throughout the succession, and conchostracan shell impressions were also found.

The trace-fossil assemblage of these dry red beds is exceptional and provides detailed insights into Permian vertebrate and invertebrate lifestyles, as well as into Permian ecosystem functions. We are grateful for the work performed by more than 80 international volunteers to uncover this ancient ecosystem, and we are look forward to further cooperation in the excavation season of 2026.

Keywords: Ichnology, Tetrapoda, Red beds, Arthropoda, Microbially induced sedimentary structures

Abstract (Oral communication)

Symposium: S6

Ecological implications of soft tissues in anurans and fish from the Eocene Geiseltal Konservat-Lagerstätte

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The diverse vertebrate fauna of the Eocene Geiseltal *Konservat Lagerstätte* (Saxony-Anhalt, Germany) is represented by more than 25,000 specimens. Early literature on the taphonomy of the vertebrates reported preservation of diverse tissue and cell types in silica. Our research confirms that certain soft tissues – anuran skin, fish scales and fish muscle – are indeed replicated in authigenic minerals, but in calcium phosphate, not silica; other soft tissue features are defined by layers of sulfurised melanosomes. SEM and synchrotron-XRF analysis of the preserved melanosomes in the fossil anurans exhibit tissue-specific geometries and chemistries. Comparative analysis of these fossil melanosomes and examples from extant anurans reveals that melanosome geometries in the eyes and internal tissues are similar in fossil and extant species, but not in the skin. These trends in melanosome evolution are probably controlled by tissue-specific physiological constraints on melanosome function. Evolutionary conservation of functional roles for melanin is not unexpected, as the lifestyle of ancient anurans is likely to impose similar functional constraints as in anurans today. For example, our data imply that the functions of ocular melanin in the visual system of anurans has not changed since the Eocene. Melanosomes in the skin may diverge from this trend due to evolutionary trade-offs linked to one, or several, changes in behavior and ecology (e.g., colour display).

SEM analysis of fossil fish from Geiseltal reveals layers of melanosomes in at least three parts of the body including in the eyespot, in the body cavity and external to fish scales. The melanosomes exhibit tissue-specific geometries. Ongoing comparative analysis with data from extant fish is exploring the extent of evolutionary conservatism in the geometries of fish melanosomes and its ecological implications.

Keywords: Melanosomes, Phosphatisation, Evolutionary conservatism, Taphonomy, Mineralisation

Cenomanian-Turonian calcareous nannofossil biostratigraphy of the Mudurnu section (Turkey)

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The Oceanic Anoxic Event 2 (OAE 2), which occurred across the Cenomanian/Turonian boundary, represents a key interval of the Mesozoic, characterized by a major perturbation of the global carbon cycle. OAE 2 reflects a significant disruption of the ocean–climate system, marked by rapid global warming, elevated atmospheric CO₂ levels, and a profound shift in marine redox conditions. Widespread anoxia, driven by increased primary productivity, led to enhanced production and burial of organic matter, resulting in a pronounced positive $\delta^{13}\text{C}$ excursion that is globally recognized in both marine and terrestrial records (i.e. Jenkyns, 2010).

Changes in calcareous nannofossils were documented both before and during the OAE 2 interval, which is characterized by variations in abundance and a high rate of turnover driven by extinctions and the occurrences of new species (Leckie et al., 2002; Erba et al., 2026).

This study aims to characterize the calcareous nannofossil assemblages across the OAE 2 in the Mudurnu section (Turkey), through a new biostratigraphic analysis. The Mudurnu section, located in the Mudurnu–Göynük Basin within the Sakarya Zone, was deposited in the Neo-Tethys Ocean. The investigated outcrop is approximately 20 m thick and spans from the middle Cenomanian to the lower Turonian.

Preliminary results from this study, despite the presence of moderately to poorly preserved calcareous nannofossil assemblages, allow for a detailed biostratigraphic characterization of the section.

References:

- Erba E., Miniati F., Bottini C. (2026). Revised calcareous nannofossil biozonation of the Cretaceous at low and middle latitudes. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 681, 113407. <https://doi.org/10.1016/j.palaeo.2025.113407>
- Jenkyns H.C. (2010). Geochemistry of oceanic anoxic events. *Geochemistry, Geophysics, Geosystems*, 11, Q03004, <https://doi.org/10.1029/2009GC002788>
- Leckie, R.M., Bralower, T.J., Cashman, R., (2002). Oceanic anoxic events and plankton evolution: biotic response to tectonic forcing during the mid-Cretaceous. *Paleoceanography* 17, 1041. DOI: 10.1029/2001PA000623.

Keywords: Micropaleontology, Biostratigraphy, Nannofossils, Mudurnu, Cenomanian-Turonian

Monsoon-driven genesis of a Cretaceous dinosaur *Lagerstätte*

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The Villaggio del Pescatore *Konservat-Lagerstätte* near Trieste, Italy (Late Cretaceous, Campanian, 80 Ma) is preserved within a laterally confined sedimentary body, characterized by finely laminated dark-to-beige carbonate rhythmites, preserving articulated dinosaurs, crocodylomorphs, fishes, decapods, and floral remains with soft-tissue outlines. By employing a multi-proxy approach that integrates sub-mm microstratigraphy, synchrotron micro-XRF/XRD, bulk geochemistry, detailed taphonomy, and Hadley Centre paleoclimate model outputs, we refute earlier interpretations of the rhythmites as seasonal varves, tectonically controlled brackish depressions, or isolated sinkhole/cenote fills. Our new interpretation indicates that VdP records a daily-resolved, semidiurnal tidal flat system subject to neap–spring modulation, characterized by high depositional rates. Further, our findings constrain the net accumulation of fossil-bearing sediments to multi-decadal (~40-year) timescales, providing unprecedented resolution of taphonomic processes. Within this framework, centimeter-scale debris-flow and matrix-supported breccia beds bearing megafauna record episodic hyperpycnal/overwash pulses. Dark, TOC- and S-rich packages correspond to humid, runoff-dominated intervals with elevated terrigenous proxies and productivity; lighter packages record drier, better-ventilated conditions. Microbial mats rapidly stabilized and promoted early cementation of each individual lamina, enabling exceptional preservation by tidal drape and microbial sealing. Paleoclimate ensembles indicate a robust summer-dominated monsoon domain at ~29°N and support frequent monsoon-enhanced tropical cyclones delivering sediment, nutrients and carcasses. We identify a process linkage whereby monsoon-driven hydrological extremes interact with tidal mechanisms, facilitating effective trapping of terrigenous sediments, nutrients, and organic matter. By delineating criteria for recognizing similar rhythmites in low-latitude carbonate platforms, we underscore the potential of extreme monsoon-cyclone regimes to generate decadal windows of fossil preservation.

Keywords: *Konservat-Lagerstätten*, Cretaceous, Italy, Paleoclimate modelling, Monsoon dynamics, Vertebrate taphonomy

Facing the truth- the sample size matters! Contrasting responses of bony and cartilaginous fishes to the end-Cretaceous extinction event

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Fish communities have played a crucial role in marine ecosystems for over 400 million years. Discussions of conservation priorities emphasize the importance of drawing inferences from past environmental upheavals and highlight the need for combining paleontological and neontological evidence. Resulting data can help protect marine ecosystems from anthropogenic environmental crises and biodiversity loss. Such integration requires high-resolution fossil record data with precise taxonomic expertise in order to establish a robust data framework for deciphering the magnitude of past environmental disasters. In contrast to micropaleontology, this approach is particularly challenging for deciphering the aftermath of biotic crises on fish communities, as vertebrate fossils are generally scarce.

We analyzed the effects of the end-Cretaceous (K-Pg) mass extinction on marine vertebrate communities (bony and cartilaginous fishes) based on extensive sampling of >5 tons of sediment in Austria, Germany, and Bulgaria. All studied K-Pg successions represent deep-marine environments of the Tethyan Realm. Recovered cartilaginous fish teeth were taxonomically analyzed and quantitatively compared with bony fish assemblages. Our results contrast with previous studies based on limited samples or insufficient taxonomic resolution. High-resolution sampling and precise stratigraphy reveal that deep-sea cartilaginous fishes were more resilient to the K-Pg extinction than bony fishes. The dataset (>20000 ichthyoliths) allowed the identification of nine new shark species and three new genera, and extends the fossil record of some squaliform sharks.

Our comprehensive approach aims to encourage colleagues to intensify field-based data collection, contributing to the systematic expansion of the fossil record. These well-founded datasets will help better decipher the K-Pg mass extinction event and enable more reliable extrapolation of the outcomes of environmental disturbances to modern contexts.

Keywords: Extinction, K-Pg event, Fish, Shark, Diversity

Born in Calcium, Preserved in Iron: Microbial Pathways to Skeletal Fossilization

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In paleontology, *exceptional preservation* typically refers to fossilization that captures easily decomposable parts, such as soft tissues or non-biomineralized structures, which usually decay rapidly after death. However, unusual preservational pathways can also arise through remineralization, allowing fossil remains to persist under conditions generally unfavorable for preservation.

Conodont residues from Silurian limestones of the Carnic Alps (Italy and Austria) yielded three-dimensional fossil skeletal remains that are normally lost during standard acid digestion procedures. These fossils, mostly derived from benthic organisms with originally calcareous skeletons, are preserved as ferruginous external coatings or internal molds produced by early mineral replication. The assemblage is dominated by trilobites, bryozoans, echinoderms, bivalves, gastropods and ostracods, often retaining fine morphological details. Their formation resulted from early precipitation of iron oxides and hydroxides that replicated the skeletons prior to dissolution. A multi-analytical approach combining optical microscopy, SEM/ESEM with EDX microanalysis, X-ray powder diffraction and confocal Raman spectroscopy reveals that the replicas consist mainly of chamosite, magnetite, goethite, and hematite, with minor siderite, birnessite, quartz, and amorphous phases. The frequent association with carbonaceous material indicates a strong microbial control on mineralization, highlighting the role of microbially mediated ferruginous processes in exceptional fossil preservation in Paleozoic ferruginous marine settings.

Keywords: Taphonomy, Biomineralization, Skeletal replicas, Hematite, Goethite

Genus-level $\delta^{88}\text{Sr}$ signatures in Late Devonian conodonts from Kowala, Poland

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Conodonts are among the earliest vertebrates known to have evolved mineralized parts. Primarily used for their biostratigraphic significance across a span of over 300 million years, from the late Cambrian to the earliest Jurassic, yet their ecology and trophic roles remain uncertain.

Stable strontium isotopes ($\delta^{88}\text{Sr}$) were analyzed from the six most iconic conodont genera of the Late Devonian in the upper Famennian Kowala Quarry (Holy Cross Mountains, Poland). Isotopic measurements ($\delta^{88}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$) were obtained via MC-ICPMS following diagenetic screening. Our results show statistically significant, genus-dependent differences in $\delta^{88}\text{Sr}$ values: *Palmatolepis*, *Bispathodus*, and *Pandorinellina* cluster at higher values, while *Branmehla*, *Mehlina*, and *Idioprioniodus* display lower ones. The crystallographic assessment of bioapatite and the absence of trends in either $^{87}\text{Sr}/^{86}\text{Sr}$ or $\delta^{88}\text{Sr}$ indicate that these patterns are unlikely to arise from diagenetic alteration. The observed offset ($\sim 0.2\text{--}0.3\text{‰}$) aligns with trophic fractionation patterns seen in living vertebrates, suggesting different trophic levels occupied by these taxa. When combined with apparatus architecture, the isotopic signal shows the strongest correlation with P_1 element morphology. Taxa bearing blade-like P_1 elements (*Branmehla*, *Mehlina*, *Idioprioniodus*) are associated with lower $\delta^{88}\text{Sr}$ values, whereas platform (*Palmatolepis*), icrion-bearing (*Bispathodus*) taxa or those with enlarged basal cavities (*Pandorinellina*) show comparatively higher values. This pattern suggests that, in general, conodonts with blade-like P_1 elements might have occupied higher trophic levels than those with more morphologically complex P_1 structures.

Our findings show that stable Sr isotopes offer a new proxy for reconstructing trophic structure and ecological differentiation in extinct marine vertebrate communities.

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Keywords: Bioapatite, Isotope fractionation, Trophic ecology, Physiological differentiation, Vital effects

Triassic steps in the Northern Calcareous Alps: potential new track evidence from the Raibl Formation

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We report a newly discovered assemblage of possible vertebrate tracks from the early Upper Triassic Northern Alpine Raibl Formation near Lake Achensee (Tyrol, Austria). The structures occur on steeply dipping dolostone bedding planes and are distributed across multiple stratigraphic horizons within an interval approximately 10 m thick, appearing both as isolated impressions and clustered assemblages at three distinct levels. The surrounding sedimentological context is characterized by current ripples, subaqueous dunes, and additional indicators of shallow-water depositional conditions.

On the largest exposed bedding plane, two morphotypes can be tentatively distinguished based on size and spatial arrangement and are interpreted as manus and pes impressions. These occur in paired configurations (manus ~15 cm, pes ~30 cm), consistent with a lateral-sequence gait. Preservation, however, is poor: the structures are expressed mainly as shallow, elliptical concave epireliefs, occasionally partially infilled with sediment. Although diagnostic morphological features are largely absent, the overall form is compatible with digitigrade locomotion and may represent an undetermined ichnotaxon.

Tetrapod ichnofossils are notably rare in Austria; confirmed occurrences from the Lower, Middle, and Upper Triassic are currently restricted to the Drau Alps (Krainer et al., 2012). Given the limited preservation but potential significance of this finds for Austrian ichnology, we present these structures as putative vertebrate tracks and explicitly invite discussion. Input from ichnology specialists is sought to further constrain their origin, refine ichnotaxonomic interpretation, and evaluate their implications for Upper Triassic paleoecology in the Northern Calcareous Alps.

References:

Krainer K., Spencer G.L, Ronchi A. (2012). Tetrapod Footprints from the Alpine Buntsandstein (Lower Triassic) of the Drau Range (Eastern Alps, Austria). *Jahrbuch der Geologischen Bundesanstalt*; 15 2(1–4): 205–212.

Keywords: Tetrapod ichnofossils; Raibl unit; Alpine stratigraphy

The fossil shark egg capsule *Fayolia* and the curious case of *Fayolia bohémica* from the Pennsylvanian of Nýřany, western Czech Republic

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The fossil shark egg capsule *Fayolia* comprises 16 types so far, which have been described from predominantly freshwater successions of Europe, Asia and the USA, ranging from the Late Mississippian (Viséan) to the Late Triassic (Carnian). Remains are 45–400 mm in total length, with most capsules being 80–130 mm long on average. Due to stratigraphic co-occurrence with xenacanthiform shark remains in the same strata, these sharks are considered the most likely producers of *Fayolia*. The capsule has a cylindrical shape with an elongated body gradually tapering at both ends into short and pointed pedicle (posterior) and beak (anterior), the latter with a coiled tendril. *Fayolia* was composed of two spirally twisted bands, each accompanied by a row of small circular or elliptical scars (scar-line) and overlaid by a protruding flange, giving the capsule a "screw-like" appearance.

From the late Pennsylvanian (Westphalian D) of Nýřany, in the western Czech Republic, *F. bohémica* was recovered from lacustrine black shales associated with sapropelic cannel coals seams. Originally described as *Palaeoxyris*-type capsule, it clearly belongs to *Fayolia* because of the two capsule-forming bands and the presence of scar-lines. Due to the specific fossilization conditions in the Nýřany coalfields, only the rhombic-forming band margins, and the scars are preserved as pyritized structures in all known specimens. Almost half of the specimens consist of double capsules that are tied anteriorly together with their tendrils. Two size classes of *F. bohémica* can be distinguished: a small form with a length of 60–90 mm and a second, somewhat rarer form with a total length of 140–180 mm. The smaller type can be assigned to the xenacanthid *Xenacanthus parallelus*, while the larger type corresponds to the diplodoselachid *Orthacanthus bohemicus*, the only two sharks occurring in Nýřany. This makes this locality currently the only known location worldwide where two different types of *Fayolia* co-occur.

Keywords: Shark egg capsule, Freshwater, Xenacanthiform, Nursery, *Fayolia*

Is *Acitheca isomorpha* De Stefani a younger synonym of *Acitheca polymorpha*?

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The late Paleozoic marattialean ferns of the family Psaroniaceae are characterized by a complex taxonomic history, largely attributable to the high morphological variability of their fronds. Among the debated taxa described by Carlo De Stefani in his monograph on the Permo-Carboniferous paleoflora of Tuscany is *Acitheca isomorpha* De Stefani, 1901, a species generally regarded as invalid and subsumed within the broad intraspecific variability of *Acitheca polymorpha* (Brongniart) Schimper, 1879 (Zodrow et al., 2006). However, this assessment has never been directly applied to the De Stefani syntypes, alongside its original collection, which is currently housed in the Paleontology section of the Museum of Natural History of the University of Florence. The present study re-examines this plant fossils using an integrated quantitative approach that combines traditional morphometric measurements of pinnule laminae with image-based outline shape analysis. The comparative dataset includes specimens described by De Stefani (1901) from the Monti Pisani, alongside additional *Acitheca* material from the Permo-Carboniferous of Iano, Tuscany. This framework enables a reproducible evaluation of morphological variation and the identification of characters with potential discriminant value, providing a revised basis for the taxonomic status of *A. isomorpha* and its relationship to *A. polymorpha*.

References:

- De Stefani C. (1901). Flore carbonifere e permiane della Toscana. Pubblicazioni del Reale Istituto di Studi Superiori pratici e di perfezionamento, 212 pp., Firenze.
- Zodrow E.L., Šimůnek Z., Cleal C.J., Bek J. & Pšenička J. (2006). Taxonomic revision of the Palaeozoic marattialean fern *Acitheca* Schimper. *Review of Palaeobotany and Palynology*, 138: 239–280.

Keywords: Taxonomy, Carboniferous-Permian, Tuscany Paleoflora

On the southern margin of the Central Pangaea Mountains: Integrated macrofossil and palynological insights from Iano (Tuscany) across the Late Carboniferous–Early Permian

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The Paleozoic flora of Tuscany remains insufficiently documented despite its significance for paleobiogeographic reconstructions along the northwestern margin of the Paleo-Tethys. During the Pennsylvanian–Cisuralian, the area corresponding to the present-day Tuscany was located in a transitional sector between the southern margin of the Variscan belt and its foreland along the northwestern margin of the Paleo-Tethys. In this setting, transcurrent to transtensional tectonics promoted the development of pull-apart basins, where terrestrial and marine systems developed interacting in dynamic coastal environments. Plant fossil assemblages from Tuscany, particularly those from the Iano area, were deposited in near-coastal swamp environments and provided a valuable archive for investigating vegetation responses and taphonomic effects of sea-level fluctuations. Ongoing work focuses on the revision of historical Permo-Carboniferous collections, including the Strozzi collection and previously unstudied material. Taxonomic revisions of these assemblages reveal a diverse flora in a complex paleoenvironment, supported by the co-occurrence of a variety of plant macrofossils and marine invertebrates, indicating a marine influence and transitional depositional conditions.

This revision is complemented by new fieldwork, including detailed stratigraphic logging and the collection of stratigraphically constrained fossils. These data permit us to define the stratigraphic relationship between the terrestrial and marine fossils found in the historical collections. In addition, integrated palynological analyses improve our understanding of the floristic composition and biostratigraphic constrain of the fossils, allowing a more robust characterization of plant communities across the Carboniferous–Permian transition.

Keywords: Paleobiogeography, Paleoecology, Biostratigraphy, Paleozoic, Paleo-Tethys

Abstract (Oral communication)

Symposium: S4

A paleoecological approach to inform nature conservation in alpine areas

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Rising temperatures and abrupt changes are threatening alpine ecosystems, reducing their resilience and increasing their vulnerability to extreme events and long-term ecological shifts. Research analyzing vegetation responses to various pressures often lacks a long-term perspective, which is essential to fully understand the scale of these phenomena (Gillson et al., 2021). Addressing this challenge requires integrating proxy records from natural archives with modern field ecology. This multidisciplinary approach combines the analysis of co-registered biological and geochemical variables preserved in sediments (i.e. nutrients, microbotanical remains) to trace the natural history of past landscapes, detect early signs of human interference and follow its development across different timescales.

A new high-resolution paleoecological record from the Stelvio National Park (Central Alps) is currently under investigation. Spanning the last 10,000 years ca., this record traces the vegetation dynamics of subalpine environments and reveals the role of natural and anthropogenic disturbances regimes, including glacial fluctuation, wildfires, pastoralism and silvicultural practices. The research aims to deliver a reconstruction of site-specific ecological dynamics, revealing natural ecosystem trends, ecological baselines, and cultural history in montane and alpine areas. These reconstructions are essential for informing conservation strategies and guiding the restoration of traditional alpine landscapes (Finsinger et al., 2023).

References:

Finsinger W., Bigler C., Schwörer C., & Tinner, W. (2023). Rates of paleoecological change can inform ecosystem restoration. *EGUsphere*, 2023, 1–14.

Gillson L., Dirk C., & Gell, P. (2021). Using long-term data to inform a decision pathway for restoration of ecosystem resilience. *Anthropocene*, 36, 100315.

Keywords: Alpine vegetation history, Ecosystem trajectories, Human-environment interactions, Multi-proxy approach

Earliest and new *Willsiostrobus* with *in situ* pollen from the Early Triassic of Tunguska Basin, Siberia

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The genus *Willsiostrobus* includes pollen cones of voltzian conifers and enumerates eleven previously described species, most of which are known from the Middle Triassic of Europe. The new species, *W. mogutchevii* (Karasev et al., 2026), was described based on the material from the Dvurogian Regional Stage (Early Triassic) of the Tunguska Basin (Siberia), being the oldest thoroughly studied representative of the genus.

Cones of *W. mogutchevii* are cylindrical, terminal and are underlain by bracts or vegetative leaves. The microsporophylls are loosely arranged and consist of a thin stalk and a narrow, kite-like lamina. The pollen is bisaccate, striate, and leptomate. It was assigned to an *Illinites*-type. The saccus contains both a cavity and a complex system of alveoli, and thus occupies an intermediate position between typical proto- and eusaccus. *W. mogutchevii* is most similar in its morphology to the type species of the genus, *W. willsii*. As for *in situ* pollen, it stands closer to the Ladinian representatives which often possess pollen of *Illinites*-type, but differs from numerous Anisian representatives, most of which are characterized by non-striate pollen of *Voltziaceasporites*- and *Alisporites*-types. Pollen ultrastructure was studied for the Anisian representatives only and showed a protosaccate structure.

W. mogutchevii is the first thoroughly studied member of Voltziaceae from Siberia. The presence of *Willsiostrobus* in the Early Triassic of Siberia allows us to confidently assert that at least some of the conifers discovered in the Siberian Triassic belonged to Voltziaceae. Voltzians probably migrated from Euramerica to the high latitudes of Angaraland during the warming and drying of the climate in the Early Triassic.

References:

Karasev E., Forapontova T. & Zavialova N. (2025). A voltzian strobilus with *in situ* pollen from the Early Triassic of Tunguska Basin (Russia, Siberia). Review of Palaeobotany and Palynology, 346: 105497.

Keywords: Early Triassic, Voltziaceae, *in situ* pollen

Abstract (Oral communication)

Symposium: S10

Unraveling the exceptional preservation of the Sinemurian (Jurassic) Osteno Konservat-Lagerstätte (Como, NW Italy).

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The Osteno *Konservat-Lagerstätte* (Sinemurian, Lower Jurassic) provides a fundamental archive for understanding the reorganization of marine ecosystems following the Triassic-Jurassic mass extinction (Pinna, 1985). This contribution provides a synopsis based on new sedimentological and geochemical data that integrates the paleontological data.

Beyond its exceptional fossil content (ranging from unique soft-bodied organisms, peculiar crustaceans to rare vertebrates), a pivotal discovery is the reinterpretation of the fossiliferous interval as a primary laminated spiculite. A 'source-to-sink' depositional model is proposed: biological communities, dominated by decapod crustaceans and thylacocephalans (e.g., *Ostenocaris*), flourished in 'sponge grounds' located on oxygenated outer ramps (100–200 m depth) and were subsequently transported into adjacent depressions (grabens) characterized by transient anoxia.

The exceptional preservation of soft tissues (muscles, gills, hypertrophic eyes) was facilitated by early diagenetic phosphatization driven by microbial activity (sulfate-reducing bacteria) in anoxic interstitial waters. The absence of bioturbation (Ichnofabric Index 0) and the presence of pyrite framboids confirm bottom conditions hostile to permanent benthic life. The strong biotic affinities with the Lyme Regis locality and the discovery of new taxa suggest that Osteno should be regarded as a reference site for Lower Jurassic Neotethyan biodiversity (Franceschi et al., 2026).

References:

Franceschi F., Pellegrino L., Martire L., Marramà G. & Carnevale G. (2026). The Osteno *Konservat-Lagerstätte* (Como, NW Italy): exceptional preservation in the Sinemurian (Jurassic). *Bollettino della Società Paleontologica Italiana*, 65(1).

Pinna G. (1985). Exceptional preservation in the Jurassic of Osteno. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences*, 311: 171–180.

Keywords: Soft-tissue preservation, Soft-bodied fossils, Phosphatization, Sponge ground, Dedolomitization.

Abstract (Poster)

Symposium: other topics

Vertebrate remains from the Rotzo Formation (Pliensbachian, Trento Platform, NE Italy): a diverse Early Jurassic embayment

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The Rotzo Formation (Lower Jurassic; Calcarei Grigi Group) of the Trento Platform (Southern Alps, Italy) is renowned for its rich invertebrate fauna and dinosaur tracks (Petti et al., 2011; Posenato et al., 2013), whereas its vertebrate skeletal remains remained largely neglected. Herein we describe small assemblage consisting of more than 50 specimens recovered from two distinct stratigraphic intervals within the lower Rotzo Formation.

The vertebrate assemblage includes molariform teeth pertaining to pycnodontiform fishes, ginglymodian ganoid scales, teeth, and cranial elements, articulated skeletons of small-sized stem-teleosts, hybodontiform remains, a possible chimaeriform dermal denticle, and thalattosuchian teeth. The thalattosuchian remains are especially relevant since they represent some of the oldest records for this group in southern Europe. Hybodonts dominate the assemblages, while neoselachians are absent, showing an opposite trend compared to the paleofauna recorded in the Osteno *Konservat-Lagerstätte* (Franceschi et al. 2026), possibly representing an anticipation of the Toarcian ecological shift in which hybodonts were relegated to more coastal areas, while neoselachians dominated in open waters.

The composition of the two distinct vertebrate assemblages, coupled with petrographic characters, support the paleoenvironmental interpretation of two different bedsets: the first corresponds to a brackish, eutrophic, marginal-marine setting, whereas the second one records a mesotrophic, fully marine environment with echinoderms and large benthic foraminifers. The Rotzo embayment was a complex and heterogenous ecosystem with brackish coastal ponds and open-marine areas, inhabited by durophagous actinopterygians, chondrichthyans, and marine reptiles, and adjacent to vegetated islands with terrestrial vertebrates.

References:

Franceschi F., Pellegrino L., Martire L., Marramà G., Carnevale G. (2026). The Osteno Konservat-Lagerstätte (Como, NW Italy): exceptional preservation in the Sinemurian (Jurassic). *Bollettino della Società Paleontologica Italiana*, 65(1): i-lviii.

Petti F.M., Bernardi M., Ferretti P., Tomasoni R. & Avanzini M. (2011). Dinosaur tracks in a marginal marine environment: the Coste dell'Anglone ichnosite (Early Jurassic, Trento Platform, NE Italy). *Italian Journal of Geosciences*, 130: 27–41.

Posenato R., Bassi D., Avanzini M. (2013). Bivalve pavements from shallow-water black-shales in the Early Jurassic of northern Italy. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 369: 262–271.

Keywords: Early Jurassic, Lagoon, Thalattosuchia, Ginglymodi, Stem-teleosts

Indirect evidence for predation on crinoids from the Lower Devonian Hunsrück Slate, Germany

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Among the great diversity of stalked crinoids from the Lower Devonian Hunsrück Slate, many species possess spines at arms, anal sac, or calyx. This indicates predator pressure or presence of parasites and raises the hypothesis that crinoids were frequently attacked by predators. In this study, different predation-defense features are tested for the crinoids. Mobility as an escaping strategy, can be largely excluded. No trace fossils are known to resemble the crawling traces of extant stalked crinoids as pictured in Brom et al. (2018), and the morphology does not show any adaptations for swimming, unlike living feather stars.

The frequency of arm regeneration is very low (< 2%) compared to other crinoid communities, such as the Mississippian Maynes Creek Formation with approximately 15% of individuals, ranging from 0–27% among species (Gahn & Baumiller, 2005) or 12–75% in recent stalked crinoids (Oji, 1996; Baumiller, 2008). The expected arm loss (= EAL; Oji & Okamoto, 1994), a metric to evaluate predation-resistant arm branching pattern, was compared for the different taxa. Lower EAL values indicate a higher predator resistant arm branching. The results show that the genera with low EAL values, all possess spines and thus were probably threatened by predators. In contrast, the genera with the highest EAL values are spineless and were probably not prone to predators. Potential predators in the Early Devonian Hunsrück Sea, such as placoderm and acanthodian fishes, arthropods and cephalopods, are discussed.

References:

- Baumiller T.K. (2008). Crinoid ecological morphology. *Annu. Rev. Earth Planet. Sci.*, 36(1): 221–249.
- Brom K.R., Oguri K., Oji T. et al. (2018). Experimental neoichnology of crawling stalked crinoids. *Swiss J Palaeontol*, 137: 197–203.
- Gahn F.J. & Baumiller T.K. (2005). Arm regeneration in Mississippian crinoids: evidence of intense predation pressure in the Paleozoic?. *Paleobiology*, 31(1): 151–164.
- Oji T. (1996). Is predation intensity reduced with increasing depth? Evidence from the west Atlantic stalked crinoid *Endoxocrinus parrae* (Gervais) and implications for the Mesozoic marine revolution. *Paleobiology*, 22(3): 339–351.
- Oji T. & Okamoto T. (1994). Arm Autotomy and Arm Branching Pattern as Anti-Predatory Adaptations in Stalked and Stalkless Crinoids. *Paleobiology*, 20(1): 27–39.

Keywords: Crinoids, Regeneration, EAL, Spines, Predation

Extraordinary high diversity of crinoids and their attachment structures from the Lower Devonian Hunsrück Slate, Germany

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About 30 genera and 61 species of stalked crinoids have been described from the Lower Devonian Hunsrück Slate. The exceptional preservation in this *Konservat-Lagerstätte* makes it possible to study their attachment structures. These crinoids were well adapted to the muddy fine-grained substrate of the former sea floor, but show a high variety of different attachment structures. To classify these structures, we follow the terminology from Brett (1981). Some genera, such as *Parisangulocrinus*, possess radices at the distal stem, to anchor in the sediment. Alternatively, some taxa, such as *Taxocrinus*, have branched cirri along a part of the stem to prevent sticking to the clayey substrate. *Gastrocrinus* exhibits whorls of five cirri along the complete stem, classified as cirriferous runner, that is very common in living stalked crinoids. Other species do not have any stem appendages. The short stem of *Senariocrinus* possibly stuck in the sediment (Ausich et al., 1999), while *Codiocrinus* may have had a „cobra-like“ stem posture and *Acanthocrinus* had a distal coiled column for anchoring. Discoidal holdfasts are rather uncommon in this ecosystem. Especially juveniles often attached to stems of adult crinoids or to objects, such as brachiopod valves, bivalves or gastropod shells, orthocones and rugose corals. Adult crinoids could also attach to stems of larger crinoids to reach a higher position in the water column that probably was advantageous for filter feeding. A comparison to the extant stalked crinoids shows, that today the diversity of attachment structures is much lower than in the Lower Devonian.

References:

Ausich W.I., Brett C.E., Hess H. & Simms M.J. (1999). Crinoid form and function. In Hess H., Ausich W.I., Brett C.E. & Simms M.J. (eds.), Fossil crinoids. Cambridge University Press: 3–30.

Brett C.E. (1981). Terminology and functional morphology of attachment structures in pelmatozoan echinoderms. *Lethaia*, 14(4): 343–370.

Keywords: Stalked crinoids, Holdfasts, Cirri, Attachment structures

Exceptional soft tissue preservation from the terrestrial early Permian of the Thuringian Forest, central Germany

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The late Carboniferous and early Permian fossil record of the Thuringian Forest Basin, central Germany, is exceptional in its abundance and quality, comprising plants, invertebrates, vertebrates and various ichnofossils from a wide range of continental deposits. Its vertebrate ichnofossil record is unique worldwide and comes from several localities, including the famous Bromacker locality, representing one of the most significant sites of late Paleozoic tetrapods and their trace fossils. This includes detailed skin and body impressions, showing soft tissue preservation of terrestrial vertebrates, which is otherwise very rare. Although some of these resting traces represent historical findings, recent more detailed re-evaluations provide novel insights into the soft tissue anatomy and behavior of early land vertebrates. The findings include, among others, the new ichnospecies *Bromackerichnus requiescens* in association with *Dimetropus leisnerianus* footprints, representing the earliest body impressions and epidermal scales assignable to Synapsida (mammalian amniote lineage) and documenting the earliest aggregation behavior in sphenacodontids. Moreover, the new ichnospecies *Cabarzichnus pulchrus* documents the oldest and most complete body impression and epidermal scales of a Paleozoic reptile (Bolosauria) via its unequivocal association with *Varanopus microdactylus* footprints. *Cabarzichnus* further shows some unique anterior tail scale impressions around a transversal lineament indicating a subhorizontal vent-like structure similar to the cloaca in modern squamates. This finding represents the earliest cloacal record of early amniotes. Together with a review of stem amniote trace fossils, these discoveries document the occurrence of epidermal scales in eight independent groups of late Paleozoic tetrapods. This indicates that the origin of scaly skin preceded the early Permian global warming and aridification and probably enabled the early diversification of amniotes.

Keywords: Paleozoic, Vertebrates, Tetrapods, Soft tissue, Ichnofossil

Taphonomic insights into Burgess Shale-type preservation: Evidence from the Cambrian Qingjiang Lagerstätte

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Burgess Shale-type (BST) preservation was initially defined as the compression of non-mineralized organisms characterized by organic carbonaceous remains (Butterfield, 1990). While these fossils are crucial for understanding the Cambrian explosion (Erwin & Valentine, 2013; Gaines, 2014), the nature of their preservation remains debated. Controversy centers on whether associated clay minerals are original or secondary, and the role of mineralization, such as pyritization, in replicating soft tissues (Anderson et al., 2012; Orr et al., 1998; Gabbott et al., 2004). The Qingjiang Lagerstätte is ideal for taphonomic study as it has not undergone high-temperature metamorphism or intense weathering (Fu et al., 2019; Qiao et al., 2023).

Using EPMA-WDS, we conducted comprehensive elemental analysis across various phyla from the Qingjiang Biota. Our results demonstrate that these fossils exhibit pure organic carbonaceous preservation without inter-taxa or inter-tissue differences. Concentrations of sulfur (S) and iron (Fe) are low and irregularly distributed, failing to replicate morphological features. No authigenic mineralization, such as phosphatization or silicification, was observed. These findings support the initial carbonaceous film model of BST preservation. Furthermore, the high sensitivity of EPMA-WDS to carbon (C) accurately replicates anatomical features of unstable tissues. Significant variations in C concentration among different tissues enable the differentiation of superimposed organs, offering a novel analytical perspective to resolve the limited three-dimensional spatial resolution inherent in BST fossils.

References:

- Anderson R.P., Tosca N.J., Gaines R.R., Koch N.M. & Briggs D.E.G. (2018). A mineralogical signature for Burgess Shale-type fossilization. *Geology*, 46: 347–350.
- Butterfield N.J. (1990). Organic preservation of non-mineralizing organisms and the taphonomy of the Burgess Shale. *Paleobiology*, 16: 272–286.
- Erwin D.H. & Valentine J.W. (2013). The Cambrian explosion, the construction of animal biodiversity. Roberts and Company: 1–416.
- Fu D.J., Tong G.H., Dai T., Liu W., Yang Y.N., Zhang Y., Liu C., Li L.Y., Yun H., Wu Y. & Sun A. (2019). The Qingjiang biota: a Burgess Shale-type fossil Lagerstätte from the early Cambrian of South China. *Science*, 363: 1338–1342.
- Gabbott S.E., Hou X., Norry M.J. & Siveter D.J. (2004). Preservation of Early Cambrian animals of the Chengjiang biota. *Geology*, 32: 901–904.
- Gaines R.R. (2014). Burgess Shale-type preservation and its distribution in space and time. *The Paleontological Society Papers*, 20: 123–146.
- Orr P.J., Briggs D.E.G. & Kearns S.L. (1998). Cambrian Burgess Shale animals replicated in clay minerals. *Science*, 281: 1173–1175.
- Qiao Y., Cui L.H., Xing G.Y., Fu D.J., Chang C., Gaines R. & Zhang X.L. (2023). Thermal history of Burgess Shale-type deposits: new insights from the early Cambrian Chengjiang fossils and Qingjiang fossils of South China. *Journal of Earth Science*, 34: 1611–1622.

Keywords: Burgess Shale-type preservation, Qingjiang Biota, Carbonaceous films, Taphonomy, EPMA-WDS

Abstract (Oral communication)

Symposium: S18

The Prosanto Formation near Davos - an amazing Middle Triassic *Konservat-Lagerstätte* in the Eastern Swiss Alps

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Since 1989, more than 3000 well preserved actinopterygian fishes have been collected together with a few sauropterygian and archosaur reptiles from the marine Middle Triassic Prosanto Formation in the Duncan and Landwasser region near Davos (Canton Graubünden, Eastern Swiss Alps) (Furrer, 2019; Klein et al., 2022). The sequence of dark limestone, shale and dolomite of the Prosanto Fm. occurs as a 100 to 200 m thick and more than 20 km wide lenticular intercalation in shallow water dolomites of the strongly deformed sediments of the Austroalpine Silvretta Nappe. During systematic bed-by-bed excavations in several alpine localities at 2600–2800 m altitude, also some echinoderms, crustaceans, bivalves, gastropods, foraminifers, coprolites, dasycladacean algae and terrestrial plants were documented. Index fossils are missing, but the precise U-Pb age determination from a volcanoclastic layer in the upper Prosanto Fm. indicates an age of 241 Ma, suggesting an earliest Ladinian to latest Anisian age for the whole formation. The characteristic finely laminated limestone and shale with the articulated marine nekton must have formed in a small basin below wave base. The rare macrobenthos was probably washed into the basin by storms and superficial currents from the adjoining carbonate platform, together with terrestrial archosaurs and plant debris. The Austroalpine Prosanto Fm. of Graubünden can be well compared to the *Konservat-Lagerstätte* of the UNESCO World Heritage site Monte San Giorgio (Switzerland/Italy), a time equivalent restricted basinal facies in the Southern Alps.

References:

- Furrer H. (2019). Fische und Saurier aus dem Hochgebirge. Fossilien aus der mittleren Trias bei Davos. Neujahrsblatt der Naturforschenden Gesellschaft in Zürich, 221: 112p.
- Klein N., Furrer H., Ehrbahr I., Torres Ladeira M., Richter H. & Scheyer T.M. (2022). A new pachypleurosaur from the Early Ladinian Prosanto Formation in the Eastern Alps of Switzerland. Swiss Journal of Palaeontology 141: 12.

Keywords: Actinopterygian fishes, Reptiles, Invertebrates, Paleoecology, Taphonomy, Paleogeography

Exceptional preservation in a deep-marine setting: The *Konservat-Lagerstätte* of Meljski hrib (Early Miocene, Slovenia)

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The ophiuroid beds of Meljski hrib represent a rare deep-water *Konservat-Lagerstätte*, preserving an exceptionally detailed snapshot of early Miocene benthic communities in the Central Paratethys. Dominated by mass mortality accumulations of brittle stars, most other taxa occur as isolated specimens with remarkable preservation, including delicate skeletal structures and soft tissues (Gašparič et al., 2021).

Exceptional preservation is exemplified by a stomatopod showing soft tissue replication in calcium phosphate (Gašparič, 2022), with preserved abdominal muscle bundles, and a complete deep-water holothurian retaining body wall ossicles and ferro-phosphatic bodies. Evidence of trophic interactions include a benthopelagic vertebrate regurgitalite containing basking shark gill rakers with calcified cartilage tesserae (Gašparič et al., 2022), alongside exceptionally preserved echinoids and actinopterygians, offering a rare window into deep-marine biodiversity and ecosystems.

Together, these fossils highlight Meljski hrib as a *Konservat-Lagerstätte* preserving hard and soft tissues and enabling reconstruction of Paratethyan deep-marine benthic communities and their trophic dynamics.

References:

- Gašparič, R. (2022). New exceptionally preserved stomatopod from Early Miocene of Meljski hrib. 6. Slovenski geološki kongres, Rogaška Slatina: 33–33.
- Gašparič, R., Tshudy, D., Chan, T.Y. & Čorić, S. (2021). A new deep-water lobster, *Metanephrops serendipitus* sp. nov. (Crustacea, Decapoda, Nephropidae), from lower Miocene of Meljski hrib (Maribor, Slovenia). Boletín de la Sociedad Geológica Mexicana, 73(3): A240521.
- Gašparič, R. Košťák, M. & Mazuch, M. (2022). Cetorhinid gill rakers from Early Miocene of Meljski hrib. 6. Slovenski geološki kongres, Rogaška Slatina: 34–34.

Keywords: *Konservat-Lagerstätte*, Soft tissues preservation, Trophic interactions, Early Miocene, Slovenia

An Overview of alpine terrestrial reptiles during the Carnian Pluvial Episode

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Large scale changes in the composition of ecosystems are often correlated to major changes to the environmental conditions. The Carnian Pluvial Episode (CPE) is one such instance in geological history, where significant changes to the environment over an extended period may have impacted large parts of the marine and terrestrial ecosystems. This period of increased precipitation in the Middle Triassic has been reported to coincide with shifts in both marine and terrestrial community compositions. Here we showcase a part of these communities by presenting an overview of terrestrial reptiles from the alpine regions of Austria, France, Germany, Italy and Switzerland. For this we provide a review of the current literature on this topic as well as a comprehensive overview of the different reptile groups and species found during this time. We furthermore investigated the taphonomy of the fossils included in this study, to help us better understand possible changes in depositional environments associated with the increased precipitation during the CPE. This is largely done because the specifics of these depositional environments in fossil sites that provide insights into this time are often subject to ongoing debate.

The aim for this work is to contribute to the ongoing research as part of the WETTEST project, which focuses more on the changes in flora during this time, in attempting to better understand the effects of the CPE on terrestrial ecosystems as a whole.

Keywords: CPE, Reptiles, Alps, Carnian, Triassic

Paleoecological changes based on micro- and nannofossil assemblages during the Badenian-Sarmatian transition in the eastern Vienna Basin

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Micro- and Nannofossil assemblages represent the paleoenvironmental changes in the Central Paratethys around 12,65 Ma. We present records from 41 shallow drill-cores along the Stempfelbach in Lower Austria. The *Spirorutilus*-, *Bulimina-Bolivina*-, "Verarmungs"- (Badenian) and *Anomalinoides dividens*-Zones (Sarmatian) were identified by foraminiferal assemblages. All samples can be attributed to the NN6-Nannoplankton Zone and are dominated by reticulofenestrids and *Coccolithus pelagicus*. High percentages of *H. walbersdorfensis* occur in the uppermost part of the Badenian. A short bloom of large morphotype of *R. pseudoumbilicus* in the lower part of the Sarmatian points to the Mediterranean nannofossil Zone MNN6b. Otolith findings show the presence of mostly juvenile *Paratrisopterus* and Gobiids.

Results from foraminiferal proxies show: 1. High numbers of epiphytic species (*Asterigerinata*, *Elphidium*, *Lobatula*) are characteristic for the base of the succession, followed by an increase of *Amphistegina*. 2. High contents of planktic foraminifera indicate a normal marine ingress (highstand systems tract) coeval to predominance of infaunal, marine species (mass-occurrences of *Bolivina*) near the end of the Badenian. 3. Planktic foraminifera disappear and infaunal species drop significantly at the Badenian-Sarmatian boundary. Reworked Badenian benthic and planktic foraminifera become frequent (up to 75%) in the Sarmatian. 4. The assemblages point to normal marine conditions for the base of the Sarmatian. 5. Presumably brackish conditions start not until c. 12 m above the Base of the Sarmatian. Epiphytic species dominate the entire section except during the *Bolivina* bloom and at the base of the Sarmatian (*Anomalinoides dividens* mass-occurrence). Sarmatian assemblages show distinctly impoverished faunas (species numbers and diversity). Vegetated seafloor at least in the vicinity of the depositional area (sea grass meadows or kelp forests) and muddy lagoons and basins are indicated.

Keywords: Foraminifera, Nannofossils, Otoliths, Badenian, Sarmatian

Reinvestigation of an assemblage of phosphatised Ordovician arthropodans from Öland island, Sweden

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Orsten-type preservation *sensu stricto* yields three-dimensionally preserved microfossils with exceptional morphological detail and is known from several localities worldwide, spanning from the Lower Cambrian to the Upper Ordovician. These assemblages are typically associated with low-energy, low-oxygen depositional environments and are usually dominated by hollow phosphatized arthropodans, particularly representatives of Crustacea *sensu lato*. Here, we redescribe an Ordovician Orsten-type assemblage from Öland Island, Sweden, originally described by Andres (1989). This assemblage represents one of the youngest known occurrences of this type of preservation. In contrast to typical Orsten faunas, it is characterized by an exceptionally high abundance of parasitic arthropodans, such as pentastomidans and thecostracans, associated with abundant conodont elements. Other arthropodan remains are present but are rare, fragmented, and generally poorly preserved. These fragments can be identified as, for example, “lobopodians”, Phosphatocopina, probably Agnostina or related groups, and Crustacea *sensu lato*. The high abundance of pentastomidans in the assemblage allowed us to perform morphospace analyses on different body parts. This assemblage therefore provides new insights into the early evolution and diversification of Pentastomida. Moreover, it gives new clues on the closing of the window of Orsten-type preservation *sensu stricto*.

References:

Andres, D. (1989). Phosphatisierte Fossilien aus dem unteren Ordoviz von Südschweden. *Berliner Geowissenschaftliche Abhandlungen A*, 106: 9–19

Keywords: Ordovician, Arthropoda, Orsten, Pentastomida

Abstract (Poster)

Symposium: other topics

Ontogenetic patterns in large felids: lessons from modern skeletal collections

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Among felids, only five extant species can be classified as large predators belonging to the genus *Panthera*: the Lion, Tiger, Leopard, Snow Leopard, and Jaguar. Although these taxa currently occupy well-defined ranges across Africa, Eurasia, and the Americas, their fossil record documents a much broader diversity and distribution. Despite the ecological importance of large felids, detailed studies on skeletal growth in extant species remain limited, as most zoological research has focused primarily on dental eruption and cranial morphology. Postcranial ontogeny has received comparatively little attention, and much of the available literature dates back to the 1970s–1990s. However, ontogenetic data are essential in paleontological contexts, where the identification of immature individuals directly affects taxonomic attribution and estimates of the minimum number of individuals represented within fossil assemblages. Misinterpretations of growth stages may therefore bias paleoecological and taphonomic reconstructions. To address this issue, we compiled a comparative dataset on skeletal development in extant large felids, excluding the jaguar, from specimens housed in museums across Europe and the United States. The study includes nearly 120 skeletons, 60 of which belong to the genus *Panthera*.

Our analyses revealed a marked lack of standardized and homogeneous data among institutions and taxa. Nevertheless, several anatomical features useful for species-level identification in early ontogenetic and perinatal stages were recognized. Results also show that dental and postcranial development follow partially dissociated trajectories, despite broader correlations between ontogeny and behavior. Skeletal maturation appears to proceed according to relatively conserved patterns until adulthood. This dataset expands current knowledge of skeletal ontogeny in large felids and provides a new comparative framework for the identification and interpretation of fossil large carnivores.

Keywords: Ontogeny, Genus *Panthera*

Broken but not defeated: CT evidence for survival after juvenile forelimb trauma in a cave lion from Kanegra

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The Kanegra sinkhole, located in Istria (Slovenia, northern Adriatic), is one of the few European sites that preserve multiple individuals of Pleistocene cave lions, offering significant insights into the biogeography and evolutionary history of this extinct lineage. This study investigates the traumatic pathology of a young lion's humerus, specimen MGGC 22655, currently housed in Bologna. It presents the first comprehensive analysis of a cave lion that successfully regained functional capacity after sustaining a severe forelimb injury during late juvenile development. The bone was examined using computed tomography, supplemented by an extensive macroscopic analysis of its external morphology. Complete fracture remodeling, minimal early-stage arthrosis at the joint, and experimental data on age-dependent healing collectively suggest that the injury occurred prior to the individual reaching full skeletal maturity, most likely during late juvenile development. Importantly, new U-Th dating situates this specimen within Marine Isotope Stage 6, approximately 164 ka, making it one of the earliest securely dated instances of postcranial pathology in the cave lion lineage. This novel finding underscores the biomechanical resilience of cave lions, suggesting their capacity to endure significant injuries while maintaining the essential functionality required for survival and potential reproduction.

Keywords: CT scan, *Panthera spelaea*, Traumatic injury

Abstract (Oral communication)

Symposium: S14

A diverse Carnian (Late Triassic) flora from Monte Pora (Southern Alps, Italy): systematics, paleoecology, and implications for vegetation dynamics during the Carnian Pluvial Episode

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The Carnian Pluvial Episode (CPE) represents a major climatic perturbation in the Late Triassic, marked by elevated humidity, environmental instability, and significant biotic turnover (Dal Corso et al., 2020). The fossil flora of Monte Pora (Northern Italy) provides a key window into vegetation dynamics during this interval. Over 1,000 specimens housed in the Museo di Scienze Naturali “E. Caffi” (Bergamo) were revised and documented through high-resolution imaging. The assemblage comprises sphenophytes (*Equisetites arenaceus*, *E. macrocoleon*), marattialean ferns (*Danaeopsis* cf. *lunzensis*, *Asterotheca* cf. *merianii*), seed ferns (*Pseudodanaeopsis aberi*), cycadophytes and a diverse conifer component encompassing vegetative shoots, male and female cones, and *Porastrobis bergomensis*, a reproductive organ of uncertain affinity so far unique to the locality. Plant-arthropod interactions are documented through marginal feeding and oviposition scars and a coprolite containing plant fragments. Amber droplets associated with the conifers broaden the ecological context of the deposit. Comparative analysis with coeval Alpine floras (Lunz, Raibl, Basel) highlights regional affinities and the taxonomic richness of Monte Pora. The flora reflects humid, low-energy coastal settings and documents the expansion of hygrophytic plant groups during the CPE, contributing to a refined understanding of Late Triassic terrestrial ecosystem restructuring.

References:

Dal Corso, J., Bernardi, M., Sun, Y., Song, H., Seyfullah, L.J., Preto, N., Gianolla, P., Ruffell, A., Kustatscher, E., Roghi, G., Merico, A., Hohn, S., Schmidt, A.R., Marzoli, A., Newton, R.J., Wignall, P.B., Benton, M.J. (2020). Extinction and dawn of the modern world in the Carnian (Late Triassic). *Sci. Adv.* 6, eaba0099. <https://doi.org/10.1126/sciadv.aba0099>

Keywords: Carnian Pluvial Episode, Triassic, southern alps, Paleoflora, Paleoecology

***Triceratops* and *Torosaurus* synonymy and possible implications for ceratopsian systematics**

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Triceratops (Marsh 1889) is a genus of ornithischian dinosaur, belonging to the family Ceratopsidae, known for their elaborate frills and prominent horn cores. This taxon lived during the Maastrichtian stage of the Late Cretaceous until the Cretaceous-Paleogene (K-Pg) extinction event. The longstanding debate over the possible synonymy between *Triceratops* and *Torosaurus*, first proposed by Scannella and Horner (2010), is critically discussed through a review of the main hypothesis present in literature.

The main focus of the presentation is the reexamination of data from Maiorino et al. (2013), utilizing multivariate statistics (such as PCA, clustering, and regression analyses) to isolate regional ontogenetic trajectories. Crucially, rather than relying on *a priori* taxonomic assignments to test for differences between predefined taxa, this approach employs unsupervised, data-driven clustering to objectively determine whether these morphogroups are mathematically legitimate. This methodology yields a different conclusion compared to the original paper.

Based on the observations on specimens observed and data found in the literature, an alternative hypothesis is proposed, interpreting the observed variation as a form of phenotypic plasticity associated with the ontogenetic development of the frill, within a model of optional “toromorphism”. It is proposed that this secondary development phase can be triggered by environmental pressures, specifically thermoregulatory needs observed in different regions and in different stratigraphic periods (e.g. L3 and U3 zones in Hell Creek formation).

This perspective may have significant implications not only for Ceratopsidae systematics, but also on our understanding of morphological diversity in other fossil vertebrate groups.

References:

- Marsh, O. C. (1889). Notice of gigantic horned Dinosauria from the Cretaceous. The American Journal of Science, Series 3, 38: 173–175.
- Scannella, J. B., & Horner, J. R. (2010). *Torosaurus* Marsh, 1891, is *Triceratops* Marsh, 1889 (Ceratopsidae: Chasmosaurinae): Synonymy through ontogeny. Journal of Vertebrate Paleontology, 30(4): 1157–1168.
- Maiorino, L., Farke, A. A., Kotsakis, T., & Piras, P. (2013). Is *Torosaurus* *Triceratops*? Geometric morphometric evidence of Late Maastrichtian ceratopsid dinosaurs. PLOS ONE, 8(11): e81608. DOI: 10.1371/journal.pone.0081608

Keywords: *Triceratops*, *Torosaurus*, Ceratopsians, Toromorphism, Synonymy

Procoelous vertebrae and the effect of different center of rotation on Range of Motion analyses in sauropod tails from the Late Jurassic of Tendaguru (Tanzania)

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In this study, we investigate the ranges of motion (RoM) in the caudal series of two Late Jurassic sauropods from Tendaguru (Tanzania), *Wamweracaudia keranji* and *Dicraeosaurus hansemanni*. Three-dimensional models of the vertebrae were arranged in four cartilaginous neutral poses (CNPs) to account for unknown intervertebral cartilage thickness. As both taxa show procoelous articulations in the anterior section of the tail, we tested for the first time in this morphology how different placements of the centre of rotation (CoR) affect maximum RoMs. Two configurations were used: CoR.1 at the condyle apex and CoR.2 within the condyle center. For amphicoelous joints, the intervertebral disc was modelled as an ellipsoid solid, using its center as CoR of the joint.

The distinct caudal morphologies of the two taxa, especially neural spine orientation, affect the curvature and orientation of their tails. The tail of *Dicraeosaurus* curves strongly downward in its anterior portion, corresponding to elongated neural spines, and is dominated by amphiplatyan and amphicoelous articulations. In contrast, the more linear tail of *Wamweracaudia* shows pronounced procoely in the anterior region.

Our results indicate that CoR placement significantly influences maximum RoMs in procoelous vertebrae, consistent with findings for other articulation types. This effect is especially evident in dorsiflexion of the strongly procoelous anterior caudals of *Wamweracaudia*. Importantly, CoR is not fixed but varies during motion due to changing stress distributions. Caudal procoely has been associated with shear stress in sauropods and is more pronounced in *Wamweracaudia*, suggesting a greater need for stabilization of the vertebral column. Overall, these findings provide insight into intra- and interspecific differences in sauropod behaviour. Comparing RoMs across species from the same formation may improve our understanding of how these animals communicated within herds during long-distance migration and how they defended themselves against predators.

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Keywords: Ranges of Motion, Tendaguru, Sauropods, Tail biomechanics, Vertebrae

Abstract (Oral communication)
Symposium: S8

Revisiting parasemionotid (Actinopterygii) anatomy and relationships using X-ray CT and synchrotron tomography

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The Early Triassic parasemionotids have been known for over a century from exceptionally preserved specimens but their phylogenetic position remains controversial. Endoskeletal anatomy such as a double jaw joint has been used to suggest a halecomorph (crown holostean) affinity, but other features of the skeleton, such as the presence of large clavicles and a broad preoperculum, suggest a position on the neopterygian stem. Evidence from the endocast is equivocal, with little to tie parasemionotids to either the crown or stem. Despite the wealth of anatomical data and taxonomic diversity in this assemblage, only a single terminal is typically represented in phylogenetic analyses. This taxon, *Watsonulus eugnathoides*, is frequently used to calibrate the neopterygian crown node in timescales of actinopterygian evolution. Here we used lab- and synchrotron tomography to investigate several three-dimensional, articulated parasemionotids from the Early Triassic of Greenland. We find high levels of anatomical variation between the braincase of these specimens, as well as with published taxa, indicating that multiple distinct taxa are currently contained within a single genus. The endoskeleton reveals previously unknown anatomies, including elongate, hook-like anterior processes on the hypobranchials; short epibranchial processes, and elaborate gill rakers. Unexpectedly, the first infrapharyngobranchial articulates on the ventral face of the braincase, as in early fossil teleosts and most generalised early actinopterygians, rather than with a notch on the parasphenoid, as in *Amia* and *Lepisosteus*. Three interhyoid elements are present, adding an additional layer of complexity to the story of hyoid arch evolution in early actinopterygians. These data confirm the need for detailed restudy of parasemionotids to resolve their status and position in neopterygian phylogeny.

Keywords: Actinopterygii, Fishes, Triassic, CT scanning

Why Unsupervised Vision Transformers Outperform Supervised Models in Trace Fossil Recognition?

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The application of Computer Vision to ichnology faces three challenges. First, a trace fossil is a three-dimensional structure intersecting bedding, so a single burrow system presents radically divergent geometries in transverse, oblique, and longitudinal section. Second, substrate control means that an identical behavioral program yields different morphologies as substrate properties vary, even under subtle differences in water content. Third, Computer Vision is intrinsically data-hungry, yet even modest reference datasets (>500 images per ichnotaxon) are unavailable for most ichnotaxa.

We address these challenges using an invertebrate trace fossil dataset from the area of Sesto (Permian-Triassic) together with dinosaur and bird tracks from various localities and ages. In this study, we investigate the stability of the invertebrate ichnofossil latent space using a Vision Transformer (ViT) architecture, comparing the structural reliability of unsupervised frozen embeddings against traditional supervised fine-tuning. Our results reveal that the unsupervised approach identifies a sharp, natural geometric discontinuity (Structural Vacuum) between the biogenic and abiotic domains, demonstrating that the distinction between trace fossils and the sedimentary matrix is intrinsic to the data topology. Conversely, we demonstrate that imposing supervision generates a paradox: while fine-tuning optimizes the recognition of idealized tubular morphotypes, it induces a contraction of decision boundaries. This phenomenon causes the model to “dislearn” valid but morphologically ambiguous specimens, such as circular cross-sections and poorly preserved traces, misclassifying them as geological noise.

The same framework holds direct promise for vertebrate ichnology, where dinosaur tracks pose an acute version of the convergence problem: genuine footprints, undertracks, and pseudo-tracks of tectonic or sedimentary origin can be virtually indistinguishable to automated classifiers. Applied to large tracksite photogrammetric archives, this approach offers a means of evaluating contested ichnotaxa and surfacing atypical track morphologies that supervised pipelines, trained on canonical specimens, routinely overlook.

Keywords: AI, Bioturbations, Tracks, Ichnotaxa

First Campanian record of gars (Neopterygii, Lepisosteiformes) from the Late Cretaceous of Austria

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Terrestrial biota of the Late Cretaceous archipelago of Lower Austria mainly come from Campanian strata of the Grünbach Formation, representing mostly brackish to freshwater ecosystems with marine influences. Despite a plethora of fossil findings, surprisingly little is known about the animals primarily inhabiting these aquatic environments. Here, we present the first fish remains from the Campanian Grünbach Fm., comprising two well-preserved lepisosteid teeth from Grünbach am Schneeberg. These predatory fishes were widespread in the Late Cretaceous archipelago of Europe. Their occurrence in sediments with continental influences is consistent with our current knowledge about their preferred habitats and past distribution patterns. Given that their depositional environment was most likely not fully marine and that gars are ichthyophagous, we assume that complex, non-marine food webs existed in the aquatic ecosystems of the Grünbach Fm. The collar enameloid of the teeth is characteristically infolded in the lower portion. A micro-CT scan revealed that most of the pulp cavity is occupied by irregularly infolded dentine (plicidentine). This histology resembles, to some degree, the eusthenodont and the polyplocodont type, but also displays significant differences. The Austrian gar teeth also differ from those from the Santonian of Hungary in their histology and both differ significantly in their histology from that of living lepisosteids. This indicates that the Late Cretaceous gars of the European Archipelago might represent a hitherto unrecognized genus, potentially represented by more than one species, that show the gradual decrease of osteodentine pulp cavity infill. This hypothesis, however, requires further studies for confirmation.

Keywords: Lepisosteidae, Plicidentine, Grünbach Formation, Campanian

Abstract (Oral communication)

Symposium: S12

Planktonic foraminifera response to orbital and millennial-scale climate variability in the western Mediterranean (ODP Site 975) during Marine Isotope Stages 20 and 19

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Marine Isotope Stage 19 has been extensively investigated in recent years because it represents the closest orbital analogue to the present interglacial and therefore provides a valuable framework for investigating natural climate variability. Previous studies based on Mediterranean marine records integrating micropaleontological signals (calcareous plankton and pollen assemblages) with biogeochemical proxies (stable isotope stratigraphy and biomarkers) documented millennial- and submillennial-scale climate variability across Termination IX, reflecting North Atlantic climate perturbations in the western and central Mediterranean basins.

Here we present new high-resolution records of planktonic foraminiferal assemblages together with seasonal and annual foraminifera-based SST (Sea Surface Temperature) reconstructions from sediments recovered at Ocean Drilling Program Site 975 in the Algero-Balearic Basin, spanning the late MIS 20–MIS 19 interval. These datasets are integrated with geochemical and calcareous nannoplankton records from the same site to investigate climate variability at both orbital and millennial timescales.

Comparison with climate records from the northern Gulf of Cadiz and the Iberian Margin provides new insights into the role of air–sea interactions and the coupling between Mediterranean and North Atlantic climate dynamics during the latest MIS 20 and MIS 19.

Keywords: ODP Site 975, Millennial-scale SST, Planktonic foraminifera

Abstract (Poster)

Symposium: S1

A complete skull and mandible of an anhanguerid pterosaur from the Araripe Basin: morphological and photogrammetric analysis

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This study describes an exceptionally preserved complete skull and mandible of an anhanguerid pterosaur. Currently housed in the paleontological collection of Serrapetrona (Marche, Italy), taphonomic evidence and host rock characteristics strongly suggest it originates from the Romualdo Formation (Albian, Lower Cretaceous) of the Araripe Basin, Brazil. The skull, measuring approximately 605 mm in length, displays asymmetrical taphonomic preservation: the left side retains a three-dimensional morphology, while the right side is flattened by lithostatic pressure. The lack of abrasive wear and bone surface integrity point to a Behrensmeyer stage “0”, implying rapid burial with minimal subaerial exposure. The specimen exhibits a prominent premaxillary crest and a “rake-like” dentition adapted for a piscivorous diet, housing 36 upper and 36 lower teeth. Crucially, the specimen represents one of the few known specimens preserving an associated complete mandible. Due to the lack of precise stratigraphic data and debates regarding the taxonomic validity of premaxillary crests, a very preliminary and conservative assignment to anhanguerid indet. is proposed. To ensure digital preservation and facilitate research, a high-resolution 3D photogrammetric model was generated using 220 photographs. This approach integrates traditional morphometrics with digital techniques, offering a robust framework for systematic and functional studies presently in progress.

Keywords: Pterosaur, Araripe Basin, Skull, Mandible, Photogrammetry

Biostratigraphy and Paleoenvironmental Reconstruction of Neogene Cetacean-Bearing Deposits in Piedmont (NW Italy): a micropaleontological approach

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This study aims to shed some light on the ecology, age, and paleoenvironmental conditions of Neogene sedimentary deposits where cetacean fossils were recovered among the surroundings of Asti, in the Piedmont region (NW Italy). The sediments associated with the fossil remains were analyzed to identify their foraminiferal assemblages. The forams preserved in those ancient seabeds provide a plethora of paleoecological and paleoenvironmental parameters that, when combined, allow the reconstruction of the marine settings where the cetacean remains were deposited.

The picking process was conducted under a stereomicroscope for a total of sixteen samples, with the aim of collecting approximately 300 specimens per sample, whenever possible. The specimens were identified, counted, and photographed in detail using SEM imaging. In addition to taxonomic identification at species level, a series of diagrams were created to assess assemblages' diversity and define their ecological characteristics.

Preliminary results point to highly diverse assemblages, with no single taxon dominating the community. Planktonic foraminifera are present in all samples, exceeding 50% in a few cases. The benthic taxa are mostly hyaline and differ, among samples, in the relative abundance of epifaunal and infaunal forms, suggesting shifts in seafloor conditions.

From a biostratigraphic perspective, all samples range from the Miocene to the Pliocene and are thus in agreement with previous studies carried out directly on the cetaceans.

The possibility of a detailed paleoenvironmental reconstruction for each sample will allow a better understanding of the sedimentary conditions characterizing the depositional environments in which the cetaceans were recovered. This, in turn, may contribute to a broader understanding of the deeper portion of the Tertiary Piedmont Basin seafloors.

Keywords: Biostratigraphy, Paleoecology, Micropaleontology, Foraminifera, Cetaceans

The first detailed description of the rostral neurovascular system in a sauropod dinosaur: paleobiological implications and reconstruction of perioral soft tissues

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The rostral neurovascular system consists of an intricate network of intraosseous canals branching within the maxillary, premaxillary, dentary, and nasal bones of the skull, housing the terminal branches of the trigeminal nerve and the peripheral blood vessels of the perioral region (Porter & Witmer, 2020). It is directly involved in facial sensory perception, cranial thermoregulation, and the vascular supply and innervation of the dentition and perioral soft tissues. The present study aims to provide the first detailed description of this system in a sauropod dinosaur, based on a previously undescribed titanosaur specimen from the El Nerets site (Upper Cretaceous, Catalonia, Spain). Micro-CT scans were performed on the preserved premaxillary, maxillary, and dentary bones of the specimen. The resulting data were processed through image segmentation using Avizo (version 2024.1), and subsequently reassembled and reconstructed using Blender (version 4.0) and Geomagic Design X (version 2024). The morphological description of the vessel branching illustrates how the neurovascular system interacts with and supplies the alveolar region, supporting the high rate of tooth replacement in these taxa (D'Emic et al., 2013). Furthermore, the terminal branching of the vessels, along with the superficial bone morphology and facial foramina, was used to reconstruct the covering tissues, revealing features indicative of pronounced keratinization in the perioral region.

References:

- D'Emic M.D., Whitlock J.A., Smith K.M., Fisher D.C. & Wilson J.A. (2013). Evolution of high tooth replacement rates in sauropod dinosaurs. *PLoS ONE*, 8: e69235.
- Porter W.R. & Witmer L.M. (2020). Vascular patterns in the heads of dinosaurs: evidence for blood vessels, sites of thermal exchange, and their role in physiological thermoregulatory strategies. *The Anatomical Record*, 303: 1075–1103.

Keywords: Rostral Neurovascular system, Sauropoda, Dental replacement, Corneous beak

Shallow-marine ostracods during the Permian–Triassic climate crisis in the Southern Alps

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The Permian–Triassic boundary (~252 Ma) is marked by the most severe biodiversity loss in Earth's history. Among the affected taxa, ostracods are abundant, diverse, and widely distributed microfossils across the Permian–Triassic boundary. For this reason, their fossil record provides valuable insights into marine ecosystem responses to these severe environmental changes. Here, we investigate ostracod assemblages across Permian–Triassic successions in the Southern Alps, within a paleo-equatorial setting, to characterize the extinction pattern of this group in the region. We analyzed ostracod records from four stratigraphic sections distributed along a carbonate ramp, covering a gradient from shallow to deeper depositional environments. This quantitative, regional-scale comparison of community and extinction dynamics allows us to distinguish between local extirpation and extinction signals and to assess the influence of dolomitization and diagenetic overprint on fossil preservation. Our results reveal different extinction patterns across the ramp. The shallowest-water sections show an early and pronounced loss of diversity, coinciding with intense dolomitization and poor fossil preservation. In contrast, deeper-water sections, less affected by diagenesis, show a more gradual, less pronounced decline in ostracod diversity and turnover throughout the interval. These differences show that preservation bias amplifies the perceived severity and abruptness of extinction in shallow settings. Overall, our findings suggest a water depth-dependent response of ostracod communities to the environmental crisis. This study highlights the spatial heterogeneity and temporal complexity of extinction and the importance of a regional view that integrates taxonomy, sedimentology, and quantitative analysis to disentangle the extinction signal from preservation and sampling biases.

Keywords: Permian–Triassic boundary, Ostracods, Extinction dynamics

Craniocervical biomechanics of *Ouranosaurus nigeriensis* (Dinosauria: Ornithopoda): a virtual approach

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The neck mechanics of extinct tetrapods, such as non-avian dinosaurs, have been demonstrated to play a key role in their feeding styles by enabling or limiting the reach of their snouts, which opened new perspectives on their lifestyles, ecology, and behavior. While the functional anatomy of the neck has been extensively studied in saurischian dinosaurs, comparatively little work has been done on ornithischians. Here, we provide a three-dimensional reconstruction of the neck of the Lower Cretaceous ornithopod *Ouranosaurus nigeriensis*, and analyze its range of motion. Surface-scanned models of the cervical and anterior dorsal vertebrae of both the holotype and paratype specimens were retrodeformed and articulated into osteologically neutral pose, together with the skull. The range of motion in dorsal, ventral, and lateral flexion was measured by deflecting each cervical vertebra pair until either disarticulation or an osteological stop occurred. The characteristically elongated neural spines of dorsal vertebrae are the principal osteological stop, limiting the range of motion in dorsiflexion. The neck of *Ouranosaurus* also showcases ample mobility in lateral flexion, with the animal capable of looking behind its back without the need to turn its body. Finally, we propose a myological reconstruction of the craniocervical musculature, including the putative presence of the nuchal ligament, by comparing osteological correlates with other extinct and extant archosaurs.

Keywords: Virtual paleontology, Biomechanics, Dinosauria

Paleobiogeography of Early Cretaceous hybodontiform chondrichthyans during the breakup of Pangaea

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Among living chondrichthyans, only a minor fraction of neoselachians (sharks and rays) tolerate reduced salinity conditions, in contrast to the predominantly stenohaline nature of most extant species. However, this modern restriction is merely an ecological snapshot that does not fully reflect the group's diverse paleoenvironmental history, during which multiple chondrichthyan lineages occupied non-marine environments. The last to flourish in such settings were hybodontiforms, extinct shark-like chondrichthyans that are considered the sister group of neoselachians. Following their Paleozoic origin, hybodontiforms achieved global prevalence in the Jurassic, inhabiting environments ranging from marine to continental settings. By the Early Cretaceous, the hybodontiform fossil record is dominated by continental occurrences, and they persisted until the end of the Mesozoic. During the Cretaceous, ongoing fragmentation of Pangaea promoted the diversification of non-marine hybodontiforms and led to the emergence of three major paleobiogeographic provinces: Asia, Europe–North America, and Africa–South America. This complex pattern suggests that hybodontiforms in continental settings were not solely the result of competitive exclusion from marine environments by rapidly diversifying neoselachians, but instead reflect an inherent ecological flexibility rooted in an ancestral capacity for euryhalinity. The European–North American province remains incompletely understood despite a long history of research, with most records derived from the United Kingdom, limiting interprovincial comparisons. Here, we present results from an ongoing study of a freshwater hybodontiform assemblage from the Lower Cretaceous upland locality of Balve in Germany, which is renowned for its diverse aquatic and terrestrial vertebrate fauna. These findings refine our understanding of Early Cretaceous continental ecosystems and hybodontiform paleobiogeography across Europe and beyond.

Keywords: Chondrichthyans, Hybodontiformes, Paleobiogeography, Germany, Cretaceous

Supernumerary digits in fossil footprints: three questions for confident diagnosis

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Supernumerary digits are a relatively common pathology in modern vertebrates. However, impressions of supernumerary digits in fossil tetrapod footprints are extremely rare and potentially represent either plesiomorphic polydactyly (an ancestral, species-typical condition retained from Devonian stem-tetrapods) or pathological polydactyly, an individual-level anomaly arising from trauma-induced alteration, genetic mutations, or developmental disruption. Despite documentation of pathological polydactyly in tetrapod skeletal material, no systematic diagnostic framework exists for identifying such conditions in the ichnological record. We present the first structured protocol for diagnosing pathological polydactyly in fossil footprints, based on three sequential steps: i) Taphonomic validation (real anomaly or the result of ichnotaphonomy?), ii) Morphological coherence (does it have a biological meaning?), and iii) Contextual assessment (is it pathological?). The protocol assigns graded confidence levels (Certain, Probable, Possible, Indeterminate) based on cumulative evidence, with trackway-level replicability, bilateral asymmetry, and solid thresholds for both taphonomic and morphological preservation quality as the strongest diagnostic criteria. Furthermore, we applied this protocol to a Triassic specimen of *Rhynchosauroides* potentially showing polydactyly. This framework provides essential safeguards for future ichnotaxonomic work and establishes a methodological foundation for biomechanical modelling and experimental ichnology studies of digit anomalies in fossil trackways.

Keywords: Ichnology, Tetrapods, Polydactyly, Taphonomy

New insights into protostegid (Pan-Cheloniodea) evolution from the upper Cenomanian of northeastern Italy

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Here we present preliminary analyses of two undescribed sea turtle remains from the black shales of the OAE2 record (Bonarelli level) of Valdagno (Vicenza, northeastern Italy). A phylogenetic analysis places these findings within the family Protostegidae. Ongoing anatomical analyses of these specimens show a unique combination of characters. The larger specimen (IG 292957) exhibits both plesiomorphic and apomorphic traits, whereas the smaller specimen (IG 292954) may represent a juvenile, with some features potentially related to ontogeny. Finally, histological investigation based on a thin section of the coracoid of IG 292954 supports this hypothesis, showing particularly large osteocyte lacunae and a lack of remodeling. Protostegidae is one of the most iconic families of Cretaceous sea turtles, although its evolution during the Cenomanian-Turonian interval (94–88 Ma) remains poorly understood due to a sparse fossil record. In the Tethys Ocean, known protostegids from this timeframe are mainly represented by the genus *Rhinochelys* and a few isolated remains from Germany. Our preliminary results on the new Italian material suggest the presence of at least one still undescribed endemic taxon from the western Tethys, increasing the knowledge of the diversity of the Cenomanian protostegids.

Keywords: Sea Turtles, Upper Cretaceous, Bone histology, Tethys, OAE2

Abstract (Oral communication)
Symposium: S3

Global patterns are key to understanding macroevolution

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Global-scale analyses of the fossil record have provided invaluable insights into macroevolutionary patterns, including mass extinctions and long-term biodiversity change. Recently, however, these global perspectives have been increasingly questioned, as biodiversity trajectories may vary across regions and spatial heterogeneity in fossil sampling may obscure true biological signal. This has motivated a shift toward regional analyses, which are assumed to better reflect underlying evolutionary processes. Yet, the reliability of regional diversification patterns remains largely untested. We assess the biological fidelity of regional diversification rates using fossil occurrences of marine invertebrates. We find that many regional first and last appearances of genera do not correspond to true global originations and extinctions, but instead reflect a combination of migration, sampling artefacts, and regional sedimentary histories. Regional “originations” and “extinctions” frequently coincide with the appearance and disappearance of fossil-bearing localities, indicating that regional diversification rates are strongly influenced by spatially heterogeneous sampling rather than intrinsic evolutionary dynamics. Distinct tectonic and sampling histories among regions generate uneven spatial sampling, while restricting analyses to regional scales amplifies temporal sampling biases and complicates the interpretation of diversification rates. In contrast, global analyses integrate data across regions and environments, thereby mitigating region-specific biases and recovering a higher proportion of genuine biological signal. Our results demonstrate a fundamental trade-off between spatial resolution and temporal robustness in diversification studies, and show that global patterns remain indispensable for inferring macroevolutionary dynamics over deep time.

Keywords: Diversification rates, Marine invertebrates, Sampling bias, Regional vs global analysis

Silicified echinoderm ossicles from the upper Ladinian Pelsa/-Vazzoler Lagerstätten of the Agordo Dolomites (Italy, Belluno Province) and their bearing on post-Paleozoic recovery

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Following the end-Permian extinction, the diversification of the surviving echinoderm classes (Reich et al., 2018) reached a first peak in late Anisian and a second peak in early Carnian times. The latter is best documented for Crinoidea and Echinoidea in the Cassian and Heiligkreuz formations of the Dolomites (Hagdorn, 2011; Kroh, 2011). Bulk sampling of skeletal elements including Asteroidea, Ophiuroidea, Holothuroidea, and Ophiocistoidea reveals the overall diversity in the early Carnian tropical archipelago of the Dolomites (e.g. Hausmann et al., 2021; Gale, 2024). The comparably poor Ladinian echinoderm record raises the question of the onset of the Carnian diversity peak. Here, the late Ladinian Pelsa-Vazzoler *Lagerstätten* in the Sciliar Formation (Protrachyceras biozone) add new data to improve the understanding of the course of the post-Paleozoic echinoderm recovery.

Besides other invertebrates, the Pelsa '*liberation Lagerstätten*' (Hausmann et al., 2021) yielded isolated and partly articulated silicified skeletal elements of each of the five dominating post-Paleozoic echinoderm classes among which many elements could be assigned to families or even genera or species. The Pelsa faunas extracted from three subsequent shell beds contain Anisian as well as early Carnian taxa plus Paleozoic-like proterocidarid ambulacrals. In joint ongoing work the Pelsa echinoderms are compared to Middle and early Late Triassic faunas. Compared to other Triassic echinoderm assemblages, crinoid remains played a minor role in the Pelsa lagoon. Echinoidea is the most diverse clade, however, the club and shovel shaped spines typical of the Cassian and Pachycardia beds are missing. In general, in the Pelsa *Lagerstätten* echinoderms represent a mix of Anisian and early Carnian taxa plus a paleocidarid holdover of Paleozoic faunas. Ecological factors and collecting artefacts have not been considered.

References:

- Gale A.S. (2024). New starfish (Asteroidea, Echinodermata) from the Upper Triassic (Lower Carnian) of northern Italy. *Acta geologica Polonica*, 74(3): 27.
- Hagdorn H. (2011). Benthic crinoids from the Triassic Cassian Formation of the Dolomites. *Geo.Alp*, 8: 128–135.
- Hausmann I.M., Nützel A., Roden V.J. & Reich M. (2021). Palaeoecology of tropical marine invertebrate assemblages from the Late Triassic of Misurina, Dolomites, Italy. *Acta Palaeontologica Polonica*, 66(1): 143–192.
- Kroh A. (2011). Echinoids from the Triassic of St. Cassian – A Review. *Geo.Alp*, 8: 136–140.
- Reich M., Stegemann T.R., Hausmann I.M., Roden V.J. & Nützel A. (2018). The youngest ophiocistoid: A first Palaeozoic-type echinoderm group representative from the Mesozoic. *Palaeontology*, 61(6): 803–811.

Keywords: Fossil-Lagerstätten, Triassic, Echinodermata, Italy, Dolomites

Deutero-gen3sis: A Grammar for Biotic Forcing of the Geosphere

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Biodiversity is usually modelled as a response to geodynamics and climate. Here I argue for the reverse direction as well: life does not merely adapt to planetary change; it also helps reshape the planet itself. Forests stabilize slopes and alter erosion, roots fracture rock and enhance weathering, reefs build topography, burrowers rework sediments, vegetation reorganizes hydrology, and ecosystems redirect carbon through time. The geosphere is therefore not only a boundary condition for biodiversity; it is also biotically forced.

I present gen3sis2 as a formal grammar for expressing, formalizing and testing such feedbacks. Beyond simulating biodiversity as an outcome of environmental change, and eco-evolutionary theory, gen3sis2 aims to make model structure, assumptions, and hidden choices explicit, comparable, and open to criticism. In particular, it seeks to expose secondary assumptions: decisions about scale, coupling, trait representation, process formulation, initialization, and feedback strength that often shape model outcomes as strongly as primary hypotheses, yet remain poorly documented.

This matters directly for the emerging field of biogeodynamics. If biodiversity can modify erosion, sedimentation, weathering, hydrology, and carbon cycling, then eco-evolutionary models must represent not only biosphere responses to Earth history, but also biosphere feedbacks on Earth system dynamics. I discuss how such a framework can help turn this ambition into a reproducible research program by formalizing alternative causal structures and making parametric, structural, and scenario uncertainty transparent.

gen3sis2 therefore serves not only to simulate biodiversity, but to formalize disagreement, expose hidden assumptions, and make uncertainty productive for biogeodynamics.

Keywords: biodiversity–geosphere feedbacks, life–Earth coevolution, biogeodynamics, model formalization, causal structures, reproducible modelling

The "king-crinoid" in echinoderm *Lagerstätten* of the Lower Devonian Talacasto Formation (Argentine Precordillera)

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In silty layers of the Talacasto Formation (Lower Devonian, Pragian) of the "Loma de los Piojos" mountain range (Argentine Precordillera) occur obrution *Lagerstätten* of diverse and exceptionally-preserved echinoderms, in some of which one crinoid is a sort of king: This "*Acanthocrinus*" *benedettoi* is rather similar to the famous coeval *Acanthocrinus rex* (rex = king) from the "Hunsrück Slates" (Rhenish Massif, Germany) – a beautiful crinoid figured in many textbooks, but lost by the end of World War II. Both taxa share a rather large crown with - irreversibly - backwards-directed arms spread between calycal oar-form spines and a strongly heteromorphic stem. Hence, "*Acanthocrinus*" *benedettoi* is certainly a closely allied representative of the bulk of *Acanthocrinus* species. It is rather more "king-like" than *A. rex* because it has a sort of a rayed "crown": a short anal tube with distal strong thorns. Eventually, this "crown" is covered by a parasitic platyceratid snail, which looks like a "*Jacobine* cap" as another approximation to the monarchistic symbol by "revolutionarily suppressing" it. Micro-CT scanning and digital reconstruction were used to visualise the skeletal structures in "*Acanthocrinus*" *benedettoi* specimens. Evidence supports a new genus closely related to Lower Devonian German and North African species of *Acanthocrinus* and *Monstrocrinus* (and coeval spines from Brazil). The record of new endemic crinoid genera from SW-Gondwana is relevant in discussions about biogeographic patterns supporting the Malvino-Xhosan Realm as a major biochorema during the Early Devonian, classically supported on the basis of trilobites and brachiopods information.

Keywords: Argentina, Precordillera, crinoids, Micro-CT scanning, Devonian

Large questions require large-scale comparisons: an example from quantitative morphology in Euarthropoda

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In paleontology like in other scientific disciplines, researchers have traditionally been specialized in a certain subdiscipline, using the terminology of this subdiscipline, and often mainly interacting with other researchers from this subdiscipline. This tradition is also today still solidified by job descriptions at universities and museums searching for a specialized researcher, or by academic curricula dividing teaching into strictly separate categories. All these traditions neglect the developments of the last decades towards strongly inter- and transdisciplinary research, which requires thinking beyond the limits of the own (sub)discipline and interacting with researchers from other fields. In the here presented study, we tackle a research question by incorporating data from a wide range of groups of Euarthropoda, which are usually not studied together. In the focus of our study are grasping structures in Euarthropoda, which have evolved numerous times independently. We use a large data set of several thousand specimens to compare grasping structures with a quantitative morphological approach for different types of similarity, which might be indicators for a comparable function. Our comparisons include fossil and extant specimens, different ontogenetic stages, grasping structures on different body regions, and specimens living in different habitats such as marine vs. continental habitats. This large-scale comparison allows us to search for patterns, which cannot be detected if the analysis is restricted to only a specific systematic group or a certain habitat. This kind of overarching and interdisciplinary studies are crucial to understand entire ecosystems or to approach larger questions in evolutionary biology, to name only some examples.

Keywords: Quantitative morphology, Interdisciplinarity, Euarthropoda, Grasping appendages

Quantitative morphology provides a diversity measure that is sensitive where taxonomic measures are not

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Measuring biodiversity has become a major task for modern society, providing data for political decision makers. Changes in biodiversity, as provided by the fossil record, give insights into past processes, allowing to extrapolate possible future ones. However, measuring biodiversity in past and present faunas is not easily comparable, modern fauna usually outnumbering most fossil faunas concerning taxonomic richness. Quantitative measures of morphological structures are less biased by the abundance of modern data and can detect diversity losses even in comparison to the modern fauna. I present several examples from different ingroups of Insecta demonstrating such losses. The analyzed structures include mouthparts, legs and other ecological relevant structures that allow inference of ecological function also for extinct organisms. Individuals included in the analysis are mostly larvae, as these often outnumber the adults, representing a larger biomass and having longer interaction times with the biota. However, the larvae are also included as losses in diversity in larval forms do not necessarily correlate with changes in the diversity of adult forms. It is well known that larvae and adults can evolve independently to a certain degree, but the fact that this also affects diversification events seems not generally recognized. The example should underpin that: a) larvae are an underestimated part of biodiversity in general, but also particularly in paleo-biodiversity, b) measuring diversity via morphological proxies can detect signals of biodiversity changes where taxonomic proxies fail to do so, and c) using morphological proxies allows the inclusion of specimens that are challenging to treat in a taxonomic frame, such as larvae.

Keywords: Quantitative morphology, Biodiversity, Proxies, Larvae

Detailed examination of bicuspid hooks in *Hoploscaphites* cf. *nebrascensis* using μ CT and neutron tomography

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Direct evidence of ammonoid brachial crowns has never been found. The only indication are hook-like structures found associated with scaphitid ammonites. They are thought to have functioned as grasping structures on tentacular clubs and therefore allow first insights into the brachial crown organisation of scaphitids. These hooks have been intensively studied in the species *Rhaeboceras halli* and are also known and described in the genus *Hoploscaphites*. Hooks in *R. halli* consist of variable morphological types which differ from those in *Hoploscaphites* and it is thought that *Hoploscaphites* hooks are very similar to each other in morphology and size. However, detailed analyses as in *R. halli* are still missing for *Hoploscaphites*. Therefore, we are examining a well-preserved specimen of *Hoploscaphites* cf. *nebrascensis* using a complementary approach of μ CT and neutron tomography data. The fossil is from the Late Cretaceous Pierre Shale Formation deposited in the Western Interior Seaway and was collected in Meade County (South Dakota, USA). It is a macroconch measuring c. 14 cm in maximum extent. Some of the embedded hooks are visible in the broken body chamber. Tomography data are currently being investigated and preliminary results show that around 20 hooks are contained, many of them fully hidden by sediment. Since the body chamber is incomplete, an originally higher number of hooks can be expected. All hooks are hollow structures with a wall thickness of approximately 200 μ m. They consist of a round open base and two cusps which are bent into one direction. Size and morphology are more variable than previously thought and will be described using landmark analysis. Hook size can differ by approximately a factor of five. Although generally both cusps on a single hook bend in the same angle from the base to one direction, we also found in one hook different bending angles of the cusps.

Keywords: Ammonite, Brachial crown, Scaphitidae

Preservation and diagenesis of horseshoe crab fossils in different depositional environments

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Horseshoe crabs (Xiphosura) are iconic extant arthropods and have a fossil record dating back to the Ordovician (~485 Ma). Modern horseshoe crabs incorporate a significant amount of metals into their exoskeleton, when these elements are present in high abundance in their ecosystem. As a result, the exoskeletons serve as a natural marker for trace elements in the water column. However, while the accumulation in modern organisms is due to direct interaction with their surroundings, fossilized organisms may reflect a similar primary signature or in many cases undergo diagenesis, thus changing the original composition of the tissues. To understand the composition of fossil horseshoe crabs and their diagenetic pathways we analyzed 14 fossil specimens from 8 deposits (7 Carboniferous, 1 Jurassic) and 4 modern specimens from 2 localities (Florida and the Philippines). All specimens were analyzed with scanning electron microscopy (SEM) coupled with energy dispersive X-ray spectrometry (EDS). Additionally, selected specimens were analyzed with other methods, including electron probe microanalysis, synchrotron micro-X-ray fluorescence elemental mapping, ICP-MS, and ICP-OES, together with comparison to previously published data.

Modern horseshoe crab specimens were analyzed as a baseline to understand carapace composition, as well as natural concentrations of major and minor elements that could be incorporated. The fossil specimens represented three preservation modes: (1) siderite nodules, (2) Plattenkalk, and (3) claystone.

Siderite nodule specimens are predominantly preserved as a combination of siderite, pyrite and iron oxide, with rare chalcopyrite and barite replacement. Calcium phosphate and rare salt crystals have replaced the Plattenkalk specimen. The Plattenkalk specimen is also enriched in REEs that provide insights into the diagenetic history of the deposit. Finally, the claystone specimens are predominantly preserved through iron oxide and barite replacement.

Keywords: Arthropods, SEM, Imaging, Taphonomy, Elements

Challenges in imaging of insect amber inclusions

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Fossilised resin, or amber, has preserved animal and plant inclusions over millions of years and is considered a unique window into the past. Inclusions in amber are often well preserved, sometimes even in an almost lifelike condition. Especially insects can be preserved in great detail, and in some specimens it is not preservation that limits the assessment of very fine details, but documentation. This is especially true for amber pieces, e.g. in museum collections, which cannot be further processed, e.g. cut or polished, due to the risk of damage.

Documenting amber inclusions is often difficult due to irregularities within the amber, or unevenness in the surface. Depending on the incidence of light, reflections can occur in amber, which can lead to massive artefacts in light microscopy. Inclusions of other materials, such as soil residues, bubbles or others, can also obscure an area of interest.

Some of these problems can be avoided by using micro-computed tomography (μ CT), but this method also comes with some challenges for amber inclusions. Amber can contain metallic inclusions that lead to massive image artefacts. Another challenge can be too little difference in X-ray density between the inclusion of interest and the amber, resulting in low contrast in the projection images. It is often difficult to predict in advance how well μ CT will work on a particular specimen, meaning that testing is required.

We discuss different approaches to reducing these problems in imaging of amber specimens and the need to combine different methods.

Keywords: Imaging methods, μ CT, Fossil resin, Arthropods

From Static Labels to Dynamic Retrieval for Taxonomy: Introducing the Ostracod Foundation Model

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The integration of artificial intelligence into paleontological taxonomy offers immense potential for processing large datasets, yet it remains hindered by the "black-box" nature of traditional supervised classifiers. Conventional models rely on fixed-label classification, making them highly vulnerable to label noise, the long-tail distribution of rare taxa, and the fluid nature of taxonomic revisions. Furthermore, these models cannot easily integrate the vast, often image-poor historical literature that forms the foundation of paleontological nomenclature.

To address these challenges, we present a methodological shift in AI-assisted taxonomy: transitioning from rigid classification to an explainable, similarity-and-search framework. Using ostracods, a microfossil group critical for paleoecological and biostratigraphic reconstructions as our model taxon, we developed a retrieval-based AI assistant. The system is trained on a comprehensive database comprising over 640,000 high-resolution specimen images and more than 40,000 taxonomic research papers.

By integrating Vision-Language Models (VLMs) and Retrieval-Augmented Generation (RAG), our pipeline maps images and textual descriptions, into a shared multi-modal space. Rather than outputting an unexplainable species label, the system functions as a digital taxonomic assistant. Given an image of an unknown specimen, it retrieves the most morphologically similar specimens and relevant historical literature, providing researchers with visual candidates, textual evidence, and diagnostic explanations in standard taxonomic terminology.

Crucially, this approach bridges the gap between modern imaging and 19th-century text-only descriptions, reducing the need for taxonomists to mentally visualize historical texts. It naturally adapts to taxonomic updates: where a new species or revision simply becomes a new record in the database without requiring model retraining. By prioritizing explainability and human-in-the-loop verification, this framework improves the reliability of long-tail rare species identification and offers a reproducible, scalable pipeline for other fossil groups, ultimately enhancing the accuracy of paleoenvironmental reconstructions.

Keywords: Taxonomy, Ostracod, Microfossil, Multi-modal Large Language Model, Retrieval-Augmented Generation

First paleohistology study of the regeneration tail in an early-branching sauropterygian (Reptilia: Neodiapsida)

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Regenerative ability has been extensively studied since its discovery. Among extant tetrapod taxa, tail regeneration is widely distributed among salamanders, but also in non-ophidian squamates, the tuatara and crocodylians (Fröbisch et al., 2015; Alibardi and Meyer-Rochow, 2021). Salamanders can regenerate a near-complete tail, but in other groups, regenerated tails are structurally simplified, typically consisting of a cartilaginous rod. Although tail regeneration in extant animals has been relatively well studied, research on fossils remains extremely scarce, largely due to the rarity of preservation in the fossil record. This limits our understanding of the evolution of tail regeneration. Here we report a basal sauropterygian from the Triassic of Yunnan, China, that preserves a regenerated tail. The tail is missing at approximately the proximal one-third, with a regenerated tail preserved distal to the break. External morphology indicates two distinct regions: a relatively regular proximal part and a dark, band-like distal portion. Histology shows that, apart from a few chondrocytes, the tissue consists of unusual mineralized cartilage. This condition is comparable to tail regeneration in extant lizards. Our study provides the first histological study of fossil regenerative tail and indicates that a squamate-like mode of regeneration was already present in Triassic sauropterygians.

References:

- Alibardi L. & Meyer-Rochow V.B. (2021). Regeneration in reptiles generally and the New Zealand tuatara in particular as a model to analyse organ regrowth in amniotes: A review. *Journal of Developmental Biology*, 9: 36.
- Fröbisch N.B., Bickelmann C., Olori J.C. & Witzmann F. (2015). Deep-time evolution of regeneration and preaxial polarity in tetrapod limb development. *Nature*, 527: 231–234.

Keywords: Regenerated tail, Histology, Mineralized cartilage, Sauropterygia, Middle Triassic

Abstract (Oral communication)

Symposium: S11

The oldest fossil insect from Italy: description and comparative study of a spiloblattnid hind wing from the Carboniferous of southwestern Sardinia

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Paleozoic roachoids (stem group of the extant *Dictyoptera* Leach, 1815) are primarily known and classified by their fore wings, whereas hind wings are rare and often poorly preserved, being typically concealed beneath the fore wings in articulated specimens. In this study we present a detailed morphological description and comparative analysis of a fossil roachoid hind wing from the late Moscovian (Pennsylvanian, Carboniferous) fluvio-lacustrine succession of the San Giorgio Basin, southwestern Sardinia, Italy. The exquisitely preserved fossil, characterized by a distinctive darkened seams along the main veins and the fenestrate type color pattern, can be tentatively attributed to the Family Spiloblattnidae Handlirsch, 1906, a family known between the Moscovian and the Kungurian (315.2 ± 0.2 to 274.4 ± 0.4 Ma). Due to the limited knowledge of hind wings within this group, we cannot assign this specimen to the genus and species level. This discovery represents, to date, the first formally described fossil insect from Sardinia and the oldest fossil insect from Italy, providing new and significant insight into Carboniferous insect diversity and early insect evolution. Furthermore, it constitutes the first occurrence of this Family in the peninsula, expanding current knowledge of the paleobiogeographic distribution of roachoids during the late Paleozoic.

Keywords: Insecta, Blattodea, Moscovian

New insights on late Early Pleistocene carnivorans of Europe from the hyenas of Pirro Nord and Slivia (Italy)

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Large mammal faunas of the late Early Pleistocene of Europe document important changes, primarily resulting from the dispersal of new species from Africa and Asia. This is a crucial timespan for investigating early *Homo* dispersal Out of Africa, and, in this regard, research on carnivorans occupies a special place, from providing biochronological constraints to helping to infer the paleoecological context. Here, we present new results on carnivorans from Pirro Nord and Slivia, especially focusing on the analysis of hyenas. Two Faunal Units (FUs) are named after these localities, which yielded a rich and diverse vertebrate fossil record, including many carnivorans (Bon et al., 1992; Petrucci et al., 2013). Hyenas of Pirro Nord and Slivia are represented by abundant material of the giant hyena *Pachycrocuta brevirostris*. Both localities yielded abundant remains of this iconic Quaternary predator, which is replaced by *Crocuta crocuta* in subsequent Galerian faunas. Although the occurrence of *C. crocuta* has also been recently reported from Pirro Nord, its presence is limited to Pirro III. Pirro III is a distinct and younger site, probably of Middle Pleistocene age, than those that yielded the typical Early Pleistocene fauna of the Pirro Nord FU (Iannucci et al., 2026).

References:

- Bon, M., Piccoli, G., & Sala, B. (1992). La fauna pleistocenica della breccia di Slivia (Carso triestino) nella collezione del Museo Civico di Storia Naturale di Trieste. *Atti del Museo Civico di Storia Naturale di Trieste*, 44: 33–51.
- Iannucci, A., Stefanelli, D., Conti, J., Marino, M., & Sardella, R. (2026). Occurrence of *Crocuta* (Carnivora, Hyaenidae) from a potential Middle Pleistocene site at Pirro Nord (Apricena, southern Italy). *Journal of Quaternary Science*. DOI: 10.1002/jqs.70065
- Petrucci, M., Cipullo, A., Martínez-Navarro, B., Rook, L., & Sardella, R. (2013). The late Villafranchian (early Pleistocene) carnivores (Carnivora, Mammalia) from Pirro Nord (Italy). *Palaeontographica Abteilung A*, 298: 113–145.

Keywords: *Pachycrocuta brevirostris*, *Crocuta*, Large mammals, Faunal turnover, Villafranchian

Revising Bethlehem suids and implications for chronology and paleobiogeography

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The “Levantine Corridor” is a crucial biogeographic crossroad between Africa and Eurasia, and the Pliocene represents a key timespan to understand the role of intercontinental faunal exchanges in the development of subsequent paleocommunities. The site of Bethlehem is one of few continental fossil localities of the region, bearing a diverse “Villafranchian” fauna (Hooijer, 1958) that has promoted correlations either with the Late Pliocene or the Early Pleistocene. Recent research on proboscideans and rhinoceros suggested a Pliocene age (Rabinovich & Lister, 2017; Pandolfi et al., 2020) but Hooijer (1958) reported the presence at Bethlehem of the suid *Sus strozzii*, a species that only appeared since the Early Pleistocene. Here, we carried out a revision of Bethlehem suids, considering relevant Pliocene and Pleistocene species from Eurasia and Africa, clarifying their attribution. The suid species present at Bethlehem is *Sus arvernensis*, a species that went extinct shortly after ca. 3 Ma, reconciling the available biochronological indications and supporting a Pliocene age. *Sus arvernensis* is a species of Eurasian biogeographic affinity, and Bethlehem documents an admixture of African and Eurasian species.

References:

- Hooijer D.A. (1958). An Early Pleistocene mammalian fauna from Bethlehem. Bulletin of the British Museum (Natural History). Geology, 3: 265–292.
- Pandolfi L., Rivals F., Rabinovich R. (2020). A new species of rhinoceros from the site of Bethlehem: '*Dihoplus*' *bethlehemsis* sp. nov. (Mammalia, Rhinocerotidae). Quaternary International, 537: 48–60.
- Rabinovich R. & Lister A.M. (2017). The earliest elephants out of Africa: Taxonomy and taphonomy of proboscidean remains from Bethlehem. Quaternary International, 445: 23–42.

Keywords: Suidae, *Sus*, Large mammals, Levantine Corridor, Pliocene

The "Alpine cave bear period" in Northern Italy: morphometric and morphodynamic analyses paint the most complete evolutionary picture available.

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Cave bears are among the most iconic representatives of the European Ice Age fauna. They are generally considered herbivorous, feeding predominantly on herbs and leaves of deciduous trees. Consequently, cave bears have been used as environmental proxies for the areas surrounding the caves in which their remains have been found. For instance, a warm climatic phase in the Alpine region — the "Alpine cave bear period" — lasting approximately 30,000 years (60–30 kya), based on fossils discovered at elevations of up to 2800 m a.s.l., was identified (Rabeder et al., 2025). Cheek teeth are of particular interest due to their key role in foraging behavior. Throughout the Pleistocene, cave bear cheek teeth exhibit progressive modifications of the occlusal surface, with an increased rate of change toward the end of the epoch (Rabeder, 1999). These patterns may reflect regional dietary specializations. Cave bears are also common in Northern Italy, where significant advances in the understanding of their morphometric, morphodynamic, and behavioral characteristics have been achieved over the past two decades. This study presents a review of the dental morphology of Italian cave bear populations dated to the "Alpine cave bear period". The aim is to identify similarities and differences among populations from different regions of Italy and Europe, assess potential relationships among these groups, and highlight remaining open questions.

References:

- Rabeder, G. (1999). Die Evolution des Höhlenbärengebisses. Mitteilungen der Kommission für Quartärforschung der Österreichischen Akademie der Wissenschaften, 11: 1–102.
- Rabeder, G., Kavcik-Graumann, N., Withalm, G. (2025). The Conturines Cave in the Dolomites and the Alpine climate of the last 70,000 years. Reconstruction of the climate based on fossilized vertebrate remains from caves. e-Research Reports of Museum Burg Golling, 15: 1–11.

Keywords: Cave bears, Dentition, Morphodynamic analysis, Northern Italy

Abstract (Poster)

Symposium: other topics

The enigmatic mid- to large-bodied ziphodont avetheropod (Dinosauria, Theropoda) from the Lower Cretaceous Iberian Peninsula: New insights into the non-spinosaurid theropod record of Europe

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The theropod skeletal fossil record of the Lower Cretaceous Iberian Peninsula shows a clear predominance and high paleobiodiversity of Spinosauridae. The isolated dental record also has this predominance, but ziphodont teeth represent the most common non-spinosaurid remains, even though their producer still remains elusive. Here, we studied a sample of 42 isolated teeth recovered from the Cameros Basin (Castrillo de la Reina and Golmayo formations, and the Enciso Group) and the Maestrazgo Basin (Artoles, Blesa, Camarillas, El Castellar, and Mirambel formations). Systematic, morphometric, and cladistic analyses enable their classification into four distinct morphotypes, all referred to indeterminate avetheropodans. Morphotype 1 is interpreted as representing mesial dentition, whereas morphotypes 2–4 correspond to lateral dentition. These morphotypes are primarily differentiated based on the variation in their morphology and on the extent and orientation of the carinae. Morphotype 1 appears to be restricted to the lower Barremian Blesa Formation (Maestrazgo Basin), while the lateral morphotypes are distributed throughout upper Hauterivian to the lower Aptian deposits in both basins. Our study indicates that dental remains reflect a greater diversity than that documented by the non-dental fossil record. Most of these specimens were found in fluvial and alluvial deposits, in contrast to the coastal and lacustrine environments typically preferred by spinosaurids. Furthermore, the largest accumulations of ziphodont teeth are associated with dinosaur carcasses, which are interpreted as feeding sites. Their relative scarcity in lacustrine–palustrine and coastal settings suggests that these taxa preferentially occupied inland continental environments, where preservation potential is comparatively low, whereas spinosaurids predominantly inhabited water-associated settings more conducive to fossil preservation.

Keywords: Teeth, Avetheropoda, Early Cretaceous, Palaobiodiversity, Morphometric methods

Dating the growth hormone gene duplication event in passerine birds

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Passeriformes (passerines), a clade of birds comprising over half of extant avian diversity, share a unique and unreversed duplication of the growth hormone (GH) gene. Although this feature sets them apart from all other birds, its potential role in the remarkable diversification of passerines remains underexplored. Here, we estimated the timing of this gene duplication event in order to assess its potential relevance to passerine diversification by dating a fossil-calibrated gene tree using a Bayesian phylogenetic approach (MCMCTree). Our results suggest that this event occurred in the early Eocene, coinciding with recent estimates for the origin of Passeriformes, preceding the geographic expansion and radiation of major passerine lineages. We also discuss challenges and approaches to improving the precision of the time line of gene duplication events.

Keyword: Passerines, Gene duplication, Molecular dating, Bayesian phylogenetics

Chinese Radiodonts in Canada? The Early Cambrian Mural Formation and the first giant predatory arthropods of North America

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The Cambrian period represents a pivotal interval in the history of life, in which modern animal body plans first enter the fossil record. The Mural *Lagerstätte*, located in Jasper National Park, Alberta (Canada), preserves a remarkably diverse soft-bodied fauna dated to the Early Cambrian (Stage 3/4) of Laurentia (Sperling et al., 2018). Within the Mural fauna, radiodonts stand out: they were unmineralized stem-arthropods and among the first apex predators (Potin & Daley, 2023). Their ecological disparity was driven mainly by the differentiated frontal appendages, their tools for prey capture, ranging from predatory to filter-feeding systems. Our study of the Mural material (41 specimens), based on an integrated taxonomic, phylogenetic and morphometric analysis, uncovers three radiodont taxa: a new species of *Ramskoeldia*, closely allied to *R. consimilis* from the Early Cambrian Chengjiang Biota, China; a new species of *Guanshancaris*, closely allied to *G. kunmingensis* from the Early Cambrian Guanshan Biota, China; and a new genus with key evolutionary characters like rare gnathobase-like structures. Our investigation of Mural radiodont taxa reconfirms a striking pattern: the strong connection between distant paleocontinents Laurentia and South China (Zeng et al., 2026), on opposite sides of the superocean Panthalassa, consistent with faunal homogenisation of coeval biotas.

References:

- Sperling E. A., Balthasar U. & Skovsted C. B. (2018). On the edge of exceptional preservation: insights into the role of redox state in Burgess Shale-type taphonomic windows from the Mural Formation, Alberta, Canada. *Emerging Topics in Life Sciences*, 2: 311-323.
- Potin G.J.-M. & Daley A.C. (2023). The significance of *Anomalocaris* and other Radiodonta for understanding paleoecology and evolution during the Cambrian explosion. *Frontiers in Earth Science*, 11: 1160285.
- Zeng H., Liu Q., Zhao F., et al. (2026). A Cambrian soft-bodied biota after the first Phanerozoic mass extinction. *Nature*, 651: 679–687.

Keywords: Radiodonts, Early Cambrian, Mural Formation, Frontal appendages, Laurentia

Dive into Deep Time: exploring ancient ecosystems with Virtual Reality

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Have you ever wondered what it was like to survive as *Hallucigenia* in the Cambrian seas? Or to swim in a Cretaceous lake 125 million years ago? Paleoart has long played a fundamental role in “bringing fossils to life”, making paleontological research more accessible and engaging. In recent decades, emerging technologies have expanded this potential, enabling paleoartists to explore new formats such as 3D modelling and virtual reality (VR). While 3D reconstructions of ancient life are now widely used in documentaries and museums, fully immersive VR experiences remain relatively underexplored. To address this, we assembled an interdisciplinary team of paleontologists, paleoartists, and software developers to reconstruct ancient ecosystems using the most up-to-date scientific literature. Every aspect is carefully considered, from the sculpting and animation of organisms to the creation of their environments. Informative graphics are also integrated directly into the VR experience. Our goal is not simply to depict ancient ecosystems, but to reconstruct the dynamic interactions between organisms within fully immersive virtual environments. The resulting software can support museum exhibitions as well as broader educational initiatives. Our first project, ‘A More Ancient Garden: Bringing the Ediacara Biota Back to Life with Virtual Reality’, recreated a 600-million-year-old seafloor. We are currently developing two new projects: (1) ‘La Pedrera VR: Reawakening an Exceptional Fossil Site through Virtual Reality’, designed for a local museum in Catalonia (Spain); and (2) ‘The Burgess Shale: Walcott Quarry VR’, in its early stages. Here, we present the initial steps in the development of these new, yet ancient, immersive experiences.

Keywords: Virtual Reality, Paleoart, 3D modelling, Ecosystems, Deep time

More than a pattern - chorionic microstructure of insect eggs in Eocene amber

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Knowledge about the reproduction of insects from the Eocene is scarce, and even less is known about their eggs. Insect eggs are particularly rare in the fossil record, including amber. The reasons for the limited quantity of eggs found in fossils are primarily related to taphonomy: due to their often highly delicate structure or their location in areas inaccessible to resin, e.g. under bark or in the soil, they have rarely been preserved. In addition, camouflage may have led to misidentification or confusion of eggs with plant seeds or fungi. Their small size and the focus of researchers on adult specimens has led to them being overlooked. Eggs from groups that are rarely preserved as adult animals, such as Lepidoptera (butterflies, moths), are of particular interest as they provide important information about the occurrence of these groups in deep time.

Insect eggs may be quite small, but they exhibit a wide variety of morphologies. The chorion (eggshell) is highly diverse as an adaption to different habitats, environmental conditions and protection from predators. While it can be difficult to identify eggs without additional information such as the oviposition site or their producer, the chorion structures of the eggs have characteristic morphological features that can be observed under high magnification. These features can be useful for identification.

We describe rare cases of insect eggs in Baltic amber with remarkably well-preserved chorion structure and discuss the possibilities of identifying insect eggs based on surface structures and μ -CT data.

Keywords: Baltic amber, Insects, Reproduction, Imaging, Morphology

A fossil a day keeps the doctor away – what other disciplines can learn from paleontology

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“What relevance does paleontology still have as a science today?” is a question that is being asked more frequently in times of limited financial resources and a focus on future issues. What role does paleontology play in relation to future challenges and the themes that will concern people today and in the future?

Fields such as paleontology and history, which study the past, seem backward-looking at first glance. However, it is precisely in these disciplines that a great amount of knowledge is generated that can be applied to both the present and to topics relevant to the future. In fact, knowledge transfer seems increasingly essential, paleontologists also have the unique opportunity to look back at the past and systematically assess potential impacts.

However, many findings cannot be directly applied. This requires extensive translation and adaptation work first. This step is necessary, though, as paleontology provides insights that can benefit a wide variety of future research fields. To make this happen, researchers must open their expertise and fields of study to other disciplines and enter dialogue with them. Although it may not seem obvious at first glance, paleontology can provide important insights into seemingly less related fields, such as biomimetic research or the medical field. By forming networks and synergies, larger amounts of data can be collected and analyzed.

Here we present an exemplary research project at the University Medical Center Rostock, which brings together the disciplines of paleontology, entomology, and biomedical research. The study combines various imaging techniques, integrates diverse areas of expertise, and expands and applies interdisciplinary knowledge to identify morphological structures for potential medical applications.

Keywords: Future of paleontology, Knowledge transfer, Networks, Synergy

Abstract (Oral communication)*Symposium: S18***Regionally heterogeneous food web restructuring across the Permian–Triassic mass extinction and the impact of temporal scale on ecological inferences****Baran Karapunar**University of Leeds, United Kingdom; b.karapunar@leeds.ac.uk

The Permian–Triassic mass extinction (PTME) was Earth’s most devastating biotic crisis, eliminating >80% of marine species. The PTME is thought to have triggered a globally pervasive top-down collapse of marine food webs, followed by bottom-up reassembly. However, it remains unresolved whether this pattern and the extinction selectivity were globally uniform or varied regionally. Furthermore, the effect of the temporal scale on interpretations of community structure and extinction selectivity remains unexplored. Metacommunity food webs from seven regions show that trophic collapse was not globally uniform, and that higher trophic levels were not globally truncated (Karapunar et al., 2026). Instead, patterns of disruption and recovery were geographically structured, shaped by environmental forcing, species traits, and pre-extinction food web architecture. Analysis of a comprehensive species-level marine community dataset from Meishan (China), spanning the PTME across multiple temporal scales, suggests that time averaging preserves broad trends in food web metrics. However, the placement of time-bin boundaries can shape ecological inferences. High-resolution analyses further show that the Meishan community approached a structural tipping point in the Early Triassic, becoming increasingly vulnerable to secondary extinctions. Extinction selectivity regimes also shifted markedly between background, extinction, and post-extinction intervals. Altogether, novel findings suggest that i) food webs did not collapse globally in the PTME, ii) extinction selectivity and community restructuring were geographically non-uniform, iii) inferences of selectivity and trophic dynamics are highly sensitive to temporal scale.

References:

Karapunar, B., Strydom, T., Beckerman, A.P., Ridgwell, A., Wignall, P.B., Dunne, J. A., Little, C.T., Hull, P., Pimiento, C. & Dunhill, A. (2026). No global collapse of food webs across the Permian-Triassic Mass Extinction. *bioRxiv* doi.org/10.64898/2026.02.24.707709

Keywords: Permian–Triassic mass extinction, Selectivity, Food web modelling, Time scale, Dolomites

Decay and preservation potential of the keratose sponge *Lendenfeldia chondrodes* under simulated *Lagerstätten* conditions

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Keratose sponges represent one of the earliest metazoan lineages, yet they are scarcely represented in the fossil record. Vermiform microstructures have been interpreted as possible fossils of non-spicular keratose demosponges, although the taphonomic processes underlying their formation remain unclear (see Turner, 2021). Their lack of mineralized spicules likely reduces their preservation potential, hindering interpretations of early animal evolution.

This project experimentally investigated decay processes in the keratose sponge *Lendenfeldia chondrodes* under controlled conditions designed to emulate anoxic *Lagerstätten* environments using combinations of sterile and non-sterile sponge tissue and sediment. Oxygen availability, sediment sterility, and sponge tissue sterility were assessed to determine their influence on soft-tissue decay dynamics, sedimentary alterations, and mineral precipitation.

Experimental setups were monitored using dissolved oxygen measurements, pH analyses, image documentation, and light microscopy. Microbial community analyses and Raman spectroscopy were additionally conducted to characterize microbial dynamics and identify mineral precipitates.

Setups containing non-sterile sediment displayed progressive sediment darkening with distinct black banding, independent of sponge tissue presence. Furthermore, sponge tissue exhibited progressive darkening and increased translucency, while spongin fibers remained visible in all treatments. Reflective golden mineral precipitates, possibly indicating the presence of pyrite, emerged predominantly in setups containing non-sterile sediment and non-sterile sponge tissue, remaining absent in fully sterilized conditions.

Overall, the results demonstrate persistence of spongin fibers alongside mineral precipitation, supporting the possibility of keratose sponges leaving indirect fossil traces.

References:

Turner E.C. (2021). Possible poriferan body fossils in early Neoproterozoic microbial reefs. *Nature*, 596: 87–91.

Keywords: Experimental taphonomy, Fossilization, Microbial decay processes, Fossil preservation, Mineralization

Preservation in the Rhynie chert – An Early Devonian hot-spring ecosystem frozen in time

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The Early Devonian Rhynie chert *Konservat-Lagerstätte* in Aberdeenshire, Scotland, contains an abundance of structurally preserved fossils of organisms that lived together in an early terrestrial geothermal-wetland ecosystem. Taxa documented thus far include cyanobacteria, fungi and fungus-like organisms, algae, land plants, and animals, the latter ranging from testate amoebae to various chelicerates, and soft-bodied animals. The chert also provides ample direct evidence of interactions between different organisms. Many of the fossils are preserved *in situ* and reveal astonishing details at the (sub-)cellular level, suggesting that entombment in silica occurred rapidly to virtually instantaneously. However, not all fossils from the Rhynie chert are excellent; there are also signs of desiccation and shrinkage, as well as biological decay and mechanical destruction. Understandably, most attention has been directed at the well-preserved fossils, while the tattered, fragmented, (partially) decayed, and otherwise inferior ones have received little attention. Examples of the varying quality of preservation of organic remains in the Rhynie chert will be given and the underlying taphonomic processes will be discussed.

Keywords: Rhynie Chert, Preservation, Plants, Animals

The Lilliput effect and the illusion of size selective extinction

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Body size underpins major macroevolutionary patterns, yet its role during environmental crises remains contested. Two dominant paradigms are rarely evaluated together: the Lilliput effect (crisis-driven dwarfing) and size-selective extinction (apparently favoring large taxa). Here, we integrate both perspectives to reassess the generality and drivers of body-size dynamics across the Phanerozoic.

A global synthesis of ~9,000 body-size change records reveals that dwarfing is a pervasive response of marine ectotherms to environmental perturbations, with particularly strong and volatile shifts during hyperthermal events. The magnitude of size reduction scales with warming intensity, implicating temperature-driven physiological and ecological processes as primary drivers. This suggests that much of the Lilliput signal reflects within-lineage, potentially reversible responses rather than selective extinction alone.

In contrast, analyses of fossil occurrence data indicate that the previously recorded survival advantage of large-bodied taxa across extinction episodes is largely an artifact of sampling bias: higher preservation and sampling probabilities inflate their inferred durations and reduce apparent extinction risk. Together, these results challenge conventional interpretations of size selectivity and highlight the need to disentangle ecological plasticity, evolutionary turnover, and sampling bias in addressing large-scale biodiversity change.

Keywords: Lilliput effect, Body size, Selective extinction, Marine invertebrates

The Cambrian fecal revolution: Fuel for the Cambrian Radiation

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Trophic interactions in animals have been suggested as a key driver for the Cambrian Radiation. While animals make their first appearance in the fossil record sometime around 600 Ma ago, many of the Ediacaran organisms can be problematic to interpret and are of uncertain affinity and paleobiology. Although the earliest animals appear this deep in the fossil record, few Ediacaran animals show evidence of guts and there are currently no coprolites known from Proterozoic deposits.

In contrast to the Ediacaran, Cambrian coprolites have been reported from 34 deposits, ranging from the Fortunian (~538.8 Ma) to at least the Paibian (~494.2 Ma) and in the last 20 years their ecological potential has been explored. Coprolite morphology and preservation vary significantly across the Cambrian. They range from microscopic to several centimeters in size, and range from elongated cylindrical, ellipsoid, circular, to 'exploded' fecal 'carpets', suggesting a multitude of producers, most of which are unknown.

Conversely, in modern oceans, fecal pellets are an important part of the particulate organic carbon in the water column, and the global flux of organic carbon, iron, nitrogen, and phosphorus to deep water. This suggests that the advent of fecal pellets across the Ediacaran/Cambrian boundary provided an additional source of organic carbon, as well as Fe, N, and P to deeper waters, likely resulting in more and different nutrients deeper into the water column.

We analyze the impact of the advent of fecal matter on the Cambrian Radiation by examining coprolites, animal biology, sedimentology and geochemistry and contextualizing this through the role of fecal pellets in the oceanic nutrient cycle. We illustrate the central position of coprolites in driving the Cambrian Radiation.

Keywords: Fossil-Lagerstätten, Coprolites, Paleoenvironment, Biologic pump, Nutrients

Abstract (Oral communication)

Symposium: S9

Cephalopod body size in deep time

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Body size is a parameter of high ecological relevance. Additionally, the public is fascinated by exceptionally large animals, especially in predators. Recently, a huge Cretaceous coleoid jaw led to the suggestion that *Nanaimoteuthis* might have been the apex predator of its time, potentially outcompeting even marine reptiles with respect to body size. During the late Cretaceous some ammonoids also reached large sizes such as *Parapuzosia*. We put this material into context with size data of the main groups of cephalopods and discuss the macroecological implications. Since the Ordovician, cephalopods evolved taxa that reached megafauna size, i.e. body sizes exceeding one meter. Both observations of living forms and fossil evidence indicate that most if not all cephalopods were predators, although their prey varied in size in relation to the cephalopod species. While ammonoids are considered to have been microphagous, many fossil and living coleoids are known to prey on species that are comparatively large including vertebrates. Remarkably, maximum body size of cephalopods with orthoconic conchs declines from the Early Ordovician to the end of the Triassic, while ammonoid and coleoid body size displays an overall upwards trend through geologic time. By contrast, nautilid body size was nearly constant from the Devonian until today.

Keywords: Cephalopoda, Phanerozoic, Body size, Macroecology

Exceptional preservation of Mesozoic cephalopods as important sources of paleobiological information

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Marine Mesozoic conservation deposits such as Holzmaden, La Voulte-sur-Rhône, Christian Malford, Nusplingen, the Solnhofen region, and various regions in Lebanon yield cephalopod fossils with incredible anatomical and ecological details, which furthered out knowledge of these extinct mollusks. Although they play a lesser role in terms of diversity, nautilids from the Cenomanian of Lebanon revealed a lot of their anatomy. For example, we could demonstrate the presence of renal concretions as in their modern counterparts, used as carbonate reservoir for septal formation. Ammonoids have a bad reputation for the scarcity of soft-tissue preservation; this can be explained best by their external conch, which covers most of the soft parts, by the neutral buoyancy of the conch, which makes them float until the soft parts are taphonomically lost, and possibly by their physiology. Although most coleoid groups except belemnites are rather rare, several taxa are known throughout the Mesozoic to preserve soft tissues, and of some taxa, the entire soft body is known. In this talk, we present an overview over the discoveries of the past two decades and their implications for the anatomy and ecology of these cephalopods.

Keywords: Cephalopoda, Phosphatisation, Carbonisation, Reproduction, Feeding

Extinction mechanisms of sharks and rays: The role of age and geographic range across 145 million years of evolutionary history

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Sharks, rays, and skates (Neoselachii) represent the most endangered marine vertebrate group in modern oceans. Understanding the drivers of their extinction is therefore crucial. Here, we leveraged their abundant and well sampled fossil record to study their extinction mechanisms through deep time. We first created FINS, a manually curated compilation of over 30,000 global fossil occurrences, primarily identified to the species level. This dataset integrates over 50 years of published work in 17 languages and is supplemented with data from the Paleobiology Database. Using this extensive dataset, we reconstructed diversification dynamics and assessed extinction selectivity in neoselachians over the last 145 Myr. A Bayesian framework revealed six extinction events of varying intensity, four of which were previously undocumented. We then developed and applied a novel neural network model to test for age-dependent extinction across times of elevated and constant extinction rates. Our results indicate persistent age-based selectivity: species younger than 4 Myr consistently exhibited higher extinction risk, regardless of extinction intensity. These results suggest that age is an intrinsic predictor of extinction risk across the neoselachian evolutionary history. To explore potential drivers of this pattern, we investigated the relationship between geographic range and species age. We found a consistent positive correlation: long-lived species tended to expand their ranges early, whereas short-lived species maintained constrained distributions throughout their duration. These findings suggest that spatial restriction early in a species' lifespan may underlie its heightened extinction risk, highlighting a close interplay between geographic range and longevity. By uncovering new extinction events and demonstrating a robust link between age, range size, and extinction risk, our study provides novel insights into the macroevolutionary dynamics of neoselachians.

Keywords: Age-dependent extinction, Diversification dynamics, Extinction mechanisms, Geographic range, Sharks

An Extensible Earth Data Entity Network

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Digital databases of fossil occurrences have become cornerstones of quantitative paleobiology. Knowing when and where past organisms lived enables the research of evolution and ecology over large scales of both space and time, and the contextualization of ancient life with reconstructions of paleoenvironments. However, the increasing call for more robust, higher density and richer types of data is matched with a fragmented data provision system that is managed and curated by disjunct communities. While the joining of data from various sources has become an everyday task of researchers, a provider-level integration would offer easier, more equitable access to higher volume, more uniform and higher-quality data, allowing more dynamic reinterpretation of the past in the face of growing knowledge.

The integration of relevant data into a single, shared system can open up a new generation of research, but will require collective governance, transparent data policies and consistent funding. While establishing these remains a long-term goal, strategically-planned design choices and gradual transitions can pave the way to a globally integrated data infrastructure that allows the registration and access to any relationship between its entities. We recommend the establishment of a formal network of independently managed data provision systems and argue that network-level integration can be enabled with persistent identifiers and a standardized cross-reference interface across data systems. We illustrate the benefits of fine-scale modularization of existing systems as the leading strategy for a community-governed, shared, and open data infrastructure. We aim to establish an informal community of researchers that use these data, and invite all members of the community to help define requirements of the next generation of paleontological data provision.

Keywords: Database, Fossil, Integration, Strategy, Community

Redlichia needs revision: cranial measurements show substantial overlap between trilobites of the genus *Redlichia*

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Trilobites from the genus *Redlichia* Cossman, 1902 are found in many early Cambrian rocks from modern-day Australia, China, Iran, Korea, Morocco, Pakistan, and Spain. Over the past hundred years, many *Redlichia* species have been described from fragmentary or distorted specimens, and it is likely that the genus has been substantially 'oversplit'. Revision of the genus is required, especially given that *Redlichia* is often considered an informal index taxon of unnamed Cambrian Series 2 (Stage 4), and could potentially be used in defining this problematic interval. Here, we present analysis of cranial measurements of Australian *Redlichia*, including new material from the upper Stage 4 (Ordian) Wirrealpa Limestone in the Flinders Ranges, South Australia. The measurements investigated include several that have been consistently used to diagnose differences between *Redlichia* species. Results suggest substantial overlap in morphology between previously described species, suggesting that either (a) *Redlichia* species cannot be reliably identified by cranial measurements alone, and/or (b) the genus is oversplit and species need to be synonymized. We propose future work for addressing these issues that will guide taxonomic revision of the genus, and greatly assist in local and regional correlation.

Keywords: Cambrian, Trilobites, Taxonomy, Gondwana

Testing salinity reconstructions based on data from recent Baltic Sea Ostracoda

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The Baltic Sea is characterized by a wide range of salinities, water depths and other environmental parameters resulting in different habitats with specifically adapted plants and animals. A widespread, abundant and diverse taxon in the Baltic Sea is Ostracoda. Those are microscopically small bivalved crustaceans which inhabit a wide range of aquatic environments. They can easily fossilize due to their calcareous shells, making them good proxies for paleontological reconstructions and valuable tools in geosciences.

We compiled a database with published papers, unpublished “gray” literature as well as unpublished data of recent ostracod occurrences covering the whole Baltic Sea and its coastal lagoons and estuaries. With the accompanying environmental factors like salinity, substrate and water depth a new method of Habitat Analysis as well as a salinity transfer function were developed.

To test the new and improved reconstruction methods a previously studied core from the Pudagla lowland on the Island of Usedom, was re-analyzed. Additionally to applying the new method of Habitat Analysis and the salinity transfer function, the Mutual Ostracod Salinity Range (MOSR) was applied. All three methods of salinity reconstruction overlap in 43.1 % of the tested samples, and in all samples if the error bars of the transfer function are considered. Looking at only two reconstruction methods, the overlap is higher: MOSR and Habitat Analysis: 100 %, MOSR and transfer function: 79.2 %, Habitat Analysis and transfer function: 44.4 %. This shows that a reliable salinity reconstruction for fossil samples is possible with all methods, but for the best result a combination of multiple methods is recommended.

Keywords: Ostracods, Paleoenvironmental reconstruction, Transfer function, MOSR method, Habitat analysis

Paleoecological context as a basis for CO₂ reconstruction from fossil plants

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Reconstructions of past atmospheric CO₂ levels are increasingly based on gas exchange models applied to fossil plants. These models integrate leaf conductance with photosynthetic capacity, providing a mechanistic link between the anatomical traits of fossil leaves and paleo-CO₂ reconstructions. Leaf conductance is derived from measured stomatal data, whereas photosynthetic parameters for fossil plants are typically inferred from values observed in extant species. However, estimates of photosynthetic rates in fossil plants are subject to substantial uncertainty. First, photosynthesis is influenced by climate factors such as air temperature, humidity, and soil water availability. CO₂ reconstruction from stomatal data therefore requires data on paleoclimate. Second, the error margin of physiological parameters of photosynthesis and gas exchange in fossil plants remain essentially unknown. For instance, empirical values for stomatal aperture width are used. To date, however, there has been no assessment of whether the stomatal aperture widths observed in extant plants can reliably be applied to fossil species. Biochemical photosynthetic parameters inferred from extant relatives represent another major source of uncertainty. It remains unclear whether these parameters have changed over time in response to ancient environmental conditions. In this contribution, we demonstrate how CO₂ reconstructions using stomatal data and $\delta^{13}\text{C}$ signatures from fossil material are influenced by paleoclimate factors. We further consider the impact of uncertainties in photosynthetic parameters and stomatal aperture. As a whole, CO₂ reconstruction requires a more holistic ecophysiological approach and potential strategies are discussed.

Keywords: CO₂, Paleoclimate, Stomata, Fossil leaves

Abstract (Oral communication)

Symposium: S12

Reevaluation of the brackish “*Oncophora* (=Rzehakia) Beds” in the Bavarian North Alpine Foreland Basin

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The southeastern Bavarian North Alpine Foreland Basin (NAFB; formerly Molasse Basin) contains thick successions of the so-called “Oncophora Beds”, reaching up to ~80 m. These deposits include the lithological units “Mehlsande”, “Schillhorizont”, “Glimmersande”, and “Schillsande”. As these terms have long been used in geological mapping and remain in official maps, their validity was reassessed through field investigations, aiming at a consistent basin-wide stratigraphic framework.

The bivalve Rzehakia (formerly Oncophora), indicative of brackish conditions, occurs throughout the succession. The “Mehlsande” mark the transition from marine to brackish environments. The “Schillhorizont” likely represents reworked shell concentrations derived from these sands. “Glimmersande” consist of mica-rich fine- to medium-grained sands, while a clear distinction of “Schillsande” is not supported due to discontinuous shell accumulations. Nevertheless, isolated shell layers and articulated Rzehakia occur in outcrops and drill cores.

The succession has traditionally been interpreted as entirely brackish. However, the Grafendwald B, Q25 drill core revealed an anomalous interval of greenish fine sand to marly silt. Micropaleontological analyses yielded exclusively fragmented *Pinna* shells, contradicting a strictly brackish setting.

Similar deposits were identified in March 2026 near Triftern (~40 km SW of Passau). These units, provisionally termed “Pinna beds”, incise into the “Glimmersande” and typically occur in their upper third.

A marine ingress, likely from the north via a channel system, is proposed. If confirmed, this would represent the first clear evidence of marine influence in the Bavarian south-east NAFB during this interval. The lack of additional fossils currently prevents precise biostratigraphic dating; further sampling is planned.

Keywords: Stratigraphy, NAFB, Miocene

Integrative ichnological reconstruction of Miocene paleoecosystems in the Vinchina Basin, Northwestern Argentina

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The Miocene Vinchina and Toro Negro formations in northwestern Argentina preserve an exceptional vertebrate ichnological record documenting South American continental isolation. We employ integrative approaches combining sedimentology, taphonomy, and morphological interpretation within a phylogenetic framework to reconstruct the ancient tetrapod fauna. Vertebrate ichnodiversity is remarkably high. The Vinchina Formation contains 24 ichnotaxa, comprising: 10 mammalian ichnospecies, including the oldest South American sparassodont tracks (*Carnivoripeda sudamericana*), dinomyid rodents (*Tacheria troyana*), macraucheniid litopterns, hegetotheriids, armadillos (*Pichipoda vizcainoi*), and specialized argyrolagid marsupials. The avian record (12 ichnospecies) features large rheids (*Aramayoichnus rheae*), flamingos (*Phoenicopterichnus rector*), and terror birds (*Rionegrina* isp.) (Farina et al., 2026). Two reptilian ichnotaxa represent freshwater turtles and small lepidosaurs. Conversely, the Toro Negro Formation records six ichnotaxa, dominated by mammals (67%), notably the monodactyl proterotheriid footprints *Okana andina* and ground sloth tracks, while the avian ichnofauna is composed of three ichnotaxa. These associations are preserved in arid to semi-arid environments characterized by anastomosing and braided fluvial systems, ephemeral lakes, and eolian interactions. These units record a mosaic of open grasslands and woodlands with seasonal water supply. Seasonal flooding and rapid burial were critical for the exceptional preservation of tracks on floodplains and sandbars. These findings highlight the potential of vertebrate ichnology to assess Cenozoic paleocommunities and summarize more than 20 years of study in the area.

Keywords: Miocene, Mammal tracks, Bird tracks, South America

Fossil *Magnolia* (Magnoliaceae) from Paleogene subtropical evergreen broadleaved assemblages in central Germany and its paleobiogeographic implications

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Magnolia was a common but subordinate floristic element in the Cenozoic European vegetation, as evidenced by macrofossil and pollen records. However, systematic and paleobiogeographic relationships of fossil-species are still incompletely known. A re-examination of leaf taxa from the western and central European regions of the Atlantic-Boreal Phytoprovince has revealed the presence of different morphological types related to different sections of the genus. Similar assumptions can be made based on evaluation of the Paleogene seed and wood records. Moreover, shared biological identities of most of the fossil-species based on detached organs are still unresolved. Therefore, an integrated analysis of the entire macrofossil record should be done to figure out taxonomic and systematic relationships among fossil-taxa and to extant clades. *Magnolia dorotheae*, described from ca 300 leaves from a Eocene riparian site in the coastal lowlands of the Paleo-North Sea, was suitable for detailed taxonomic comparison and infraspecific studies of leaf-architectural and cuticle micromorphological variability. The most distinctive character, i.e., the presence of uniseriate two-celled trichomes on densely pubescent abaxial surfaces, allowed for affiliation to *Magnolia* section *Manglietia*. Today, species of this section are restricted to tropical and subtropical regions in SE Asia. These fossils provided additional evidence for the close floristic relationship between Eocene European flora and extant evergreen broadleaved forests in Asia, in which Magnoliaceae, Fagaceae, Lauraceae, and Theaceae play important roles. The oldest fossil records of section *Manglietia* in Europe dated back to the latest Cretaceous, and its representatives disappeared from mid-latitudes of the continent during the Middle Miocene Climatic Transition cooling. The present-day distribution of the section represents a relic of a formerly much wider distribution across Eurasia.

Keywords: Evergreen broadleaved forest, Leaf architecture, Leaf cuticle micromorphology, Section *Manglietia*, Subtropical paleoclimate.

Terrestrial floras during the Carnian Pluvial Episode in the Northern Calcareous Alps (NW Tethys)

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The Carnian Pluvial Episode (CPE) has been identified as a time of plant radiation and origination of new lineages, likely related to rapid changes from xerophytic to more hygrophytic floras. Increasing humidity, causally resulting from large igneous province volcanism, is considered the likely trigger for the observed changes in terrestrial ecosystems. Understanding the cause and effects of the CPE on the plant realm requires the study of well-preserved floras that are precisely aligned with the CPE. Some of the most iconic Carnian floras are known from the Alps, located in the northwestern margin of the Tethys during the CPE. This includes the famous Lunz locality with the so far most diverse and rich plant fossil assemblages, as well as Scheibling and Polzberg (Northern Calcareous Alps). This climatic episode is also linked to worldwide amber discoveries. Integrated studies of palynomorphs and macroremains reveal a variety of different plant fossil assemblages from highly diverse ones dominated by ferns and cycadophytes to plant fossil assemblages almost exclusively composed of conifers.

Keywords: CPE, Plant fossils, Terrestrial ecosystems, Climate change

The plant fossils from the Middle Triassic (Ladinian) *Fossil-Lagerstätte* of Pelsa/Vazzoler (Dolomites)

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The Pelsa/Vazzoler fossil locality represents one of the best-preserved tropical lagoonal ecosystems of the Triassic in the Dolomites, yielding a rich malacofauna and ichthyofauna. In addition, rare laminated black limestone layers preserve a significant component of terrestrial input, including plant remains, rare insects, and traces of plant–animal interactions. A comprehensive collection strategy, independent of preservation quality, has enabled a detailed reconstruction of the terrestrial ecosystem. The plant assemblage is numerically dominated by conifers, in particular *Pelourdea* and Voltziales, followed by ferns and seed ferns. Fern remains are mostly preserved as isolated pinnae or pinnules. Leaves of *Pelourdea* are typically preserved as complete organs, only rarely folded, whereas voltzialean conifers occur predominantly as fragmentary shoots. Insect remains are rare and include four coleopteran specimens (three elytrae attributable to Archostemata and one abdominal fragment) as well as a single, well-preserved roachoid nymph, supporting a terrestrial source area. Evidence of plant–insect interactions comprises margin feeding, hole feeding, and a single mining trace, all restricted to *Pelourdea* leaves. In addition, a distinct endophytic damage type, expressed as small black circular structures, is interpreted as a possible indicator of fungal infection. The terrestrial assemblage preserved within the Pelsa/Vazzoler intraplatform basin most likely originated from nearby emergent areas, such as the Coldai zone (Pale di S. Martino–Civetta platform) located approximately 7 km to the northeast, or from smaller exposed landmasses distributed across the Ladinian carbonate platform system of the Dolomites.

Keywords: Terrestrial ecosystems, Conifers, Dolomites, Ladinian, Plant fossils

A remarkable arthropod resting trace fossil from the Famennian Aoufilal *Lagerstätte* in the eastern Anti-Atlas (Morocco)

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Devonian strata crop out at several key localities of the eastern Anti-Atlas and yielded data for vertebrate and invertebrate paleontological research for nearly a century, due to their rich, diverse, and remarkably well-preserved faunas. Recently, the ichnology is receiving more interest. Despite the great potential for ichnological research, traces of certain groups such as arthropods remain poorly documented, particularly in terms of their behavioral traces as well as body-fossils. However, except trilobites, they remain poorly documented from Devonian strata, particularly from the eastern Anti-Atlas of Morocco. The present study aims to document and analyze the ichnotaxonomy of a variety of trace fossils referred to arthropods from the Famennian Aoufilal *Lagerstätte* in the Tafilalet Platform of the eastern Anti-Atlas (Morocco).

The morphological features and morphometric parameters of new material indicate at least 5 morphotypes. It consists of well-preserved convex hypichnial traces displaying a distinctive bilaterally symmetrical, carapace-like morphology organized into three areas: an anterior bilobed area with appendage imprints, a central heart-shaped region bearing longitudinal striations, and a posterior zone with digitiform extensions. The extramorphological variation among these five morphotypes is interpreted as reflecting different behavioral strategies including resting (cubichnia), feeding (fodinichnia), escape (fugichnia) and/or temporary pauses. These traces are attributed to the activity of a benthic, most likely a phyllopod-like arthropod as potential tracemaker. The preliminary results provide new insights into the behavioral diversity and ecological roles of Devonian arthropods along the northwestern margin of Gondwana and open the window for more exploration for arthropod body- and trace fossils to refine the knowledge on the change in the faunas and their behaviors after one of the most severe biological crises (Frasnian-Famennian mass extinction).

Keywords: Arthropods, *Konzentrat-Lagerstätten*, Ethology, Ichnofossils, Famennian

Abstract (Oral communication)

Symposium: S16

Preliminary insights into the Carnian palynology of the Dolomites (Northwestern Tethys)

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The Dolomites are well-known for their exceptionally well-preserved Triassic successions, providing key records of the Carnian Pluvial Episode (CPE). Occurring around 234 to 232 Ma, the CPE corresponds to a major phase of global climatic change during the Late Triassic, commonly associated with increased humidity and enhanced siliciclastic input into sedimentary basins, as well as significant biotic turnover affecting both terrestrial and marine ecosystems (Dal Corso et al., 2020). This study focuses on the Ru Assola section within the Alpe di Specie and the Borca Member of the Heiligkreuz Formation (Northern Italy) (Pecorari et al., 2023), with the aim of identifying sedimentological and palynofacies signals linked to the CPE. Lithological observations are integrated with palynofacies analysis and carbon isotope data. Preliminary results from particulate organic matter indicate a strong dominance of phytoclasts, showing limited variability and no distinct shifts between translucent and opaque phytoclasts observed throughout the section. In contrast, palynomorphs, including spores and pollen grains, are generally well preserved and relatively abundant.

References:

Dal Corso, J., Bernardi, M., Sun, Y., Song, Y., Seyfullah, J. L., Preto, N., Gianolla, P., Ruffell, A., Kustatscher, E., Roghi, G., Merico, A., Hohn, S., Schmidt, R. A., Marzoli, A., Newton, J. R., Wignall, B. P. & Benton J. M. (2020). Extinction and dawn of the modern world in the Carnian (Late Triassic), *Sciences Advances*, 6(38): 1–12.

Pecorari, M., Caggiati, M., Dal Corso, J., Cruciani, G., Tateo, F., Chu, D., Gianolla, P. (2023). Weathering and sea level control on siliciclastic deposition during the Carnian Pluvial Episode (Southern Alps, Italy). *Palaeo3* 617: 111495.

Keywords: Triassic, CPE, Palynofacies, Carbon isotope

The latest Cambrian through Tremadocian in the Eastern Precordillera of Western Argentina – A global standard succession for $\delta^{13}\text{C}$ chemostratigraphy controlled by its conodont record

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Since early bio- and chemostratigraphic studies from the Argentina Precordillera or Cuyania Terrane in the nineties, abundant paleontological, sedimentological, and ecological data was collected from limestones of the La Silla Formation. Conodont faunas from its type section at Cerro La Silla, compared to material from Laurentia, display a succession of exclusively tropical shallow water taxa typical for the North American Midcontinent. The biostratigraphic data represent background information and a basis for a re-evaluation of the classic $\delta^{13}\text{C}$ record published in the early nineties.

The sequence boundary at the La Flecha-La Silla formational boundary represents the Red Tops Lowstand. The basal 25 m of the La Silla Formation up to the occurrence of *H. hirsutus* are condensed, coeval with the *Eoconodontus notchpeakensis* Zone, span the Hellmuthia-Red Tops Boundary Event (HERB), and include the Lange Range Eustatic Event (LLRE). Several carbon isotopic events (CIEs) named and defined at Cerro La Silla section, are globally recognized and include the COTICE, TSICE, and LSICE, plus the informal negative peak 'Skullrockian Low'. Some events became intercontinental correlation tools, others can only be compared to isotopic shifts in the U.S. Great Basin.

We distinguish four regional assemblage zones (AZ): *Teridontus nakamurai*, *Oneotodus gracilis*, *Oneotodus simplex*–*Variabiloconus bassleri*, and the *Colaptoconus quadraplicatus*–*Striatodontus prolificus* AZ. Tropical shallow water species such as *Hirsutodontus hirsutus* and *Clavohamulus elongatus* characterize Laurentian subzones (e.g., Great Basin, Texas) and allow precise correlation to global sea-level changes. Such index taxa, together with the $\delta^{13}\text{C}$ record, provide a useful stratigraphic framework and enable intercontinental correlations. Biota, ecosystems and paleoenvironments are discussed with respect to Tremadocian sea-level changes, faunal and climate development on Laurentia and South China.

Keywords: Cambrian, Ordovician, Conodont biostratigraphy, Chemostratigraphy, Argentine Precordillera

When imperfection survives: developmental malformations in an Early Triassic conodont from Kashmir

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Developmental malformations in conodont elements are well documented from Paleozoic successions but remain poorly known from the Early Triassic and have rarely been evaluated in a stratigraphically constrained recovery context (Weddige, 1990). We document abnormal P₁ elements of the segminiplanate conodont *Borinella? prima* from the Guryul Ravine section (Kashmir, India), where they are restricted to a narrow interval in the upper half of submember H3, within the Smithian–Spathian transition (Leu et al., 2025). The malformed elements retain the main diagnostic characters of *B. ? prima*, but show integrated deviations from the normal morphology, including accessory denticles, notching and distortion of the platform, and partial duplication expressed by additional basal cavities and grooves. No evidence of mechanical breakage or regenerative repair was observed.

The pathological specimens occur together with pronounced short-term shifts in the size structure of associated segminiplanate populations and are closely associated with neighbouring assemblages dominated by small-sized elements. Their restricted distribution suggests that developmental instability was concentrated within a narrow phase of faunal reorganization rather than distributed randomly through the section. These observations indicate that abnormal conodont elements may provide a useful signal of ecological instability during Early Triassic recovery.

References:

- Leu M., Brosse M., Baud A., Bhat G., Vennemann T., Bucher H. & Goudemand N. (2025). Conodont diversity, biostratigraphy, and environmental dynamics: Unravelling the Smithian-Spathian transition at Guryul Ravine, Kashmir. *Gondwana Research*, 142: 152–184.
- Weddige K. (1990). Pathological conodonts. *Courier Forschungsinstitut Senckenberg*, 118: 563–589.

Keywords: Conodonts, Pathology; Smithian–Spathian boundary, Guryul Ravine, Recovery

Snakefly larvae of the Cretaceous – past development was more gradual than nowadays

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The group of Raphidioptera (snakeflies) is considered to have been more diverse in the past, especially during the Cretaceous, and as rather species-poor nowadays (250 species). Snakeflies are also considered as the group with the most ancestral type of metamorphosis in Holometabola. This includes, for example, a mobile pupa. We report 165 new snakefly immatures, most of them from Cretaceous amber from Kachin, Myanmar. We present larvae from around 1 mm to over 24 mm in size, as well as pupae, and exuviae of larvae and pupae. Together with specimens from the literature, we collected a dataset of 547 specimens including over 200 immatures from the Cretaceous. This dataset probably covers the entire ontogeny. We used four different body parts for quantitative shape analyses. Different combinations of mandible, head capsule, prothorax, and remaining trunk resulted in ten datasubsets. In total, over 2500 shapes were analyzed. The analyses show that larvae, pupae, and adults of the fossil specimens plot together, while the modern larvae and adults separate from each other, with the pupae plotting in between. The results of the different body parts indicate an even more gradual development of fossil snakeflies compared to their modern counterparts. This also supports previous qualitative observations of a more gradual development in fossils. Additionally, we discuss morphological characters in snakefly larvae that have to date rarely been in focus of research.

Keywords: Diversity, Ontogeny, Cretaceous, Amber, Quantitative Analysis

The riddle of the 100-million-year-old “beak larva” has been solved

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The “beak larva” is a holometabolan larva from about 100-million-year-old amber from Kachin, Myanmar. Four of these specimens with unique morphology have been described so far. The mouthparts constitute a prominent forward-directed beak. The identity of the larvae was long unclear, and a possible identity as a lacewing or beetle has been discussed. New details of one of the specimens could be revealed by using synchrotron radiation. Especially new insights on the composition of the beak could be achieved. The beak is formed by the labrum and labium with the mandibles being inserted laterally. Two distinct channels can be found in the beak, which are probably connected to the mandibles. The maxillae are connected to the labium and show a small endite. The details of the mouthparts are incompatible with those of lacewings and are most similar to those of some beetles, namely Elateroidea (including click beetles). Within Elateroidea, the larvae are like those of Jurasaidae and Cerophytidae. The beak larvae have a morphology intermediate to the larvae of these two groups. The new data give a deeper insight into ontogenetic aspects of the groups, including a possible development known as hypermetamorphosis. Hypermetamorphosis is a type of development with at least two different morphologies in the larval phase, probably coupled to different ecologies. In the group of Cerophytidae + (beak larva + Jurasaidae), hypermetamorphosis is mostly expressed in Jurasaidae, with a mobile early larva, a physogastric and worm-like late larva, “normal”-appearing adult males, and adult females with a morphology between larva and adult.

Keywords: Elateroidea, Beetle, Cretaceous, Amber, 3D-Scan

3D morphology of the Cambrian bivalved arthropod *Sunella* informs about head segmentation, arthrodization, and arthropodization

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A head region with specialized appendages, sclerotization, and segmentation of the trunk (arthrodization), and its appendages (arthropodization) represent three key innovations in arthropod evolution. Two scenarios have been proposed for acquisition of these innovations either in a synchronous mode or in a sequential mode. Here we describe a new species *Sunella dimorphismus* sp. nov., from the Chengjiang biota (ca. 518 Ma), which displays a bivalved carapace, raptorial frontal appendages, and an arthrodized trunk with a series of biramous arthropodized appendages revealed by new specimens and new observations with assistance of computed tomography. Phylogenetic analyses placed *Sunella* as the earliest diverging deuterozoans besides *Erratus*. Ancestral state reconstructions refine our understanding of the gain and loss of key characters in the euarthropod. The results demonstrate that trunk limb arthropodization preceded trunk arthrodization, with both prior to the evolution of a six-segmented functional head, while the trunk arthrodization is found to be secondarily lost in isoxysiids.

Keywords: Cambrian, Bivalved arthropod, Arthropodization, Arthrodization, Cephalization

Maximizing the data of dental microwear analysis in fossil carnivores: the giant wolf *Canis lupus maximus* from Jaurens cave (Late Pleistocene, France)

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The analysis of dental microwear is commonly applied for paleoecological reconstruction of fossil species. Tooth wear is usually sampled on what we call worn facets, that are produced by attrition and abrasion during the food processing. Maximizing sample sizes, especially for paleontologists, has always been a desire. To achieve it, researchers often sample upper and lower antagonist teeth (e.g. molars), assuming wear patterns on homologous facets are equivalent. However, recent studies on fossil herbivores reported discrepancies between the use of upper and lower dentition, challenging this assumption. We tested whether the homologous slicing facets of the carnassial teeth (trigonid of the m1 and metastyle blade of the P4) yield consistent ecological signals when analyzed interchangeably in a selection of extant carnivores. To achieve a high-resolution, quantitative representation of these tooth-wear patterns, we used Dental Microwear Texture Analysis (DMTA). Upon validating the equivalence of the two antagonist slicing facets of carnassial teeth, we apply an integrated approach combining the DMTA with traditional Dental Microwear Analysis (DMA), to reconstruct the diet composition of the Late Pleistocene giant grey wolf, *Canis lupus maximus* (Jaurens Cave, France; 31 ka) adapted to the cold environment of MIS 3. We composed the comparison dataset selecting different extant hypercarnivorous canids (i.e. *Canis lupus*, *Canis lupus pallipes*, *Canis lupus chanco*, *Canis simensis* and *Lycaon pictus*) to test possible ecological differences in food habits. The occurrence of larger microfeatures such as coarse and hypercoarse scratches may suggest a difference in the ecology of *C. lupus maximus* as opposed to that of extant grey wolves. These interesting results show that the TDMA can be a promising tool characterizing the paleoecology of fossil carnivores for which the data availability can be amplified comparing without distinction the tooth wear of two opposite facets.

Keywords: Canidae, Microwear, Paleoecology, Pleistocene

Synsedimentary nanofossil assemblages in laminar gypsum gives a glimpse on the water column structure during the Messinian Salinity Crisis.

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During the Upper Miocene, the Mediterranean basin was transformed into the youngest salt giant on our planet. This event, known as the Messinian Salinity Crisis (MSC, 5.97–5.33Ma), led to the deposition of more than 1 million km³ of evaporites (mainly gypsum and halite) in both deep and marginal Mediterranean basins. The Caltanissetta basin in Sicily is considered an onshore analogue of deep offshore basins. In this basin, large bodies of clastic evaporites deposited during the second stage of the crisis are interbedded with laminar gypsum intervals of debated origin.

The laminar gypsum deposits in the Caltanissetta basin, investigated for this study (developed under the STSM of COST action CA23124), are characterized by the alternation of millimeter-thick cumulitic gypsum and calcareous laminae, the latter corresponding to calcareous nanofossil ooze. This work focused on the micropaleontological analyses at the lamina scale of calcareous nanofossil assemblages through optical and SEM observations.

Calcareous nanofossil assemblages are dominated by small size coccoliths such as *Reticulofenestra minuta*, *R. haqii*, *R. producta* and, in discrete layers, *Umbilicosphaera jafari*. The synsedimentary nature of these assemblages is demonstrated by the occurrence of complete coccospheres. Reworking of older sediments, testified by the occurrence of marker species as old as the Cretaceous, is common.

Our data show a shift in abundance from bottom to top in the dominant species in a shallow, warm water column; nutrients were abundant in the upper photic zone and limited to a shallow nutricline. No distinct seasonality has been detected, despite the obvious intercalation of cumulitic gypsum and calcareous laminae. The possible relationship with high-frequency (annual?) climatic oscillations, which are little known in this time interval in the Mediterranean basin, will be further investigated.

Keywords: Nanofossils, Blooms, Messinian, Gypsum, Seasonality

simTax: a novel tool to measure weighted taxonomic similarity among fossil assemblages in R

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Quantifying β -diversity in fossil assemblages is challenging due to uneven taxonomic resolution and preservation biases. Here, we introduce simTax, a R package designed to calculate taxonomic similarity among paleontological localities using a modified Jaccard index (MJ index) that integrates species-, genus-, and family-level information with redundancy-corrected weighting. The package allows the construction of dissimilarity matrices and the execution of cluster analyses on standardized fossil taxa occurrence data. If combined with additional data visualization techniques, e.g. Principal Coordinate Analyses, this enables a robust assessment of faunal similarity across spatial and temporal scales.

We demonstrate the utility of simTax through two case studies: (A) a Palearctic salamander dataset spanning the Mesozoic to Quaternary, and (B) Italian herpetofaunas from the Miocene to Holocene. In case study A, three major faunal phases are evident: a fragmented Mesozoic fauna, a distinctive Paleogene assemblage, and a late Oligocene–Quaternary “modern” fauna dominated by extant taxa. The transition to modern faunas coincides with an expansion of taxonomic space and increased compositional differentiation, with Eastern Europe functioning as a biogeographic intermediary between Central Asia and Western Europe. In case study B, macrofossil-only localities occupy restricted taxonomic space, whereas chronological proximity often outweighs geographic distance in structuring assemblages. Pleistocene and Holocene herpetofaunas show substantial continuity, whereas a partial turnover is suggested between the Pliocene and Pleistocene.

Our results highlight the power of a hierarchical, multi-rank similarity framework to detect patterns of faunal turnover, regional connectivity, or insular dynamics. By accommodating uneven taxonomic resolution, simTax provides a flexible and conceptually robust tool for assessing β -diversity in deep-time datasets, bridging methodological gaps between paleobiology and neontological ecology.

Keywords: Weighted taxonomic similarity, β -diversity, Biases, R, Paleobiogeography, Herpetofauna

Disarticulating *Salamandra*: limits and potential of isolated bones of the three Italian species of “true salamanders”

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Comparative osteology of salamanders based on single bones is a powerful tool for the identification of disarticulated fossil remains yet insufficiently explored so far. A major limitation lies in the identification of reliable diagnostic characters: isolated elements generally permit attribution at the genus level at best, whereas species-level identification is often hindered by extensive morphological overlap.

Within this context, the genus *Salamandra* represents a distinctive case among salamandrids. *Salamandra atra* and *Salamandra lanzai*, the so-called alpine salamanders, exhibit a high degree of osteological similarity, forming a relatively homogeneous morphotype. However, both taxa can be distinguished from *Salamandra salamandra* based on discrete features observed in some skeletal elements, including vertebrae and dentigerous bones such as the vomer. These differences suggest that, under certain conditions and for particular elements, a finer taxonomic resolution may be achievable.

Despite being one of the most widespread urodeles in Europe, the fossil record of this genus remains relatively sparse. Only four of the 51 Italian localities yielding herpetofaunal fossils contain *Salamandra* sp., and just 19 of the 171 European fossil assemblages containing salamanders include this genus. Within the fossil record, a single extinct species, *Salamandra sansaniensis*, is recognized. This taxon has apomorphic, diagnostic features, but shows a morphology that is closer to *S. salamandra* than to the alpine salamanders.

Given that *S. sansaniensis* is larger than *S. salamandra*, which in turn exceeds *S. atra* and *S. lanzai* in size, we suggest that some of the observed morphological differences are size-related. This interpretation is supported by the observation that *S. salamandra* often exhibits close morphological affinities to the representatives of the biggest Italian newt (*Triturus* s.s.), despite the phylogenetic distance between the two genera.

Keywords: Urodeles, Osteology, Alpine salamanders, Isolated fossils, Fire salamander

Abstract (Oral communication)

Symposium: S6

A new specimen of *Lariosaurus* with skin preserved from the Middle Triassic of Monte San Giorgio

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A new specimen of *Lariosaurus valceresii* from the UNESCO World Heritage site of Monte San Giorgio (Switzerland) provides the first documented evidence of soft tissue preservation in this taxon. The nearly complete and articulated skeleton derives from the Middle Triassic (Ladinian) Meride Limestone and exhibits exceptional preservation of integumentary structures as a thin carbonaceous film outlining the trunk and appendages. These remains reveal the presence of small, sub-rectangular, non-imbricating scales, indicating that the body surface was covered by a scaly integument.

The distribution and morphology of the preserved soft tissues, particularly in the appendicular regions, support the presence of interdigital webbing and suggest well-developed forelimb musculature. These features are consistent with a locomotor strategy involving active forelimb-driven propulsion. It was interpreted like a “flying-rowing” mode of swimming, functionally comparable to that observed in extant otariids, and distinct from the axial undulatory locomotion traditionally inferred for early sauropterygians.

This specimen provides novel insights into the functional morphology and paleoecology of *Lariosaurus* and supports a broader diversity of locomotor adaptations among Triassic marine reptiles. The findings highlight the critical role of exceptional preservation in refining interpretations of soft tissue anatomy and locomotor function in extinct taxa (Renesto et al. 2025).

References:

Renesto, S., Ragni, C. & Magnani, F. (2025). The first specimen with skin preserved of *Lariosaurus* (Eusauroptrygia) from the Middle Triassic of Monte San Giorgio (Switzerland) allows inferences about its swimming method. *Swiss J. Palaeontol.*, 144, 56.

Keywords: Sauropterygia, Middle Triassic, *Lariosaurus*, Skin preservation, Functional morphology

Biodiversity forcing by the small mountain ranges: patterns from the Miocene intramountain lake-basins in the Dinaric Alps of SE Europe

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The Dinarides in Southeastern Europe represent a low topography NW–SE striking mountain range located between the Pannonian and the Adriatic basins. During the Miocene, numerous long-lived paleolakes developed in this area, coinciding with the extensional tectonics in the Pannonian Basin and the warm climate of the Miocene Climatic Optimum. The paleolakes' sedimentary records suggest a regional rain shadow effect between the external and internal Dinarides. Thus, only the lake successions of the latter, lee-ward positioned basins include primary evaporitic minerals such as analcime, trona and gypsum. Consistently, the mollusk record from external basins shows an exceptional phenotypic diversification, indicating persistent lacustrine systems on a million-year-scale duration favoring the accumulation of endemic faunas through iterative adaptive radiations.

The present study investigates the paleogeographic and paleoecological patterns in the Miocene fossil records from Dinarides lake basins for testing the potential effects of regional climate forcing on its biotic assemblages. Consistently, more than 4000 published occurrences of limnic and terrestrial taxa have been collected. Originating from ~400 georeferenced fossil sites and representing ~80 lacustrine basins, they have been taxonomically and stratigraphically revised to enable correlations in the spatial and temporal domain. The aquatic record is strongly dominated by gastropods, followed by bivalves and ostracods, whereas the terrestrial domain features a highly diversified paleoflora and rich mammal record. While mollusk records show an increased species richness in the west, the eastern basins mark a conspicuous diversification of endemic fish fauna. The paleoecological significance of terrestrial biota will be presented with focus on potential climate forcing.

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Keywords: Dinarides, Pannonian Basin, Miocene Climatic Optimum, Fossil record, Paleobiogeography

Burrowing in Langebaanweg: amphisbaenians and snakes from the Early Pliocene of South Africa

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The fossil locality of Langebaanweg (LBW), located approximately 110 km North of Cape Town, South Africa, is internationally renowned for the abundance and preservation quality of its terrestrial and marine fossil remains. However, the potentially rich reptile paleodiversity of the site has long been overlooked due to the scarcity of comparable skeletal specimens of extant taxa, which, as it is the case for most other African Neogene localities, hinders a thorough identification of the fossil remains. Therefore, in most cases, taxonomic assignment at species or even genus level, is not possible, at least for some groups. This is particularly true for blind snakes (suborder Scolecophidia), a group of burrowing squamates which not only are rather diverse in terms of number of southern African species but are also rather morphologically conservative in general. In fact, most of their global fossil record is identified at the suborder rank. Even if an assignment on family-level or below is not feasible yet, the report of a scolecophidian trunk vertebra from LBW fills a gap in the fossil record of this group: our preliminary report represents the first scolecophidian from southern Africa, and the second from the African continent. The burrowing LBW reptile fauna is also represented by vertebral material of the mole snake (*Pseudaspis cana*), a large pseudaspidid for which, due to recently prepared comparative material, a diagnosis of different regions of the vertebral column is now possible. The mosaic of burrowing squamates from LBW is completed by amphisbaenians, a highly derived group closely related to lacertids. The 18 trunk vertebrae from the site represent the first South African record for this taxon. Future studies, in parallel with the assembly of a comprehensive comparative osteological collection will allow a more detailed reconstruction of the reptile fauna, both from LBW and other Southern African fossiliferous localities.

Keywords: Neogene, Southern Africa, Reptile, Squamata, *Pseudaspis cana*

Abstract (Oral communication)

Symposium: S5

A preliminary analysis of the paleoherpetofauna from Bone Cave, Pleistocene of Botswana

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The current knowledge of Neogene and Quaternary paleodiversity of Southern African reptiles and amphibians remains limited, with only a small number of studies published as of 2026. As a result, existing data do not adequately reflect the true past diversity of these groups. This gap, however, is not due to a scarcity of material. On the contrary, the Quaternary record of Southern Africa has attracted considerable international attention, primarily because of its rich hominin fossil record. Extensive fieldwork at hominin-bearing sites has consequently led to the recovery of abundant remains of associated taxa. A notable example is the Pleistocene site of Bone Cave, located in northwestern Botswana near the Namibian border. The preliminary results presented here are part of the Homini'Karst project, which focuses on the exploration of karstic environments in Botswana for hominin remains. An initial survey of over 300 paleoherpetofaunal specimens reveals a diverse assemblage. Amphibians are mostly identified as indeterminate Anura, but include the second global fossil occurrence of *Hemisus* sp., the sole genus in the burrowing family Hemisotidae, an African endemic currently absent in the Bone Cave area. Reptiles are dominated by squamates, except for a single turtle carapace element. Lizard remains, largely tooth-bearing elements, indicate the presence of Gekkota, Agamidae, Scincoidea, and the large varanid *Varanus* cf. *niloticus*. The snake assemblage comprises *Python* gr. *sebae*, *Bitis* sp., Elapidae, and Colubridae s.l. Further research—particularly a more comprehensive understanding of the osteology of extant Southern African taxa—will be essential for refining interpretations of paleodiversity and for reconstructing the reptile and amphibian communities that coexisted with early humans.

Keywords: Quaternary, Southern Africa, *Hemisus*, Reptiles, Amphibians

Post-Glacial recolonization of *Globorotalia truncatulinoides* across the Western and Central Mediterranean Sea

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Globorotalia truncatulinoides is a deep-dwelling planktonic foraminifer widely used as a biostratigraphic proxy for the Quaternary in the Mediterranean region. This species, comprises five known cryptic genetic types (Types 1–5). While Types 2 and 5 exhibits right-coiling shells, Type 2 is the sole representative currently found in the Mediterranean Sea. Modern Mediterranean populations are dominated by the left-coiling variant, thriving during the winter when deep vertical mixing increases nutrient availability. This study presents a quantitative analysis of coiling ratios in *G. truncatulinoides* across 12 sediment cores from the western and central Mediterranean, tracking its post-glacial recolonization throughout the Holocene. The analysis identifies a series of key post-glacial bioevents associated with the recolonisation of *G. truncatulinoides*. Early Holocene abundances of *G. truncatulinoides* are dominated by the sinistral variant. However, the decline of the species during the uppermost part of the Early to Middle Holocene, is attributed to strong upper ocean stratification likely driven by post-glacial sea-level rise and increased freshwater runoff. A marked increase in the abundance of *G. truncatulinoides* occurs during the upper part of the Middle Holocene, coinciding with the end of the African Humid Period and a shift toward a more arid climate. During this interval, peak frequencies of the dextral coiling variant are observed across all cores, potentially reflecting a transition to a weakly stratified water column following an extended period of strong stratification. Around 3 ka, the transition to modern hydrological conditions characterized by deep winter mixing, corresponds with a decline in the dextral variant and dominance of the sinistral form. These findings highlight the utility of coiling direction in *G. truncatulinoides* as a proxy for past water column dynamics and climate-driven oceanographic change in the Mediterranean region.

Keywords: *Globorotalia truncatulinoides*, Mediterranean Sea, Holocene, Coiling direction

Skeletal assemblage shifts within persistent reef framework across Cenozoic warming intervals

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Predicting the long-term response of coral reefs to global warming is challenging due to the limited time span of extant ecological records. This study analyses the Cenozoic geological archive by investigating coral reefs from three distinct warming events: the Early Eocene Climatic Optimum (EECO; 53.3 - 49.1 Ma; Ypresian), the Late Oligocene Warming Event (LOWE; 26.5 - 24 Ma; Chattian), and the Middle Miocene Climatic Optimum (MMCO; 17 - 15 Ma; late Burdigalian - Langhian). We conducted a quantitative analysis of 247 thin sections from three key sites: Monte Postale (NE Italy, EECO), the Castro Limestone (SE Italy, LOWE), and Dağpazarı (S Turkey, MMCO), with a focus on shallow-water facies associated to coral reef depositional settings. Our results reveal that while reef frameworks persisted across all the events, the composition of the carbonate factory varied significantly. The EECO is marked by a coral production crisis, characterized by reduced coral contribution and abundant foraminifera, likely driven by extreme thermal stress, followed by calcareous red algae. Conversely, the LOWE exhibits a peak in coral abundance, facilitated by optimal temperatures and low nutrient levels. The MMCO shows a moderate decline in coral dominance, concurrent with an increase in red algae and heterotrophs, potentially linked to carbon cycle perturbations. These results are corroborated by data on the stratigraphic distribution of coral-dominated facies, an independent proxy of coral carbonate production. Ultimately, these results underscore the inherent resilience of the reef factory. Our textural and structural analysis demonstrates that, despite significant climatic shifts, the reef framework maintained its integrity under various warming scenarios, suggesting that systemic collapse is primarily triggered only by extreme thermal anomalies or by the cumulative impact of multiple environmental stressors.

Keywords: Coral reefs, Carbonate factories, Corals, Foraminifera, Cenozoic

Abstract (Oral communication)

Symposium: S8

The oldest Neogene vertebrate assemblage of the Pisco Basin, Peru

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Here we report a new elasmobranch assemblage from phosphorite layers exposed at Cerro Tiza, eastern Pisco Basin, southern Peru. Chronostratigraphic and biostratigraphic evidence indicates an Aquitanian (early Miocene) age and supports assignment of these strata to the Tunga Formation. This occurrence therefore represents the oldest Neogene vertebrate assemblage so far documented from the Pisco Basin. The assemblage includes at least 17 species and 15 genera of selachians and batoids assigned to Lamniformes, Carcharhiniformes and Myliobatiformes. Its taxonomic composition documents a diverse coastal marine ecosystem dominated by apex and mesopredatory taxa, mostly characterized by piscivorous feeding habits. These features are consistent with environmental conditions marked by elevated primary productivity, as also suggested by the phosphatic nature of the deposit. Taphonomic and paleoecological evidence indicates that the apparent dominance of a limited number of species within the Tunga phosphorite lag likely records the combined influence of ecological structure, local depositional dynamics and taphonomic filtering. The Cerro Tiza assemblage thus provides a key reference point for reconstructing the early Neogene history of marine vertebrate communities in the Pisco Basin and for assessing the onset of the highly productive ecosystems that later characterized this sector of the southeastern Pacific.

Financial support for the research was provided by the European Union – NextGenerationEU, Mission 4, Component 2, CUP I53D23002070 006, Project Title: BIOVERTICES (BIODiversity of VERTEbrates In the CEnozoic Sea).

References:

Marramà G., Collareta A., Bosio G., Bianucci G., Malinverno E., Di Celma C., Nobile F., Pellegrino L., Altamirano-Sierra A., Urbina M., Villa I.M., Villafañá J.A., Zanda A. & Carnevale G. (2026). The earliest Neogene vertebrate assemblage of the Pisco Basin, Peru. *Journal of South American Earth Sciences*, 178: 106080.

Keywords: Elasmobranchii, Early Miocene, Tunga Formation, Phosphorite, Taphonomy, Paleoecology

Abstract (Poster)

Symposium: S12

Preliminary results of the paleontological/stratigraphic study at the “Cava Bergamasca” quarry, in Bevera di Ventimiglia (IM)

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This work is based on the analysis of a 204.55 m thick stratigraphic section, composed predominantly of carbonate lithologies alternating with quartz-rich sandstone beds. A thick quartzarenitic layer occurs in the lower part of the succession. A total of 64 rock samples were collected to assess fossil diversity and abundance and to refine the petrographic description. These data were integrated with 156 Gamma-ray measurements of K, U, Th and Th/U ratios to evaluate terrigenous input and redox conditions.

Macroscopic observations reveal low fossil diversity: larger benthic foraminifera represent the dominant fossil component and are locally very abundant in some layers of the section. Oysters, and more generally bivalves, occur only sporadically, whereas gastropods are rare. Trace fossils are also abundant, particularly on bedding surfaces.

Field observations suggested that the entire measured succession may have been deposited during the middle Eocene, specifically during the early to middle Bartonian, based on the continuous occurrence of few index species: *Nummulites perforatus*, *N. lyelli* and *N. puschi*, all indicative of SBZ17. This implies that the Middle Eocene Climatic Optimum (MECO) affected at least part of the succession, encouraging the identification of specific climatic effects on both the biota and the sedimentary conditions.

A preliminary paleoenvironmental reconstruction suggests a deposition in a shallow-water setting strongly influenced by sea-level fluctuation, tectonic activity and fluvial inputs. The quartzarenitic bed points to shoreface conditions and may represent a transgressive surface underlying the rest of the succession.

The stratigraphic succession is part of the Provençal Domain and records the drowning of the Eocene ramp passing from nummulitic rich deposits to marly sediments and lastly to flyschoid units.

This study aims to provide significant new insights into the paleoenvironmental reconstruction of this paleogeographic area.

Keywords: Larger benthic foraminifera, Climate change, Gamma-ray, Eocene, Microfacies

Characterization of Mediterranean coralligenous bioconstructions by lipid biomarkers: sources and implications

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Coralligenous bioconstructions represent major biodiversity hotspots in the Mediterranean. However, they have never been investigated from a molecular perspective. This study provides a detailed characterization of lipid biomarkers preserved in coralligenous bioconstructions collected from Marzamemi (Sicily, Italy) and Capo Rizzuto Marine Protected Area (Calabria, Italy). Lipid biomarkers were released through a sequential extraction procedure, allowing discrimination between inter-crystalline organic matter and compounds tightly bound to the carbonate crystal lattice and were analysed by gas chromatography-mass spectrometry.

Low-specificity biomarkers, like short-to mid-chain saturated and monounsaturated fatty acids, are mainly associated with the detrital micrite infilling framework porosity, reflecting input of marine and terrigenous organic matter. In contrast, the two sterols cholesterol and desmosterol are associated with crustose coralline algae, the main bioconstructors. Other eukaryotic lipid biomarkers are long-chain n-fatty acids, stigmasterol and sitosterol, pointing to input from the adjacent seagrass meadows or record past Coralligenous-*Posidonia oceanica* mosaics.

The encountered abundant biomarkers of bacteria reveal the coexistence of microbial communities in bioconstructions, with many compounds reflecting input from sulfate-reducing bacteria. However, unlike other bioconstructions like coral reefs, in the studied ones, sulfate-reducing bacteria inhabited cavities but were apparently not directly involved in the formation of autochthonous micrite.

Other lipid biomarkers are demospongiac acids, indicating the presence of sponges in cryptic microhabitats. Possibly, after death microbial degradation of sponge soft tissue promoted organomineralization processes, mediating the formation of the autochthonous micrite engulfing sponge spicules. This process possibly favored the selective preservation of bacterial biomarkers within the carbonate matrix.

Keywords: Lipid biomarkers, Coralligenous bioconstructions, Molecular preservation, Organomineralization

Abstract (Poster)

Symposium: S4

Quantitative mapping of coralligenous bioconstructions: a case study from the Lamezia Terme CARG sheet

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Coralligenous is a complex biocenosis characterized by hard substrates formed by calcareous red algae. Despite its high biodiversity and ecological importance, its spatial distribution and morphometrics remain poorly constrained in marine geological mapping. In this study, carried out within the framework of the “CARG Project - Sheet 574 Lamezia Terme (CUP: H53C23001570005)”, a quantitative mapping approach was applied to the offshore sector of the Tyrrhenian coast of Calabria (Southern Italy), where Coralligenous have been identified. The workflow is based on the integration of high-resolution Multibeam Echosounder data with geomorphological and geomorphometric indices, following the protocol proposed by Maruca et al. (2025). The integration of morpho-bathymetric and backscatter data with DTM-derived indices such as slope and Terrain Ruggedness Index allowed the delineation of the spatial extent of coralligenous bioconstructions, whereas the Topographic Position Index was used to extract individual build-ups. For each extracted feature, geometric parameters, including area, volume, thickness, maximum diameter, and shape index, were calculated.

Preliminary results highlight a control of geomorphological and geobiological factors on the distribution of Coralligenous, which appear preferentially associated with seafloor morphological features related to the Quaternary evolution of the area. The application of this approach confirms the robustness of this methodology and represents a step forward in the mapping of bioconstructed environments within the CARG Project framework.

“This research has been supported by the funds of CARG Project – Geological Map of Italy 1:50.000”

References:

Maruca G. et al. (2025). Mapping benthic marine habitats featuring coralligenous bioconstructions: a new approach to support geobiological research. *Ocean Science*, 21, 1967–1986, <https://doi.org/10.5194/os-21-1967-2025>.

Keywords: Coralligenous bioconstructions, Benthic habitat mapping, Multibeam echosounder, CARG Project

Ecological, behavioural, and phylogenetic links to cochlear shape variation in odontocetes

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The morphology of the inner ear in mammals is a valuable predictor of ecology and behavior as it houses the sensory end organs for both hearing (the cochlea) and balance (the vestibular system) (Ekdale, 2013). In toothed whales, cochlear shape carries information about phylogeny, diving, echolocation, and habitat use of a species (Park et al., 2019). To investigate these variation patterns in detail, we compiled a database of 12 ecological and behavioral variables for 48 species across all families of extant odontocetes. Shape variation was investigated following the geometric morphometric protocol of Park et al. (2019). We relied on standard and phylogenetic generalized least squares regressions to assess correlation between continuous morphofunctional variables and shape. The same was performed for categorical variables using different types of analyses of variance. Phylogenetic signal was inspected by computing the K_{mult} statistic and effect size, as well as phylogenetic analysis of variance and phylogenetic aligned and phylogenetic principal component analysis. Our results highlight that deep foraging species show a tightly coiled cochlear spiral and a moderately short vestibular aqueduct, irrespective of phylogeny and allometry. Taxa using narrow-band-high-frequency echolocation stand out for the steep cochlear slope (i.e., cochlear length relative to height relative to coiling) and large fenestrae vestibuli; such shape changes are more linked to the phylogeny. Including fossil taxa in the analysis will help reconstructing the ancestral echolocation condition for odontocetes and further clarifying the lifestyle and behaviour of both extant and early toothed whales.

References:

- Ekdale, E. G. (2013). Comparative anatomy of the bony labyrinth (inner ear) of placental mammals. *PLoS ONE* 8:e66624.
- Park, T., Mennecart, B., Costeur, L., Grohé, C., & Cooper, N. (2019). Convergent evolution in toothed whale cochleae. *BMC Evolutionary Biology*, 19(1): 195.

Keywords: Odontocete, Cochlear shape, Geometric Morphometrics, Echolocation, Diving Ecology, Phylogenetic comparative methods

Abstract (Poster)

Symposium: other topics

Dental morphology of *Glis sackdillingensis* from two Early Pleistocene localities

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The abundant fossil record of rodents provides valuable insights into paleoecology, as morphological traits, particularly dental characteristics, are closely linked to dietary preferences and ecological roles. Glirids are especially important for reconstructing paleoenvironmental conditions due to their specific environmental requirements. Within this family, the genus *Glis* represents a well-documented evolutionary lineage: *Glis minor* – *Glis sackdillingensis* – *Glis glis*. In this study, we investigate variations in the shape and surface area of the lower premolar's (p4) occlusal surface in *G. sackdillingensis* from two geographically close early Pleistocene localities, Schernfeld and Weißenburg, to reveal differences related to paleoenvironmental conditions and/or relative chronology. The specimens were compared using elliptical Fourier analysis followed by principal component analysis in the software SHAPE. Additionally, the occlusal surface areas were measured and compared with a two-sample t-test. While no significant difference in occlusal shape was detected, the premolars from Weißenburg had a highly significantly larger surface area than those from Schernfeld. Nadachowski and Daoud (1994) previously established that the dental pattern of *Glis* shows an increase in size over time. This suggests that the Schernfeld specimens are older than those from Weißenburg, allowing us to date the localities relative to one another. Based on these findings, we conclude that the Schernfeld assemblage likely predates the Weißenburg assemblage. In addition, our findings contribute to the understanding of morphological changes in the dentition of *G. sackdillingensis* during the Early Pleistocene.

References:

Nadachowski, A., & Daoud, A. (1994). Patterns of Myoxid Evolution in the Pliocene and Pleistocene of Europe. *Hystrix, the Italian Journal of Mammalogy*, 6(1–2): 141–149.

Keywords: *Glis sackdillingensis*, Schernfeld, Weißenburg, premolar occlusal surface, Early Pleistocene

Abstract (Poster)

Symposium: other topics

Anatomy, histology and phylogeny of a new titanosaur from Patagonia: a preliminary integrative study

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The Bajo de la Carpa Formation (Santonian, Upper Cretaceous) of the Neuquén Basin, northern Patagonia, preserves a diverse vertebrate assemblage constituting a key window into Late Cretaceous Gondwanan paleoecology. Here we present the preliminary results of an ongoing doctoral research project focused on a recently excavated titanosaur specimen currently housed at the Museo del Desierto Patagónico de Añelo. Recovered during a 2023 field campaign, the material (MDPA-23), includes both prepared axial and appendicular elements and portions still enclosed in plaster jackets. Initial morphological examination reveals a unique combination of characters among known Santonian–Campanian titanosaurs, suggesting possible taxonomic novelty. The research aims to conduct a comprehensive osteological description of all available skeletal elements, paying special attention to postcranial pneumaticity as documented through prepared surfaces and, where feasible, CT imaging. Histological thin sections of selected long bones will be utilized to reconstruct growth dynamics and estimate the ontogenetic stage of the individual. These anatomical and histological data will be integrated into an expanded morphological matrix for cladistic and Bayesian phylogenetic analyses to assess the systematic position of the specimen within Titanosauria. The findings will be contextualized within Santonian paleobiogeographic models, providing new data on faunal endemism and diversification in southern Gondwana. This contribution presents the project's conceptual framework and the preliminary osteological observations available at this early stage of preparation and analysis.

Keywords: Titanosauria, Patagonia, Skeletal pneumaticity, Phylogenetics, Histology

Abstract (Oral communication)

Symposium: S12

Ostracod-Based Paleoenvironmental Reconstruction of the Corinth Rift During the Last 450 ka: Insights from IODP Expedition 381

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The Corinth Rift is one of the world's most active continental rifts, characterized by rapid extension, high sedimentation rates, and strong environmental variability. IODP Expedition 381 recovered a high-resolution stratigraphic archive, providing new insights into interactions between tectonics, climate, sea-level change, and basin hydrology (McNeill et al. 2026). The Quaternary evolution of the basin was investigated using integrated ostracod analyses from sediment cores recovered at Sites M0078 and M0080. Ostracods were abundant and well preserved throughout both sequences, enabling paleoenvironmental reconstruction and inter-site correlation. Ostracod assemblages record repeated transitions from brackish lacustrine to marine conditions linked to glacial-interglacial cycles. Assemblage changes identify marine incursions during glacial Terminations I, II, and V, corresponding to transitions MIS 2–1, MIS 6–5, and MIS 12–11–10. Radiocarbon dating constrained the uppermost intervals, and older sections were dated through correlations based on shifts from brackish Ponto-Caspian faunas to mixed marine-brackish and fully marine assemblages. Such chronologies match orbital-scale frameworks for the Corinth Basin derived from biostratigraphy, tephrochronology, and geophysical data. The ostracod data display rapid flooding during deglacial sea-level rise, when Mediterranean waters overflowed the shallow western sills (~50–60 m depth), transforming the basin into a marine environment. During glacials, non-marine faunas dominated and sediment accumulation rates increased significantly, reflecting strong hydrological stratification. Ostracods proved reliable indicators of salinity change, marine connectivity, and basin evolution.

References:

McNeill, L. C., et al. (2026). A high-resolution record of early rift development and tectonic, sedimentary and environmental conditions in an active rift basin: IODP MSP drilling in the Corinth Rift, Greece (Expedition 381). *Marine Geology* : 107750.

Keywords: Paleoenvironmental reconstruction, Ponto-Caspian faunas, Sea-level change, Quaternary paleoclimate

Reconstructing marine vertebrate dietary ecology through time using zinc isotopes

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Diet is a crucial trait of an animal's lifestyle and ecology. A key indicator of the diet and thus ecological role of an organism is its trophic position, a measure of the position of an organism in relation to the energy transfer from the bottom to the top of a food web. Reconstructing trophic positions across geological time provides a powerful means to identify drivers of evolutionary change and to examine how organisms and ecosystems respond to environmental and biotic crises. Until recently, such reconstructions were limited; however, new analytical approaches now make it possible to infer trophic positions from isotopic proxies preserved in tooth enamel(oid), the highly mineralized outer layer of vertebrate teeth. Among these emerging proxies enamel(oid) zinc isotope ratios ($^{66}\text{Zn}/^{64}\text{Zn}$), reported as $\delta^{66}\text{Zn}$ values, show particular promise in the marine realm.

Here I focus on this new paleobiological tool to elucidate the structure of 'deep-time' marine food webs and the ecology and trophic positions of elasmobranchs therein. I demonstrate the exceptional preservation of dietary $\delta^{66}\text{Zn}$ signatures even in Mesozoic shark enameloid and show how this proxy can be used to track ontogenetic differences in shark foraging behaviour. Moreover, pronounced isotopic variability among taxa within the same fossil assemblages enables robust reconstructions of food web dynamics and provides new insights into the ecological roles of extinct taxa with otherwise ambiguous diets. Current results indicate low variability in baseline $\delta^{66}\text{Zn}$ values across food webs, supporting the use of a consistent interpretive framework for both extant and fossil shark teeth, and thereby allowing ecological patterns to be traced across time and space. Understanding how ecosystems and their constituent species responded to past climatic fluctuations and biotic crises offers critical insight into evolutionary processes and provides a valuable framework for addressing the ongoing biodiversity crisis.

Keywords: Marine vertebrates, Sharks, Isotopes, Diet, Ecology

Deep-sea Megalodon teeth provide clues regarding the extinction of the gigantic shark

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There is a widely held belief among the general public that *Otodus megalodon* ('Megalodon'), the largest shark that ever existed, still lives today. This idea stems in part from the surprising discovery made by the HMS *Challenger* 150 years ago: i.e. some gigantic Megalodon teeth recovered from the ocean floor at several thousand meters depth. The speculation that Megalodon may still be alive in the deep sea was further fueled by an original scientific claim in *Nature* in 1959 that examined the thickness of manganese oxide coatings on the surface of two Megalodon teeth from the *Challenger* expedition and concluded that one of the teeth was Holocene in age, only 11,333 years old (Tscherneky, 1959). Of course, dating mineral coatings on the teeth do not provide an age of the tooth itself, and Megalodon teeth from the deep sea, which have no stratigraphic context, remain to be accurately dated.

Using state-of-the-art, highest-precision strontium isotope stratigraphy (SIS) and U-Pb geochronology, we conducted a comprehensive dating program by analyzing deep-sea shark teeth enameloid, including from the *Otodus*, *Carcharodon* (white shark) and *Parotodus* lineages, recovered from water depths of up to 4,920 m. Our new study busts the wildly held myth by dating those 'deep sea teeth', demonstrating that there is no scientific evidence that Megalodon exists today. More than that, our findings provide a new perspective on the timing of its extinction and consequently the hypotheses surrounding it. Only after establishing the timing of an animal's extinction can we begin to study how ecosystems responded to the extinction event and thus our results bare important implications for the timing of the Pliocene marine megafauna turnover and the shaping of the present-day marine ecosystem.

References:

Tscherneky, W., 1959. Age of *Carcharodon megalodon*? *Nature*, 184: 1331–1332.

Keywords: *Otodus megalodon*, Dating, Extinction, Strontium isotope stratigraphy, Deep-sea fossils

Ancient chitin in 1.0 billion-year-old protist reveals the organic scaffold for skeletal biomineralization

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One of the striking examples of the co-evolution of life and minerals is the evolution of skeletal biomineralization in eukaryotes, which profoundly transformed Earth's ecosystem. Skeletal biomineralization emerged in eukaryotes >800 Ma years ago, likely driven by atmospheric oxygenation, changes in seawater chemistry, and the advent of predation. Skeletal minerals are organo-mineral composites, with an organic scaffold guiding mineralization to direct nucleation and crystal growth. Chitin serves as a widely used organic scaffold in this process (Ehrlich, 2010). While chitin is widespread in modern eukaryotes, its evolutionary history is poorly resolved due to a sparse fossil record. Here, we report molecular evidence of chitin preserved in a 1.0-billion-year-old organic-walled microfossil from the late Mesoproterozoic Lakhanda Group, Siberia. *In situ* microanalyses combining spatially resolved microscopy and spectroscopy approaches identified chitin within the cell wall of a morphologically simple fossil, ~1000 µm in diameter. Phylogenetic analysis showed that chitin synthase (CHS) enzymes are widely distributed across eukaryotes, suggesting the CHS origin predates eukaryotic diversification. Integrating fossil morphology with CHS phylogeny supports affinities with deep-branching protistan lineages. Our findings propose that the organic scaffolding machinery for skeletal biomineralization was already ancient and widespread across the eukaryotic tree at least 200 million years before the first mineralized skeletons appeared in the fossil record (~800 Ma) supporting a model in which biomineralization evolved through co-option of a pre-existing chitinous framework rather than the *de novo* evolution of new biosynthetic pathways.

References:

Ehrlich, H. (2010). Chitin and collagen as universal and alternative templates in biomineralization. *International Geology Review*, 52(7–8): 661–699.

Keywords: Biomineralization, Chitin, Lakhanda *Lagerstätten*, Eukaryote evolution

Environmental and anthropogenic controls on benthic foraminifera: a comparison between living assemblages and historical records from a northern Adriatic Lagoon (Italy)

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Lagoons are transitional habitats typified by significant natural variations in salinity, oxygenation, and nutrient availability, resulting in complex ecological conditions and a fragile biological equilibrium. These fluctuations frequently lead to low ecological quality indices, making it challenging to differentiate between natural and anthropogenic stress.

The Marano and Grado Lagoon (northern Adriatic Sea, Italy) is a shallow coastal ecosystem usually regarded as well-preserved wetland, despite persisting human activities and long-time mercury contamination. This study examines for the first time the relationships between living foraminifera and the environmental conditions in which they occur, combining them with data from a sediment core. *Ammonia tepida*, *Haynesina germanica*, *Aubignyna perlucida*, and *Criboelphidium gunteri* correlate positively with TOC content, whereas *Ammonia parkinsoniana*, *Quinqueloculina* spp., and agglutinated taxa are predominantly associated with salinity. Elevated TOC values likely influence foraminiferal distribution, allowing the identification of three main biotopes: an urban biotope dominated by *H. germanica*, an inner lagoon biotope dominated by *A. perlucida* and *H. germanica*, and an outer lagoon biotope dominated by *A. parkinsoniana*. The ecological quality of these biotopes increased from the urban sector toward the outer lagoon.

The sediment core was utilized to investigate the possible effects of recent human-induced disturbances. The deformation index indicates an upward tendency from the mid-18th century, prior to significant anthropogenic influences. Total Hg concentration in sediments cannot be recognized as the driving force for the foraminifer test deformations. The findings suggest that the intermediate ecological condition of the inner lagoon is mostly controlled by natural stressors, consistent with the 'estuarine quality paradox,' although increased human activity may have affected the distribution of sensitive species.

Keywords: Marano and Grado Lagoon, Foraminifera, Biocoenosis, Sediment core, Paleo-EcoQS indices

Abstract (Poster)

Symposium: other topics

New preliminary data on crocodylomorphs and anurans from the early Eocene Lignitifero Formation (SW Sardinia, Italy)

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The Eocene vertebrate record of Sardinia reveals a diverse continental fauna, including mammals, reptiles, and freshwater fishes. However, microvertebrate assemblages from this interval remain poorly documented. Here we report new preliminary data on Eocene microvertebrate remains from the Lignitifero Formation (Ypresian–early Lutetian) exposed at Tanca Aru (Vallermosa, SW Sardinia, Italy). The fossil-bearing succession consists of continental deposits interpreted as alluvial plain sediments. The material was recovered from a thin (~8 cm) bioclastic lacustrine limestone layer and processed using a 10% acetic acid solution. The assemblage includes two teeth assigned to *Crocodylomorpha* indet. and three maxillary fragments referred to *Anura* indet. The crocodylomorph teeth are characterized by apicobasal ridges, well-developed carinae, and a marked basal constriction; one specimen shows a spatulate morphology, whereas the other, although incomplete, appears to be caniniform (Frey & Monninger, 2010). The anuran remains consist of maxillary fragments bearing a linear series of well-defined tooth alveoli, interpreted as housing pedicellate teeth, and nutrient foramina along the labial surface. The bone is thin and slightly curved, consistent with an anuran maxilla. These remains represent the first documented occurrence of crocodylomorph and anuran material from the Lignitifero Formation. This assemblage expands current knowledge of Sardinia's Eocene vertebrate diversity and provides new insights into the paleoecology and paleobiogeographic relationships of southwestern Europe during the Paleogene.

Keywords: Eocene, Sardinia, Lignitifero Formation, *Crocodylomorpha*, *Anura*

Abstract (Oral communication)

Symposium: S17

Paleoart strategies for communication: an interactive installation from the Paleontological Museum of the University of Calabria

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Within the exhibition path “*Sustainability Education Campaign - Humans, environment, animals: a unique harmony*” of the Museum System of the University of Calabria (SiMU), funded by the Calabria Region - Departments of Education and Equal Opportunities and Health and Health Services, an interactive and accessible digital installation was developed to communicate the evolution of life on Earth at the Museum of Paleontology. The installation is centered on a large touchscreen display (220 × 132 cm), through which visitors can explore multimedia content illustrating the evolution of life across the geological time scale. The project is grounded in original paleoart production: twelve illustrations, spanning from the Precambrian to the Pleistocene, reconstruct past environments and organisms based on current scientific knowledge. Each scene is structured in interactive layers, enabling users to select individual organisms (fauna and flora) and access detailed focus sheets. Geological periods are supported by concise explanatory texts. The experience is further enhanced by interactive 3D models derived from scans of fossils housed in the museum's collections. A key feature of the system is its modular and updatable design: illustrations were conceived to preserve visual coherence while allowing the addition of new taxa, and the platform supports continuous content implementation and revision. This approach ensures long-term adaptability and alignment with scientific advancements. By integrating paleoart, interaction design, and 3D modeling, the installation promotes a non-linear, multi-level exploration that enhances understanding of evolutionary processes and organism-environment relationships, while contributing to the valorization of local heritage and the development of museum-based tourism.

Keywords: Paleoart, Digital Heritage, Science Communication, Interactive Museum Design, Geological Time Scale

The vertebrate track record of the Norian Dolomia Principale/Hautpödomit of Italy and Switzerland

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The Norian Hautpödomit Formation/Dolomia Principale platforms of southeastern Switzerland and northern Italy preserve a widespread theropod and basal sauropodomorph ichnofauna referable to the *Otozoum-Pseudotetrasauropus-Evazoum-Kalosauropus* (OPEK) morphological plexus, signalling post-Carnian Pluvial Episode dinosaur diversification across the Tethyan margin.

In the Central Austroalpine Nappes (Ela, Quattervals, S-charl nappes; Canton Grison, Switzerland), OPEK components include *Pseudotetrasauropus* (Piz dal Diavel, Spi da Tantermozza), *Tetrasauropus/Eosauropus* (Piz Mitgel, Val Gravaratschas, Piz Ela, Piz S-Chalambert-Dadaint), and occur alongside theropod tracks (*Kayentapus*, *Eubrontes*) (Meyer et al. 2013, 2022).

Comparable OPEK ichnoassemblages occur in the Italian Dolomites (Tre Cime di Lavaredo, Mt. Pelmetto; Italy), with cf. *Pseudotetrasauropus/Tetrasauropus* and theropods (*Eubrontes*, *Anchisauripus*, cf. *Atreipus/Grallator*). (Mietto et al. 2020). Thus, altogether these sites document cohabitation of small-to-large theropods with basal sauropodomorphs and early sauropods on peritidal carbonates. Chirotheriid tracks (e.g., single ?*Brachychirotherium* at Mt. Pelmetto) are rare, contrasting with contemporaneous Norian siliciclastic basins (e.g., Germanic Basins). Recent reports from the Val di Fraele (Stelvio) extend this *Pseudotetrasauropus*-dominated OPEK plexus, underscoring its broad distribution.

References:

Mietto P., Avanzini M., Belvedere M., Bernardi M., Dalla Vecchia F.B., D'Orazi Porchetti S., Gianolla P., M. & Petti, F.B. (2020). Triassic tetrapod ichnofossils from Italy; state of the art. *Journal of the Mediterranean Earth Sciences* 12: 31–84.

Meyer Ch.A., Marty, D., Thüning B., Stecher R., & Thüning.S. (2013). Dinosauriensuren aus der Trias der Bergüner Stöcke (Parc Ela, Kanton Graubünden, SE-Schweiz). *Mitteilungen der Naturforschenden Gesellschaften beider Basel* 14: 135–143.

Meyer Ch.A., Klein H., Wizevich M.C. & Stecher R. (2022). Dinosauriensuren aus der späten Trias der Val d'Uina (Piz S-chalambert, Scuol) *Jahresbericht Naturforschende Gesellschaft Graubünden* 122: 99–110.

Keywords: Vertebrate Tracks, Dolomia Principale/Hautpödomit, Norian, Italy, Switzerland

Reconstructing the life and death of *Palaeoloxodon ex gr. falconeri*: New evidence from the historical Accordi & Colacicchi Collection

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The historical Accordi & Colacicchi collection represents the largest assemblage of vertebrate remains preserved at the Palaeontological Museum, University of Catania (PMC). It comprises 1,957 osteological specimens, as well as one complete individual, attributed to *Palaeoloxodon ex gr. falconeri* from Grotta Spinagallo (Cassibile, Syracuse), one of the most emblematic proboscideans within the framework of the Mediterranean “*Island Rule*.” The presence of a rich set of lower molars referable to individuals at different ontogenetic stages, ranging from neonates to senile specimens, provides a unique opportunity to apply in a paleontological context the method of Laws R. M. (1966), originally developed for *Loxodonta africana*, the extant African elephant, in order to reconstruct a demographically reliable mortality profile. For the first time, age classes will be assigned based on the integrated analysis of morphology, wear stage, and degree of ontogenetic development of the hemimandibles bearing lower molars of *P. ex gr. falconeri*. The main objective is to elucidate the complex and still highly debated taphonomic processes of Grotta Spinagallo, a pivotal and enigmatic fossiliferous site in the southeastern Sicily. The expected results will provide new insights into mortality dynamics, accumulation processes, shedding light on the paleoecological scenarios of the fossil deposit. This will significantly enhance the understanding of Sicilian dwarf elephants within the early Middle Pleistocene insular ecosystem.

References:

Laws R. M. (1966). Age criteria for the African Elephant *Loxodonta africana*. *African Journal of Ecology* 4(1): 1–37.

Keywords: Island Rule, Dwarfism, Sicily, Proboscidea, Paleontological Collection

Abstract (Oral communication)

Symposium: S3

Faunal restructuring in the aftermath of the Arabian hotspot collapse: Patterns from western India

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The Eocene Arabian hotspot (henceforth, AR)—comprising the eastern shore of the Arabian Peninsula, Pakistan, and Western India—was terminated during the middle to late Miocene, associated with the loss of shallow-shelfal habitat due to the Arabia-Anatolia collision. However, how the early Miocene marine invertebrates from the western Indian margin, a region fringing the hotspot border, responded to this aforementioned hotspot termination is unclear. In this present contribution, we have analyzed the evolution of the western Indian marine invertebrates across the timeline of termination of this hotspot (i.e., from the early Miocene till the Pleistocene), with special emphasis on the Kutch and Saurashtra basins. For this purpose, temporal species co-occurrence networks were constructed in R, using the ‘igraph’ package, and visualized in Gephi (v. 0.10), based on a compilation of 89,028 coral, echinoid, and mollusk species occurrence data compiled from the Paleobiology Database and additional published sources. The preliminary results reveal taxonomic restructuring of marine invertebrates from the early Miocene to the post-Miocene intervals across the termination of AR, with a large portion of Miocene taxa from the western Indian margin becoming extinct or exterminated. A similar, although less distinct, pattern was observed even in the nearby regions (i.e., the rest of the Asian coast of the Arabian Sea and the east coast of Africa bordered by the Arabian Sea, including Madagascar), wherein a significant fraction of the Miocene taxa from these regions became extinct/exterminated/exterminated following the AR collapse, and restructuring of the faunal community occurred in the post-Miocene interval, predominantly in the Pleistocene.

Keywords: Hopping hotspots, Miocene, Pleistocene, Network analyses

Life of a dwarf giant: preliminary results on dental analysis of the Sicilian dwarf hippo *Hippopotamus pentlandi*

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Pleistocene mammal fossils of Sicily are some of the most known Quaternary faunas in Italy, especially famous because of the phenomenon of “insular dwarfism”, which led to the occurrence of dwarf mammals, such as elephants and hippos, which thrived within the island.

The Sicilian dwarf hippo *Hippopotamus pentlandi* is one of the most emblematic dwarf mammals that inhabited the island during Late Pleistocene, represented by several fossil specimens currently stored in many museums in Italy and abroad. However, despite being known and studied for almost a century, very little is known about its paleobiology.

In this study, we present a comparative dental micro- and macro-wear analysis that has been going on between the dwarf hippo specimens stored in the Museo di Storia Naturale di Milano originating from western Sicily and the specimens stored in the Museo Paleontologico of the Università degli Studi di Catania coming from eastern Sicily.

In fact, through the observations of the traces left on the occlusal surface of the dwarf hippo molars, and their related wearing, allowed us to establish what kind of food item was especially exploited by the animal. This in order to refer hippo to one of the three main dietary classes: grazers, who feed mostly on silica-filled grass, browsers, who feed mostly on leaves and fruits, and mixed-feeders, who feed on both.

The aim of this work is to investigate the paleodietary preferences of the Sicilian dwarf hippo in both eastern and western Sicily and, indirectly, reconstruct the environment these animals inhabited, trying also to assess any potential paleobiological and paleoenvironmental differences between eastern and western populations.

Keywords: Sicily, Quaternary, Paleobiology, Paleoecology, Insular dwarfism

Latest Oligocene amphibians from Coderet (France)

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The French locality of Coderet (latest Oligocene, MP30) yielded an astonishing number of amphibian fossil remains. The studied amphibian assemblage from Coderet consists of 8,639 skeletal remains referred to 15 taxa, making it a hot spot for diversity during the Paleogene. Urodeles are the dominant group, almost 99% of the fossils, represented by the family Salamandridae, including both subfamilies Salamandrinae and Pleurodelinae. Among them, *Lissotriton* sp. is by far the most abundant taxon (7,139 remains). Other well-represented salamanders include *Chelotriton* sp. (669 remains), *Salamandra sansaniensis* (394 remains), and *Chioglossa meini* (140). Anurans are less abundant, with only 116 skeletal elements, but referred to an astonishing diversity of five families for seven taxa: Bufonidae (indeterminate to species), Discoglossidae (*Latonia ragei* and *Latonia* sp.), Pelobatidae (indeterminate), Pyxicephalidae (*Thaumastosaurus* sp.), and Ranidae (*Pelophylax* sp. and *Rana* sp.). Although limb bones and girdle elements in salamanders are generally considered not to be highly diagnostic and rarely allow identification at family or subfamily level, this study shows that they may still display apomorphic features with potential taxonomic value. The biostratigraphy of the amphibians from Coderet is characteristic of the Oligocene-Miocene transition fauna, confirming a few changes being generally observed between Paleogene and Neogene European fauna. Nevertheless, this very rich fauna helps to fill temporal gaps in the history of several taxa. Unique is the presence of *Thaumastosaurus* sp., an extinct genus that was previously only known during the Eocene. This occurrence brings forward the last European datum of approximately 10 Myr. In any case, *Thaumastosaurus* disappears at the Paleogene/Neogene transition, such as it is generally the case with other rare Eocene relic amphibians.

Keywords: Amphibians, Urodeles, Anurans, France, Oligocene

Morphological osteoderms variation in extant and extinct *Pseudopus* (Reptilia, Squamata, Anguidae)

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A sample of 522 large osteoderms (ODs) of various preservation state from the Late Pliocene of Villa Moffo, Bra, Northwest of Italy, housed at the Museo di Scienze Naturali of Turin, Italy (MGPT-PU 40863), were preliminarily identified as belonging to *Pseudopus* cf. *pannonicus* by Jean-Claude Rage in the early 90s. The specimens, which were found associated with a single proboscidean tusk and mollusks, were not analyzed ever since. In the present contribution, we aim to investigate the morphological variation of ODs along the different regions of the trunk in the genus *Pseudopus*, using both the mentioned fossil material and dry-prepared specimens of the extant species *Pseudopus apodus*. To do so, we analyzed a total of 10 rows of ODs from the dorsal and ventral regions of the extant species (5 rows from the dorsal region, 5 rows from the ventral side). In order to document both the antero-posterior (i.e. from neck to tail) and the lateral variation in OD size and shape, we maintained the position of the ODs along the *P. apodus* body while preparing the extant specimens. Then, we proceeded to number them from the central row to the lateral fold, which we used for the dorsal and ventral regions. This allowed for the morphological comparison between the extant species and the fossils remains and the attribution of the latter to different regions of the body. Our study emphasizes the importance of osteological collections as an aid for the identification of fossil remains and as a tool for the understanding of the morphological variation of osteoderms in extinct taxa.

Keywords: Pliocene, *Pseudopus apodus*, *Pseudopus pannonicus*, Neogene, Lizard

Life on the edge of a supervolcano: study of lower Permian bioturbations at Sesto

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The Sesto Conglomerate in the northeastern Dolomites is considered coeval with the Athesian Volcanic Group, although it remains uncertain whether it corresponds to the entire succession or part of it. A study of 14 outcrops in the Sesto Valley revealed the presence of bioturbations. The Sesto Conglomerate is characterized by alternating conglomeratic and arenaceous facies. Conglomerates show no bioturbation (bioturbation intensity = 0%), whereas arenaceous facies are intensely bioturbated (up to 70%). This correlation with granulometry can be explained by increased substrate mobility and/or greater availability of oxygen and organic matter. The geographical distribution of bioturbation is not homogeneous, since outcrops of the arenaceous facies are not found everywhere along the valley. Based on morphology, the trace fossils are assigned to *Planolites beverleyensis*, *Taenidium barretti*, *Skolithos linearis* and *Scoyenia gracilis* but their similar shape suggests that they may have been produced by the same or similar arthropod-like animals (Müller, 2024). The variable size of some bioturbations could indicate that they were the result of different ontogenetic stages of the same organism. Variations in bioturbation intensity reflect fluctuating environmental conditions. During periods of high-energy debris flows, bioturbation do not occur, whereas periods of low sedimentation rate allowed colonization. The studied ichnoassemblage is representative of an alluvial fan environment, as supported by the facies alternation. During favorable periods, organisms, likely represented by insect larvae, populated these freshwater habitats, marking the easternmost occurrence of bioturbation influenced by the activity of the supervolcano.

References:

Müller B. (2024). Life on the edge of a Supervolcano: Study of lower Permian bioturbations at Sesto. <https://hdl.handle.net/20.500.12608/70680>

Keywords: Supervolcano, bioturbations, Sesto Conglomerate

The paleoenvironment of Sardinia between the 6th and 5th millennium BC: preliminary results of palynological analyses

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Pollen and spores provide essential data for reconstructing vegetation patterns and climatic variations over long-time spans, which are fundamental for a correct understanding and interpretation of the paleoenvironment and paleoeconomy of ancient societies.

The aim of this study is to investigate the Sardinian flora across the centuries marked by the development of prehistoric cultures, and to explore the choices and activities of human communities in relation to their surrounding environment, as well as the evolution of vegetation and the use of wild and cultivated plants.

To reach this goal, we examined several archaeological sites in central and southern Sardinia (Italy, western Mediterranean): the Su Carroppu Rockshelter (Carbonia, SU), the open-air domestic settlement of Su Mulinu Mannu (Terralba, OR) and the open-air settlement of Gribaia (Terralba, OR).

The Holocene landscape emerging from the preliminary data acquired, cross-referenced with previously published evidence, depicts an Island that is both rich and environmentally diverse, characterised by evergreen forests, shrub formations, and herbaceous vegetation typical of Mediterranean scrub. In the more inland areas, wide conifers forest, wild trees and shrubs, and herbaceous species prevailed; in coastal and lagoonal contexts, congruent species were found, including plants typical of aquatic environments and saline soils.

In general, domesticated species, especially cereals and legumes, appear to have been introduced since the Middle Neolithic. While during the Mesolithic and Early Neolithic, the plant landscape still retained its original characteristics, starting in the Middle Neolithic and the subsequent Eneolithic, it underwent increasing alterations due to human activities, such as deforestation and wood harvesting. Although this research is still an early phase, it clearly demonstrates the value of an interdisciplinary approach.

Keywords: Paleoenvironment, Palynology, Archaeobotany

Abstract (Oral communication)

Symposium: S4

Preliminary report on dental calculus analyses in mammutid and gomphothere teeth from the Italian Pliocene

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Understanding how large herbivores respond to environmental changes is critical for assessing ecosystem resilience under ongoing biodiversity loss. Among these, proboscideans are particularly informative, as they represent key taxa for reconstructing past environments and climates as 'ecosystem engineers' by modifying, maintaining, and creating habitats. They are particularly abundant during the Plio-Pleistocene and are represented by different lineages, such as mammutids, gomphotheres, and elephantids. The diet and ecology of these groups are commonly investigated using dental proxies, including mesowear, microwear, stable isotopes, and dental calculus analyses. The latter, in particular, focuses on the study of microremains (e.g., phytoliths, starch grains, pollen) trapped within mineralized dental plaque. The present study examined dental calculus from molars of the Italian Pliocene mammutids and gomphotheres, including 1 '*Mammut*' *borsoni* and 19 *Anancus arvernensis* specimens. After applying a rapid sample-treatment protocol, microscopic observation of 28 slides revealed a collection of varied microremains, including diverse phytolith morphotypes (ELONGATE ENTIRE, ELONGATE CLAVATE, TABULAR ENTIRE, CYLINDROID ENTIRE, and possible SPHEROID ENTIRE and ECHINATE), plant tissues, and numerous microcharcoal particles. Non-Pollen Palynomorphs such as fungal remains, hyphae, putative pollen grains, and dung spherulites were also identified. These data provide preliminary insights into the paleobiology of the extinct proboscideans '*Mammut*' and *Anancus* during the latest Pliocene. Integration with microwear and stable isotope analyses will improve dietary reconstructions and help clarify large-bodied herbivore responses to the transition from the Pliocene greenhouse to the Quaternary icehouse.

Acknowledgements: We would like to thank IPHES-CERCA and the Archaeobotany unit for providing access to the laboratories and microscopes. This work was funded by the Borsa di Studio SPI 2025 (Casa d'Aste Giquello). A broader project is also supported by the EAVP Research Grant 2025 and the PalAss Research Grant 2026 (PA-RG202602).

Keywords: Phytoliths, '*Mammut*', *Anancus*, Neogene

Functional significance of the hadrosaur beak: a micro-ct study of *Tethyshadros insularis*

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Hadrosauroid dinosaurs in the Late Cretaceous of eastern Europe are exemplified by the small endemic clade Telmatosauridae, resulting from the dispersal of small-sized taxa from Asia. The exquisitely preserved *Tethyshadros insularis* from the Italian *Lagerstätte* Villaggio del Pescatore (Early-Middle Campanian), is the best-known member of Telmatosauridae and exhibits the most pronounced development of a key clade trait – three prominent denticles on the premaxillae. While this feature has significantly influenced artistic interpretations of the animal, its functional significance has remained unclear. Micro-CT scans of the premaxillae and predentary reveal that these structures are associated with extensive neurovascular structures supporting a rapidly growing rhamphotheca, observable to some extent even in other non-avian dinosaurs and living birds. Such a well-developed corneal structure and underlying neurovascular system suggest the presence of a highly multifunctional beak, utilized for complex feeding dynamics and sensitive tactile perception. Additionally, the connections between the premaxillary vascular network and narial vessels imply a functional relationship between the beak and naris, likely serving a thermoregulatory role, which is extendable to other hadrosauroids and more derived taxa. Notably, these convergent craniofacial neurovascular systems associated to beaks arose independently multiple times within Archosauria, underscoring their pivotal role in physiological adaptations. These findings have significant implications for the life reconstructions of *Tethyshadros* and other hadrosauroids, broadening the evolutionary significance of complex beak structures in Dinosauria beyond theropods.

Keywords: Tethyshadros, Villaggio del Pescatore, Campanian, Neurovascular structures, Rhamphotheca

Abstract (Oral communication)

Symposium: S10

Exceptionally preserved biotas from North Dakota reveal cryptic Ordovician shelf ecologies

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The Ordovician saw one of the greatest evolutionary radiations in the Earth's history, precipitating the assembly of modern animal-dominated ecologies in the aftermath of the Cambrian Explosion. However, Ordovician nonmineralized faunas are rare and mostly sample ecologically marginal settings. We describe small carbonaceous fossils (SCFs), including semiarticulated elements preserving submicrometric detail, from epicratonic deposits of the Deadwood and Winnipeg formations (ND). The Osterberg SCFs, associated with biostratigraphically informative conodonts and graptolites, record two successive biotas of Cambrian-Tremadocian (the "lower Osterberg" biota) and Darriwilian (the "upper Osterberg" biota) ages, demonstrating a long-term persistence of high-quality, Burgess Shale-type microfossil preservation after the end of the Cambrian. Their components open a window on normal marine, well-oxygenated Ordovician shelf habitats, revealing taxa and functional morphologies unrecorded by coeval macrofossils. These include specialized grazing and predatory molluscan radulae, triturative crustaceomorph molars, the oldest known eurypterid-type cuticles, and microphagous priapulid worms. The Osterberg fossils attest to an Ordovician co-occurrence of cryptic taxa and feeding adaptations, reminiscent of the most ecologically modern Cambrian biotas, alongside classic later-Paleozoic forms like colonial zooplankton and biomineralized early vertebrates. By contrast, they do not record classic Burgess Shale-style taxa typical of marginal or deeper-water Ordovician assemblages. These results demonstrate a lasting presence of cryptic, modern-style shelf faunas throughout the earliest Paleozoic, suggesting that exceptional Ordovician macrofossil sites are unrepresentative of the broader state of their coeval biosphere.

Keywords: Ordovician, Cambrian Explosion, Exceptional preservation, Carbonaceous microfossils

“Exotic” mammals as climate marker in the Late Pleistocene

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Fossil hamsters (*Cricetus cricetus*) and fossil jerboas (*Allactaga major*) can be used as climate indicators of a moderately warm and dry climate. This is evident from their current range in the temperate zones of Europe and Asia (Feoktistova et al. 2022, IUCN red list, 2008). Today, hamsters are found only at lower altitudes in Asia and Central Europe, whilst jerboas are widespread from Kazakhstan to the southern part of Ukraine, but not further west, also at lower altitudes. The presence of fossil sites in high-alpine caves (hamsters) at altitudes of up to almost 2,000 meters, as well as in the Rhine Valley (jerboas) suggests a climate that was significantly warmer and also drier than today (Spitzenberger, 2001, Koenigswald, 1985).

To calculate the temperature, current average values for the habitat of the species in question are used and applied to the altitude of the site. Current parameters are also used for precipitation levels, although the requirements of food plants are also taken into account.

The current data show that the remains of *Allactaga* and *Cricetus* date from MIS 3 (hamster: 60,000 to 27,000 years BP; jerboa: 30,000 to 40,000 years ago), and furthermore, fossil hamsters reappear during the first post-glacial warm phase (14,500 to 10,800 years BP), which roughly corresponds to the Meindorf-Bölling-Alleröd complex (14.6 to 12.68 ka).

The findings from MIS 3 correspond to the so-called ‘Alpine cave bear period’ (60,000 to 27,000 years ago), during which numerous remains of cave bears were found at high altitudes (Döppes et al., 2019). At the same time, Pleistocene lions and hyenas roamed Europe and at the same time when modern humans arrived in Europe.

References:

- Döppes D, Rabeder G, Frischauf C, Kavcik-Graumann N, Kromer B et al. (2019). Extinction pattern of Alpine cave bears - new data and climatological interpretation. *Historical Biology* 31(4): 422–28.
- Feoktistova NY, Meschersky IG, Shenbrot GI, Puzachenko AY, Meschersky SI et al. (2022). Phylogeography of the common hamster (*Cricetus cricetus*): paleoclimatic reconstructions of Late Pleistocene colonization. *Integrative Zoology*, 18(3): 581–99. DOI: 10.1111/1749.12687
- Koenigswald, W. v. (1985). Die Kleinsäuger aus der *Allactaga*-Fauna von der Villa Seckendorff in Stuttgart-Bad Cannstatt aus dem frühen letzten Glazial. *Stuttgarter Beiträge zur Naturkunde. Serie B (Geologie und Paläontologie)*, 110: 1–40.
- Spitzenberger F (2001). Die Säugetierfauna Österreichs. *Grüne Reihe des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft*, 131: 1–895.

Keywords: Late Pleistocene, *Cricetus*, *Allactaga*, Temperature, Precipitation

Investigating the generic affinities of European Miocene chameleons (Squamata, Chamaeleonidae) using geometric morphometrics: preliminary results

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The evolutionary history of chameleons has been mostly studied through phylogenetic approaches based on extant taxa. The fossil record of these animals is quite limited and material is often fragmentary, and thus fossils are rarely included in phylogenetic analyses. Moreover, the poor preservation of most remains has led to the description of multiple species of doubted validity, and the identification of many chameleon fossils seems uncertain. A well-preserved chamaeleonid fossil frontal from the Petersbuch 36 karst fissure (Early Miocene, Germany) and preliminarily identified as Chamaeleonidae indet. is studied here. The aim of this work is to explore the potential generic affinities of this isolated frontal through the use of geometric morphometrics (GM). To do this, a comparative sample dataset of 3D models of frontal bones from extant chameleons was gathered. The results during the analysis highlight the frontal bone in chameleons as a good candidate for GM analyses as it reveals genus-specific information, as well as suggesting that the studied fossil cannot be univocally related to any particular extant genus. Although its closest morphological affinities are with *Trioceros* and *Chamaeleo*. Considering this, the fossil could be related to either one of the two or even correspond to a new genus. Historically, fossil chameleons from the Miocene of Europe have been attributed to the genus *Chamaeleo*, including occurrences from areas as distant as the southern Balkans (Aliveri, in Greece), Central Europe (e.g., Bavarian freshwater molasse), and Iberia (Vallès-Penedès Basin). Nevertheless, GM methods reported here do not unambiguously support this referral, although this remains to be verified based on other and more complete specimens as well as with the addition of more extant taxa.

Keywords: Reptilia, Chamaeleo, Germany, Lizards, Central Europe

Abstract (Oral communication)

Symposium: S4

Temporal resolution of deep-sea invertebrate and otolith death assemblages from the southern Adriatic Sea

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Deep-sea sedimentary records provide key data on long-term climatic and oceanographic changes. While the preservation and resolution of microfossil assemblages was intensely studied, little is known about the temporal resolution of the deep-sea invertebrate and otolith fossil record. Here, we use radiocarbon dating of multiple individual specimens of brachiopods (*Gryphus vitreus*), bivalves (*Abra longicallus*, *Bathyarca philippiana* and *Timoclea ovata*), planktonic gastropods (*Clio pyramidata*) and fish otoliths (*Hygophum benoiti*) to estimate the degree of time averaging (mixing of skeletal remains of non-contemporaneous organisms) in bathyal death assemblages (surface accumulations of skeletal remains). The specimens were extracted from grab samples taken from two stations located on the western and eastern margin of the southern Adriatic Sea at 580 and 509 m water depth, respectively.

In spite of differences in lifestyle, size, skeletal architecture and mineralogy, all studied species showed centennial to millennial time averaging (interquartile age ranges: ~740–4160 years). The median ages varied between 460 and 11,600 years BP, reflecting species-specific timing of range expansion during the Holocene sea-level rise. Our results thus demonstrate that, in deep-sea settings with low sediment accumulation rates, surface accumulations of skeletal remains can provide a long-term record of past community states. Even thin-shelled, fragile taxa such as *A. longicallus* and planktonic gastropods can undergo extensive temporal mixing on the scale similar to more durable mollusk species from shallow-water environments. Moreover, pristine skeletal remains from surface sediments can still be hundreds years old, which complicates the usage of dead shells in mapping modern geographic and bathymetric distribution of deep-sea species.

Keywords: Time averaging, Bathial, Temporal resolution, Taphonomy

Abstract (Oral communication)

Symposium: S3

Terra incognita of deep time: mapping the uncharted frontiers of the Phanerozoic shallow-marine fossil record

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The fossil record provides an unparalleled archive of the history of life, yet its geographic coverage remains poorly constrained on a global scale. Here we present a quantitative assessment of the spatiotemporal coverage of the shallow-marine metazoan fossil record across the entire Phanerozoic, based on nearly 150,000 georeferenced collections from the Paleobiology Database. Binning fossil collections into equal-area hexagonal grids across 49 time intervals, we find that on average only 16% of shallow-water grid cells contain fossil data – a striking illustration of how thinly the known record is spread globally. Coverage varies considerably through time, peaking in the youngest intervals and in periods of intense research focus such as the Late Triassic and mid-Permian, and reaching its lowest values in the early Cambrian, earliest Jurassic, and late Mississippian. By modeling historical collection effort curves per time bin, we demonstrate that sampling effort is approaching or has already reached saturation for the majority of Phanerozoic intervals. Intersecting reconstructed paleo-shoreline extents with present-day geological map data available via the Macrostrat Database, we identify the regions and stratigraphic intervals where geologically accessible but as yet unsampled strata most plausibly await discovery. Most promising for further exploration are again the youngest intervals, dating back to the latest Jurassic, while most earlier Mesozoic and Paleozoic intervals appear nearly completely sampled. Our results offer a data-driven framework for guiding future fieldwork, mobilizing unpublished museum collections, and informing research funding strategies at a global scale.

Keywords: Metazoa, Phanerozoic, Macrostrata Database, Paleobiology Database

Taphonomy of marine mammal remains from the Lower Miocene deposits of the Colle della Croce quarry (Feltre, Veneto, Italy)

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The “molasse” deposits of the Lower Miocene in the Colle della Croce quarry, a recently discovered fossiliferous site near Feltre (northeastern Italy), yielded abundant fossil remains of marine vertebrates, including sharks, bony fishes and marine mammals. The latter group includes several odontocetes (Cetacea) and an extinct relative of dugongs (Sirenia), comprising an important record of the paleobiodiversity of the proto-Mediterranean region.

Here, we present an integrated taphonomic study of the fossil marine mammals from the Colle della Croce quarry, combining macroscopic, petrographic, and microanalytical analyses. Specimens typically display a high degree of disarticulation and low completeness, suggesting postmortem (re)floating of the carcasses. Bones originating from glauconitic horizons are more abraded, more rounded and a more bioeroded than those from non-glauconitic, fine-grained sediments. Bones are often deformed by lithostatic compression, yet they often preserve original histological microstructures such as osteons, lamellae and osteocyte lacunae. Additionally, they display biostratinomic features such as macro-invertebrate traces and microbial bioerosion, as well as variable mineralogical and geochemical signatures, including carbonate, silica, and iron sulfide infillings. Compositional analyses indicate that bone apatite is extensively recrystallized and enriched in F, Si and Fe, consistent with precipitation from circulating diagenetic fluids.

Taken together, taphonomic evidences suggests that carcasses likely underwent floating prior to their final deposition, and were subsequently exposed for prolonged periods at the seafloor. Our findings highlight the central role of early and late diagenesis in controlling the preservation potential of marine mammal remains in shallow-marine settings, and contribute to understanding the processes underlying the fossilization processes of marine mammals in the Mediterranean Miocene.

Keywords: Taphonomy, Thin sections, SEM, Pyrite framboids, Microborings

Abstract (Oral communication)

Symposium: other topics

A local peregrine: a second record of *Squalodon peregrinus* Dal Piaz, 1971 from the Colle della Croce quarry (northeastern, Italy), and morphofunctional considerations on the *Squalodon* species from the Venetian-Friulian Basin

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Squalodon peregrinus is an enigmatic species of heterodont odontocetes found in the sandstones of the Lower Miocene near Belluno. This taxon was established and first figured by Dal Piaz in 1971 on the holotype and only known specimen of this species, which inhabited the peri-Mediterranean Venetian-Friulian Basin (VFB) of northeastern Italy. After half a century, the finding of a second specimen of *S. peregrinus* in Lower Miocene strata of the Colle della Croce quarry near Feltre (northeastern Italy) allows us to better define its diagnostic morphological traits while strengthening the idea that this species was endemic to the VFB. We provide a brief anatomical and comparative description of *S. peregrinus*, its chronostratigraphic distribution and some ichnological remarks on the cranium of the holotype. Furthermore, as *S. peregrinus* was not the only *Squalodon* species thriving into the VFB, we compare the morphology of *S. peregrinus*, a species likely paleoendemic to this Basin, to one of the better known species *Squalodon bellunensis*, also found in the Belluno area. In particular, compared to *S. bellunensis*, *S. peregrinus* had a shorter rostrum and shorter cranium as well as a more reduced temporal fossa. The peculiar combination of these features in *S. peregrinus* suggests a partial contribution of suction feeding in the prey capture strategy of this heterodont odontocete. Conversely, *S. bellunensis* relied on a longer rostrum, capable of catching large preys with its anterior part, displaying procumbent teeth, and slashing them with the sharp but buccolingually compressed posterior teeth. Differences between these formerly sympatric species of *Squalodon* were possibly underlying niche partitioning within the VFB, a highly productive paleoenvironment.

Keywords: Paleocetology, Cetacea, Odontoceti, Marine mammals, Early Miocene

The fossil record of armoured catfishes (Callichthyidae).

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Callichthyidae are a South American clade of armored catfishes comprising well over 200 species; they are famed in the ornamental fish trade, as well as being commercially fished. The Callichthyidae conservative Bauplan is diagnosed by their two rows of lateral flanking armor plates. Knowledge of the group's deep-time evolutionary history has been hindered by the limited and fragmentary nature of its fossil record. New discoveries and the extensive study of the ossified first ray of the pectoral fin (pectoral fin spine: PFS) reported here provides a reassessment of the Callichthyidae throughout the Cenozoic of South America. Extensive fieldwork efforts in Miocene strata provided hundreds of remains from Urumaco in Venezuela, La Venta in Colombia and Pebas in Peru.

Our extensive comparative anatomical study of the PFS resulted in a matrix of 18 characters that in the distribution show diagnostic features for all extant genera. This provides a robust allocation of fossils in at least: *Brochis*, *Callichthys*, *Hoplisoma*, *Hoplosternum*, *Megalechis*, where previously elements were only accolated to the clade Callichthyidae. Most characters pertain to the differing ornamentation of the margins of the PFS, largely focusing on anterior dentations and posterior serrations. We also provide descriptions of crushed but articulated skulls, CT scanned and reconstructed, representing records of *Hoplosternum magdalenae*, *H. littorale* and *Hoplisoma*.

Integration of paleontological and molecular data has allowed more robust estimates of minimal divergence times from many callichthyid clades. Callichthyids inhabit diverse freshwater environments. Our fossil occurrences provide insight into the antiquity of callichthyid ecological preference in differing pre-amazonian environments such as the Pebas mega wetland. Our findings resolve unknown deep time taxonomy as well as provide insights into the biogeography and evolutionary history of the Callichthyidae.

Keywords: Paleoichthyology, Catfish, Callichthyidae, CT

The origin of dinoflagellates and the biological affinities of acritarchs

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Acritarchs are an important component of Paleozoic (micro-)fossil assemblages. Although they are commonly regarded as phytoplankton, their biological affinities are by definition unknown, and consequently their exact role in ancient ecosystems is uncertain as well. Some acritarchs from the Cambrian onwards show similarities with certain cysts of dinoflagellates, which today are one of the major phytoplankton groups but are only unequivocally known since the Triassic. It seems likely that some acritarchs represent precursors of this group but lack key characteristics of dinoflagellate cysts, such as paratabulation, a cingulum or an archaeopyle. Molecular clocks (Medlin & Fensome, 2013) and organic geochemical analyses (Talyzina et al., 2000) also support the presence of dinoflagellates in the early Paleozoic. The ORDINAR (Searching for the ORigin of the DINoflagellates in the Acritarch Representatives) project aims to elucidate the biological affinity of acritarchs through the systematic study of acritarchs and dinoflagellates in terms of morphology and paleobiochemistry. We use Fourier-transform infrared (FTIR) spectroscopy for chemotaxonomy alongside morphological comparisons to test possible phylogenetic relationships. Through the infrared spectra of isolated specimens, different biopolymers and ratios between functional groups can be identified. This provides evidence for both biological affinities and diagenetic alterations.

References:

Medlin L.K. & Fensome R.A. (2013). Dinoflagellate macroevolution: some considerations based on an integration of molecular, morphological and fossil evidence. In Lewis J.M., Marret F. & Bradley L.R. (eds), *Biological and Geological Perspectives of Dinoflagellates*. Geological Society of London: 263–274.

Talyzina N.M., Moldowan J.M., Johannisson A. & Fago F.J. (2000). Affinities of Early Cambrian acritarchs studied by using microscopy, fluorescence flow cytometry and biomarkers. *Review of Palaeobotany and Palynology*, 108: 37–53.

Keywords: Palynology, Acritarchs, Paleochemistry, Vibrational Spectroscopy, Phylogeny

Abstract (Oral communication)

Symposium: S9

On the biota and facies of the Late Triassic Heiligkreuz Formation at its type locality (Heiligkreuz, Santa Croce, N Italy)

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The outcrop near the Heiligkreuzkirche (Holy Cross Church, Santa Croce) close to St. Leonhard (Abtei, South Tyrol, northern Italy) represents a classical Late Triassic locality in the Dolomites. It is the type locality of the Heiligkreuz Formation and exposes a stratigraphic section of Carnian (Julian) age. The succession consists of alternating limestone and marl beds and yields a fauna of relatively low diversity. The macrofauna is dominated by the gastropod *Ptychostoma sanctaecrucis* (including its new synonym *Ptychostoma pleurotomoides*) and the bivalve *Unionites muensteri*. Ostracods are occasionally extremely abundant and are largely represented by two species: *Simeonella brotzenorum* and *Renngartenella sanctaecrucis*. Analysis of the palynoflora indicates freshwater influx in the lower part of the Heiligkreuz succession, as suggested by the high relative abundance of *Brazilea*. Such freshwater input may have enhanced water-column stratification within an already restricted basin, potentially leading to dysoxic conditions. The microfacies is dominated by peloidal mudstones and molluscan floatstones. Fecal pellets, particularly *Bactryllium*, are rock-forming components. The succession exposed near the Heiligkreuzkirche is interpreted as representing a coastal swamp deposit with euryhaline conditions ranging from freshwater to brackish. At least intermittently, the area must have had access to the open sea, as indicated by the planktotrophic larval development inferred from the larval shell morphology of the molluscs - a trait that requires marine conditions.

Keywords: Upper Triassic, Carnian Pluvial Event, Salinity, Microfacies, Fauna

Sexual Dimorphism in German *Palaeogale*

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Fossils of the basal feliform *Palaeogale* range from the Eocene to the Miocene, from Florida to France, and may offer a rare opportunity to document sexual dimorphism in an extinct carnivoran. Simpson (1946) suggested that large and small species of *Palaeogale* could represent males and females of a single species. North America lacks sites from which two or more *Palaeogale* species have been recovered in sufficient numbers to test this hypothesis. This is not the case in Germany, where two Miocene localities have yielded multiple fossils of possible species differentiated by size: Wintershof-West, Bavaria (*Palaeogale minuta* and *Palaeogale hyaenoides*) and Wiesbaden-Amöneburg, Hesse (*P. minuta* and *Palaeogale praehyaenoides*). To test Simpson's hypothesis, I gathered body mass data for extant sexually dimorphic carnivorans in museum collections and calculated average female:male size ratios for these species. Using regressions based on dental measurements, I estimated body mass for published specimens from both German sites and calculated *P. minuta*:*P. hyaenoides*/*P. praehyaenoides* size ratios. Among the extant species included in this analysis, males were 14%-66% more massive than females, while among the *Palaeogale* species pairs, the larger species was 161% (Wiesbaden-Amöneburg) to 267% (Wintershof-West) the size of *P. minuta*. These preliminary results do not support Simpson's (1946) hypothesis, but Dehm (1950) suggested that *P. hyaenoides* from Wintershof-West shows a bimodal size distribution that could indicate sexual dimorphism. Ongoing morphometric and taxonomic analysis of specimens from this and other European sites will shed light on such population-level patterns in *Palaeogale*.

References:

- Dehm, R. (1950). Die Raubtiere aus dem Mittel-Miocän (Burdigalium) von Wintershof-West bei Eichstätt in Bayern. Abhandlungen der Bayerischen Akademie der Wissenschaft, 58: 1–141.
- Simpson, G.G. (1946). *Palaeogale* and allied early mustelids. American Museum Novitates, 1320: 1–14.

Keywords: Palaeogale, Carnivora, Miocene, Sexual Dimorphism, Body Size

**Sex determination of a new specimen of *Keichousaurus hui*
(Sauropterygia:Pachypleurosauria)**

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This study presents an attempt to determine the sex of a specimen of *Keichousaurus hui* belonging to the collection of Serrapetrona (Marche,Italy). A preliminary sex determination has been conducted using morphometric ratios according to Lin and Rieppel,1998. The result has been confirmed by a multivariate statistical analysis: using a dataset of 86 specimens (Motani et al,2015), the measurements for each morphological character were normalized by the standard length of each individual. As an exploratory screening step, the ratios for each character were plotted on graphs and used to identify traits potentially indicative of sexual dimorphism, using the distance between two gravid females as a reference. Principal component analysis (PCA) was performed on the five selected variables using the residuals of linear regressions of the measurements against standard length to make the data size-independent. The resulting data were classified into two clusters using k-means (an additional clustering that showed the same results was made using hierarchical clustering, hcl). The cluster containing the two gravid females was designated as F. Linear discriminant analysis (LDA) was subsequently applied to this preliminary classification to refine group assignment, and the resulting categorization was adopted as the result. According to both morphometric ratios and the multivariate analyses, the specimen under study falls within the female morphotype and is therefore interpreted as a female individual.

Keywords: Sexual dimorphism, Multivariate statistics

Pleistocene fish remains from the Aalat Formation, Dandiero Basin, Eritrean Danakil Depression

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The Pleistocene continental deposits of the Dandiero Basin (Northern Danakil Depression, Eritrea) are well known for the 1 Ma well-preserved *erectus*-like human remains. Additionally, the productive sites of this rift basin have yielded numerous fossils documenting a rich Early to Middle Pleistocene vertebrate fauna of fishes, reptiles, birds and mammals (Rook et al., 2013; Delfino et al., 2018). In the present study we describe the bony fish remains collected from the Aalat Formation exposed in three different sites of the Dandiero Basin, including the Buia *Homo* site, Mulhuli-Amo and Dioli. Fish remains from these localities comprise a relatively well-preserved articulated head skeleton plus several isolated cranial and postcranial bones pertaining to the catfish genus *Clarias*, a pharyngeal tooth tentatively referred to the cyprinid genus *Labeobarbus*, and isolated vertebrae and a median-fin spine assigned to the family Cichlidae. The fish assemblage is indicative of the presence of heterogeneous fluvio-lacustrine habitats during the late Early Pleistocene of the Dandiero Basin.

References

- Delfino M., Candilio F., Carnevale G., Coppa A., Medin T., Pavia M., Rook L., Urciuoli A. & Villa A. (2018). The Early Pleistocene vertebrate fauna of Mulhuli-Amo (Buia area, Danakil Depression, Eritrea). *Bollettino della Società Paleontologica Italiana*, 57: 27–44.
- Rook L., Ghinassi M., Carnevale G., Delfino M., Pavia M., Bondioli L., Candilio F., Coppa A., Martínez-Navarro B., Medin T., Papini M., Zanolli C. & Libsekal Y. (2013). Stratigraphic context and paleoenvironmental significance of minor taxa (Pisces, Reptilia, Aves, Rodentia) from the late Early Pleistocene paleoanthropological site of Buia (Eritrea). *Journal of Human Evolution*, 64: 83–92.

Keywords: Early Pleistocene, Eritrea, East Africa, Fossil fishes, Taxonomy

Audited evidence of cave bear and additional faunal elements in the Alpine region

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Scientific excavation in the high Alps started in 1903 in the Wildkirchli caves, Switzerland after first cave bear remains have been identified. Numerous sites followed and enhanced our knowledge of the Alpine area during the Pleistocene. Over decades a large amount of radiocarbon dates led to a more fine-scaled time resolution of sites and distribution of single species. In this survey, the focus lies on members of the so-called Megafauna.

Going into details several issues will be discussed. First, the last evidence of the cave bear is still a question of debate. Auditing of radiocarbon dates helps to distinguish reliable from more unreliable results based on clear criteria and improves the achieved distribution pattern.

Second, evidence of certain species in the high Alps seems questionable. Among them are cave hyena and dhole at Wildkirchli caves and Drachenloch, Switzerland. Review of questionable remains helps to detect Pleistocene species diversity in the Alps.

The third question concerns the evidence of herbivores in the Alpine region. Cave bear sites are characterized by remains of cave bears and additional carnivores such as cave lion, wolves, sometimes leopard or wolverine. Typical Alpine species of today mainly ibex or marmot seem not to enter the high Alps prior to the Holocene based on preservation and previous radiocarbon dates. New evidence could argue for a different story but needs further studies.

The aim is to untangle pure faunal list of sites and single finds into a sequence of occupation phases. In course of the project SCN149-SG by the Swiss Academy of Science, the preserved material of five eastern Swiss sites has now been digitized and provides a broader basis to reconstruct occupation phases hence, subsequently to achieve a better understanding of species distribution in the Alpine region driven by climatic conditions and topography.

Keywords: Cave bear, Alps, Occupation phases

Microbial Controls on Pine Needle Preservation Across Redox Conditions

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True fossils of *Pinus* needles and twigs appear in the Early Cretaceous. Subsequent diversification of Pinaceae led to widespread distribution across the Northern Hemisphere. Pine needles differ from dicot leaves in anatomy and chemistry, possessing resistant cuticles and secondary metabolites that may influence microbial colonization, biofilm formation, and taphonomic outcomes.

We investigated microbial community development on *Pinus* needles under controlled aerobic and anaerobic conditions, focusing on biofilm formation in the presence of montmorillonite, a clay mineral associated with exceptional preservation. Freshly abscised needles were incubated in sterile Petri dishes and a sediment-filled aquarium, simulating contrasting redox environments. Samples collected over two years were analyzed using 16S rRNA gene sequencing to identify microbes associated with preservation or decay.

Sequencing revealed a substantial but partially shared core microbiome across treatments. Oxygen availability, experimental setup, and time significantly influenced community structure ($p \leq 0.002$). Anaerobic conditions consistently yielded lower alpha diversity and reduced biofilm development, as observed via SEM, indicating limited colonization and slower tissue alteration. Visually, anaerobic needles showed less decay. Distinct taxonomic patterns emerged between systems: aquarium incubations yielded more differentiated anaerobic assemblages, whereas Petri dish communities were primarily structured by oxygen availability. Genera including *Sporomusa*, *Desulfovibrio*, *Clostridium*, and *Methanosarcina* were enriched under anaerobic conditions and early time points, suggesting roles in decay suppression or early diagenesis.

Microbial communities on pine needles differ from those observed in dicot leaves, likely reflecting host-specific influences. However, a shared set of anaerobic taxa present during early decay across both systems may play a key role in promoting preservation.

Keywords: Taphonomy, Biofilms, Pines, Sequencing

New perspectives on Dama-Like deer from the latest Early Pleistocene: taxonomy, biochronology, and dispersal dynamics

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The term *Dama*-like deer refers to the group of medium-sized cervids characterized by three- or four-pointed and unpalmed antlers, widely distributed throughout the Plio–Pleistocene in Europe. Despite their abundance in the fossil record and their relevance for Early Pleistocene biochronology, the taxonomy and phylogenetic relationships of these cervids remain highly debated, resulting in diverging taxonomic interpretations and, in turn, inconsistent reconstructions of their spatiotemporal distribution.

Here we report on new data and ongoing research aimed at clarifying the complex evolutionary history of *Dama*-like deer during the latest Early Pleistocene. Particular attention is devoted to inter- and intraspecific variability within the group. The taxonomic investigations are based on both morphological and metrical analyses of fossil material and are further approached through statistical methods. Rather than relying on isolated diagnostic traits, the study seeks to identify more robust combinations of characters that enhance species discrimination and contribute to a more coherent taxonomic framework for the group.

In parallel, updated biochronological evidence from Southern European localities is presented, providing new insights into the temporal distribution of *Dama*-like deer taxa and their significance for correlations at a broader continental scale. Finally, the study addresses the paleobiogeographical history of the group in Europe by reconstructing possible dispersal patterns of some species of the group. The combined taxonomic, biochronological, and biogeographical framework proposed here offers new perspectives on the evolutionary dynamics of one of the most intriguing European Plio–Pleistocene mammal groups.

Keywords: Cervidae, Pleistocene, Biochronology

Abstract (Oral communication)
Symposium: S3

Hiding between the fronds: secrets of the "Ediacaran Garden"

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Traditionally, the “Cambrian explosion” (538.8 Ma) is interpreted as a moment of intense animal evolution and diversification. However, this presents a conundrum, which perplexed Darwin himself: where did they all come from? Molecular clocks indicate that Metazoans likely originated during the Cryogenian or Tonian (ca 800 Ma), and fossil evidence suggests many modern phyla were already present in the Ediacara. Although ecological and taphonomical explanations have been proposed, the scarcity of animals in the fossil record remains perplexing. Therefore, the Ediacaran is often seen as an ecologically and evolutionarily static environment, dominated by the “Ediacaran biota”: mostly sessile macro-organisms of uncertain phylogenetic relationships, including many extinct bodyplans. This biota was slowly replaced by the ancestors of modern animals and went extinct at the end of the period, leaving space for the Phanerozoic diversification of animals.

The result is the idea of an “Ediacaran Garden”, dominated by the Ediacaran biota, linked through simple trophic interactions and progressively losing the ecological battle with early animals. Our project aims to subvert this view, highlighting more complex ecological relationships, overlooked Metazoan diversity “hiding between the fronds”, pre-dating late Ediacaran and Cambrian diversifications, and resolving systematic and evolutionary problems using new samples and existing collections.

Keywords: Ediacaran, Early animal evolution, Paleo-ecology

Abstract (Poster)

Symposium: S11

The Paleobiology of Two Crown Group Cnidarians: *Haootia quadriformis* and *Mamsetia manunis* gen. et sp. nov. from the Ediacaran of Newfoundland, Canada

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The Ediacaran of eastern Newfoundland preserves the world's oldest known eumetazoan body fossils, as well as the earliest known record of fossilized muscular tissue. Re-examination of the holotype of the eight-armed *Haootia quadriformis* in terms of its morphology, the arrangement of its muscle filament bundles, and hitherto undescribed aspects of its anatomy support its interpretation as a crown staurozoan. We also document several new fossils preserving muscle tissue with a different muscular architecture to *Haootia*, but with only four arms. This new material allows us to describe a new crown group staurozoan, *Mamsetia manunis* gen. et sp. nov. This work confirms the presence of crown group medusozoan cnidarians of the *Staurozoa* in the Ediacaran of Newfoundland circa 565 Ma.

Keywords: Ediacaran, Cnidaria, Soft-Body preservation

Abstract (Oral communication)

Symposium: S3

Interpreting the causes and timing of Mass Extinctions: The role of species ecology and stratigraphic architecture

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A fundamental question driving research in paleontology is understanding how environmental change determines rates of evolution and whether the niches of species and higher taxa change through time. Paleontologists have the data to answer this question, but often the answer is more nuanced than originally thought and requires going beyond a direct reading of the fossil record. For example, the first order control on the first and last occurrences of species in a stratigraphic section is determined by two key features of the fossil record (1) species distributions along environmental gradients and (2) stratigraphic architecture. Stratigraphic architecture reflects variations in sedimentation rates and the shifting position of shoreline. The interaction of species distributions along environmental gradients with stratigraphic architecture establishes a null expectation for the distribution of first and last occurrences in a single stratigraphic section or across multiple sections in a basin. A key finding from modeling and empirical studies in marine settings is that first and last occurrences of species cluster at specific stratigraphic surfaces such as major marine flooding surfaces in the transgressive systems tract, and at surfaces of forced regression and subaerial unconformities. Without recognizing the stratigraphic significance of these clusters of first or last occurrences, they could be misinterpreted as representing times of elevated extinction. Determining environmental causes of extinctions are further complicated because proxies of environmental change are also subject to controls by stratigraphic architecture. Although these issues present challenges for mass extinction studies, they are also tremendous opportunities for more robust interpretations. I will argue that cross-training students in field paleontology and modern stratigraphic principles is needed to realize these opportunities.

Keywords: Stratigraphic paleobiology, Extinction, Paleoecology

Sea urchins from the Chesterian regional stage (Visean/Serpukhovian) of the USA illuminate the late Mississippian decline in echinoid diversity

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Echinoids (sea urchins) reached a first maximum in diversity during the Mississippian, particularly in carbonate-dominated open shelf environments. This “golden age” ended towards the end of the Mississippian, when echinoid diversity declined to relatively low levels for the rest of the Paleozoic, but the causes, mechanisms and patterns of this decline remain poorly understood. We provide a full revision of echinoid species and occurrences from the last regional stage of the Mississippian in North America, the Chesterian (late Visean to Serpukhovian), recorded in marine sediments of the Midcontinent region. We recognize 12 species, five of which are described as new. The echinoid faunas are dominated by proterocidarids, lepidesthids and archaeocidarids, with moderate endemism developed in different depositional basins. We analyze echinoid diversity in North America throughout the Carboniferous and find that the end-Mississippian diversity decline can be seen as two separate processes: (1) selective extinction around the Meramecian/Chesterian boundary, resulting in the disappearance of the previously successful family Palaechinidae, (2) a general diversity decline around the Mississippian/Pennsylvanian boundary, resulting in very low diversity in the early Pennsylvanian. Possible reasons for the first process are the diversification of durophagous fishes which might have targeted palaechinids as prey, a first global glaciation pulse during the early Chesterian, and successive loss of carbonate platform habitats. The second process is likely linked to the end-Serpukhovian extinction event which resulted in global loss of biodiversity as a result of the onset of the Late Paleozoic Ice Age. In the Pennsylvanian, echinoid faunas recovered and were dominated by archaeocidarids, which were better adapted to siliciclastic-dominated environments than other groups, and are ancestral to the echinoid crown group.

Keywords: Echinoidea, Mississippian, Extinction, Predator-prey dynamics

Abstract (Poster)

Symposium: other topics

Phylogeny and evolution of the Palaechinidae (Echinodermata: Echinoidea)

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The peak of sea urchin diversity during the Paleozoic was reached in the Tournaisian and Visean (early to middle Mississippian), primarily in open carbonate platform environments in north America and Europe. The dominant group in most of these environments was the family Palaechinidae, specialized forms with thick tests and small spines. We review reported occurrences of the family throughout the Paleozoic and perform a phylogenetic analysis to better understand evolutionary trends within the group as well as patterns of radiation and extinction. Only one pre-Mississippian palaechinid occurrence is found to be genuine, "*Palaechinus*" *praematurus* Nestler, 1981, from the earliest Middle Devonian of Germany. In this taxon, the radial water vessels were fully enclosed within the ambulacral plates, a plesiomorphic feature indicating an early-branching position of the family within stem group echinoids. After a ghost range spanning the entire Middle and Upper Devonian, a rapid adaptive radiation of the group occurred in the earliest Mississippian. Our phylogenetic analysis shows three general trends in palaechinid evolution through the Tournaisian/Visean interval: increasing thickness of the corona, development of a flexible peristomial region and increasing complexity of ambulacral plating. The group went extinct relatively suddenly around the end of the Visean, with almost all reported post-Visean occurrences inaccurate or doubtful. Extinction of the group appears to have been diachronous and was most likely related to the disappearance of carbonate platform environments in the course of the formation of Pangea and subsequent climate changes, as well as to the evolution of durophagous fishes during the Visean.

Keywords: Echinoidea, Mississippian, Devonian, Phylogeny, Extinction

The Lower Jurassic in the Morona-Santiago Province (south-eastern Ecuador)

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In the northern part of South America, the Jurassic outcrops form a narrow band extending southward from Venezuela and Colombia. In south-eastern Ecuador (province of Morona-Santiago) Liassic beds outcrop along the River Santiago and they were attributed to the Hettangian-Sinemurian transition. The present contribution summarizes the data we collected in 1989 in different outcrops along the road cut through the Amazonia forest from Patuca to Morona villages, in the sector between 40 and 60 km East to Patuca. In that area the River Santiago flows in a deep valley between the Condor and the Cutucu Cordilleras, at 300-250 m a.s.l. Two lithostratigraphic units can be distinguished, both of Jurassic age: the first represents the marine Santiago Formation; the second refers to the lower part of the continental Chapiza Formation. These units are exposed by separate outcrops along the road at about 500 m a.s.l. The upper Santiago Formation, often cut by sills or concordant dikes of volcanic rocks, consists of blackish shales with scattered calcareous nodules and pyrite concentrations; the muddy sequence alternates with turbiditic lithosomes. The finely laminated shales contain rich fossil assemblages of pelagic organisms, among them nektonic cephalopods and leptolepid fishes, pseudoplanktonic bivalves and serpulids epizoans on trunks. The absence of benthic records, the black colour of the shales and the pyritic nodules indicate that the primary sedimentation took place in an anoxic environment. The different fossiliferous localities provided distinct ammonite assemblages with taxa assigned to Schlotheimiidae, Arietitidae, Oxynoticeratidae and Eoderoceratidae and they can be referred to the Lower Sinemurian up to the middle part of the same stage. Among the others, a section located at 42 km East from Patuca has been sampled in detail and its *Metophioceras* and *Angulaticeras* assemblage indicates an early Sinemurian age.

Keywords: South America, Sinemurian, Ammonites, Amazonia

The Carnian ginkgophytes of Neuwelt (Switzerland)

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The Carnian Pluvial Episode (CPE) represents a major climatic perturbation of Late Triassic age, associated with pronounced changes in the composition of terrestrial ecosystems. Plant fossil assemblages documenting tropical to subtropical vegetation along the northwestern Tethyan margin are generally heterogeneous in composition. The flora of Lunz is dominated by cycadophytes and ferns, whereas Polzberg and Schaiblingsbach are composed almost exclusively of conifers.

The Neuwelt plant fossil assemblage (Switzerland) represents, so far, the only European CPE flora yielding a diverse assemblage of Ginkgophyta. This fossil assemblage is currently reassessed using a combination of macromorphological analysis with study of the epidermal characters to refine the taxonomic framework and to improve the systematic attribution of ginkgophyte remains. The integration of these datasets enhances taxonomic resolution and allows a more robust reconstruction of plant diversity and community structure at low paleolatitudes during the CPE. Furthermore, the results provide a basis for regional comparisons within the northwestern Tethyan Realm and contribute to a better understanding of the ecological role of Ginkgophyta within subtropical vegetation under changing climatic conditions.

Keywords: Neuwelt, Carnian Pluvial Episode, Ginkgophytes, Cuticles

An embryonic tooth of a Great White Shark (*Carcharodon carcharias*) from Pliocene deposits of Orciano Pisano, Italy

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Despite their significant scientific value, many specimens from the Pliocene fossiliferous locality of Orciano Pisano (Tuscany, central Italy) collected in the 19th century remain undescribed. While not representing newly discovered taxa, these remains can still make a significant contribution to our understanding of the ecology of the Pliocene Mediterranean community. Here, we present an embryonic tooth of the great white shark (*Carcharodon carcharias* Linnaeus, 1758), retrieved from mid-Piacenzian deposits of Orciano Pisano. This specimen (MGGC 22051) was rediscovered among historical samples collected by paleontologist Roberto Massimo Lawley and later donated to Giovanni Capellini. The tooth presents diagnostic characteristics of neonatal *C. carcharias* dentition, such as weakly serrated cutting edges and traces of a lateral cusplet. However, the overall size of the specimen is smaller than what would be expected for a functional tooth occupying the same row position in newborn white sharks. Based on comparisons with modern individuals we identify MGGC 22051 as a right anterior P2 from a late-stage embryo. While representing isolated remains, the presence of both embryonic and juvenile great white shark teeth in the collection could suggest the relevancy of Orciano Pisano in the reproductive ecology of the species. The paleoenvironmental context of Orciano Pisano supports conditions conducive to bathymetric gradients and seawater temperatures similar to those of contemporary pupping and nursery grounds for this species. We suggest that *C. carcharias* parturition could have occurred in nutrient-rich insular shelf habitats, with neonates migrating into inshore environments for increased protection from predation and enhanced foraging opportunities.

Keywords: Embryonic, Tooth, *Carcharodon carcharias*, Pliocene, Nursery

Reconstructions of monsoonal activity in a deglacial context

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Monsoonal activity and precipitation patterns in southeast Asia and northwestern Australia are driven largely by sea surface temperature (SST) differences between the ocean and the continents, and the position of the Intertropical Convergence Zone (ITCZ). A micropaleontological assessment of SST, upwelling, (export) productivity and bottom water oxygenation (BWO)/ temperature (BWT) allows the inter-hemispheric reconstruction of monsoonal activity. During the most recent deglaciation from the last glacial maximum to the Holocene (Termination 1), and specifically the Younger Dryas (YD; 13-11.7 ka BP) as well as Heinrich Stadial 1 (HS1; ~19–15 ka BP), important global changes, and inter-hemispheric see-saws in paleo-temperatures have been postulated from a multitude of Quaternary proxy-records.

From surface sediments and sediment cores we sample species of benthic and planktonic foraminifera for proxy calibration and inter-hemispheric reconstructions for YD and HS1. Two study areas are suited for this purpose: 1) In the northern South China Sea (SCS) upwelling related to the southeast Asian summer monsoon (ASM) is recorded, and 2) on the northwestern continental shelf of Australia (NWA), including the Timor Sea (TS), changes of SST and productivity related to the Australian monsoon (AM) are reconstructed. Both, ASM and AM are modulated by the position of the ITCZ, and TS and the SCS have the relative proximity to the Indonesian Throughflow (ITF) with warm surface waters in common. We attempt to reconstruct the inter-hemispheric see-saws with a micropaleontological approach with new information on ontogeny and confidence levels.

Elemental ratios such as Mg/Ca from the foraminiferal tests inform us about changes in SST, BWT, (export) productivity, BWO. Laser Ablation ICP-MS (LA-ICP-MS) and electron probe micro-analysis (EPMA) allow us to refine and validate calibration approaches for the targeted elemental ratios.

Keywords: Foraminifera, Shell chemistry, South China Sea, Indonesian Throughflow

Something new, something old – ‘*Martes*’ *efferens* spec. nov. (Carnivora, Mammalia) from the late Middle Miocene (MN 7/8) of Gratkorn (Styria, Austria)

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The Gratkorn claypit (Styria) contains one of the most complete vertebrate fauna from the European late Middle Miocene in the Paratethyan realm (12–12.2 Ma). A wide variety of vertebrate groups was found in a paleosol, e.g. felids and mustelids (Bastl et al., 2018). Mustelidae is the largest family of the Carnivora and represents a remarkable example of adaptive radiation with a tremendous range of ecological and phenotypic diversity, with e.g. fossorial (badgers), semi-arboreal (martens), and semi-aquatic species (otters), as well as diet specializations on rodents (weasels) or fish (otters). In the fossil record, multiple species are found in the same ecospace, showing character displacement and resource partitioning. Therefore, the phylogenetic relationships of extant and extinct mustelids (Mustelidae) are rather difficult to trace and changed in the last decades (Morlo et al., 2022). Here, we present new fossil material of a mustelid specimen recovered in Gratkorn. We performed cladistic and stratocladistic analyses of tooth morphology in extant and extinct mustelids and compared the anatomy of the ear region of the new specimen to selected extant taxa based on micro-CT scans. The skull from Gratkorn exhibits an intriguing yet complex mosaic of different stages in mustelid development. On this basis, we propose the new taxon as ‘*Martes*’ *efferens* spec. nov., which can be distinguished from similar fossil mustelids such as *Trochictis* or *Taxodon*. However, we also emphasize that the genus “*Martes*” is difficult to distinguish as early as the Middle Miocene.

References:

- Bastl K., et al. (2018). Gracanica (Bosnien and Herzegowina) and Gratkorn (Austria): New Middle Miocene carnivorous guilds. Abstract book of the XVI Annual Meeting of the EAVP, Caparica, Portugal 2018: 21.
- Morlo, M., et al. (2022). A new quantitative approach for guild analyses reveals the evolution of the carnivoran (Mammalia) guild at the Upper Miocene Proto-Rhine (Germany). *Historical Biology*, 34(8): 1337–1346.

Keywords: Mustelids, Teeth, Bony labyrinth, Gratkorn

Foraminifers in soil habitats of inland salt meadows in Germany

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Foraminifers, mainly known from marine and coastal environments, have occasionally been described from terrestrial saline springs. Recent investigations of different terrestrial salt meadows in Germany have shown that foraminifers also occur in soils influenced by salt from the underground or by salt springs. The assemblages consist of almost exclusively agglutinated species, which are usually dominated by *Entzia macrescens*, *Trochammina irregularis*, *Trochammina inflata* and *Miliammina fusca*. It seems to be clear that migratory birds regularly transported the foraminifers from coastal areas to the salt meadows. However, little is known about the population dynamics and the species-environment relations. The aim of our project is therefore to investigate various salt meadows in northern and central Germany, including those which are located close to potash mining spoil heaps, for a monitoring program allowing to detect variations of population dynamics and environmental changes. For gaining material, we periodically sample surface samples from transects along the halophyte vegetation zones in Sülldorf (Saxony-Anhalt) and other locations in Germany. We distinguish between living (stained) and dead specimens and measure ambient environmental parameters such as temperature, salinity, soil moisture and porewater chemistry. Genetical analyses of species is ongoing in order to clarify taxonomic patterns and origins of the species. Here we present first findings from different salt meadows sites of Northern- and Central Germany.

Keywords: Micropaleontology, Foraminifera, Holocene, Salt meadows, Soil habitats

Abstract (Oral communication)

Symposium: S9

The missing F: Form, Formation and Function of cephalopod cameral deposits

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Cameral deposits are conspicuous biominerals precipitated within the shells of fossil cephalopods. Although their formation had been subject to dispute for some time, recent work on excellently preserved material from the St. Cassian Formation has clarified this process (Pohle et al. 2025). Their function has traditionally been interpreted as serving as a counterbalance in orthoconic shells, though newer studies indicate a higher functional complexity (Pohle et al. 2025; Peterman et al. 2026). The improved understanding of formation and function call for increased efforts in understanding variability between taxa, since different forms can now be attributed to the (presumably genetically controlled) arrangement of cameral sheets. For this purpose, we compared multiple specimens representing different time intervals, localities and higher taxa: 1) Orthoceratida, 2) Pseudorthoceratida, 3) Actinoceratida, 4) Lituitida, 5) Lamellorthoceratidae and 6) Belemnitida. These were analysed using different techniques, ranging from cathodoluminescence microscopy to μ CT-scanning. This revealed considerable variability between higher taxa, while common, potentially homologous structures can be identified. By contrast, alleged belemnite “cameral deposits” likely represent secondary cements. These findings suggest that cameral deposits may represent a highly useful tool in differentiating between taxa. Further efforts in this direction are promising for the study of orthoceratoid diversity and evolution.

References:

Pohle A., Hoffmann R., Nützel A., Seuss B., Aubrechtová M., Kröger B., Stevens K. & Immenhauser A. (2025). Microstructural and geochemical evidence offers a solution to the cephalopod cameral deposits riddle. *Palaeontology*, 68: e70032. DOI: 10.1111/pala.70032

Peterman, D. J., Landman, N., & Ciampaglio, C. (2026). Exploring the influence of cameral deposits on the stability, orientation, and maneuverability of orthocone cephalopods. *Paleobiology*, 21 pp. DOI: 10.1017/pab.2025.10085

Keywords: Cephalopoda, Orthoceratoidea, Biomineralization, Virtual palaeontology, Taxonomy

Project presentation: CRITIS - Critical tipping points in the Earth System

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Mass extinctions in Earth history are often linked to the crossing of critical thresholds in the Earth system, triggering cascading feedback and long-term reorganization. The Interreg project *CRITIS* builds on paleontological evidence from major crisis intervals at the Permian–Triassic and Triassic–Jurassic boundaries to investigate mechanisms of tipping points, ecological collapse, and recovery. These events are associated with large-scale perturbations ultimately leading to severe biodiversity loss and restructuring of marine and terrestrial ecosystems. Current anthropogenic climate change, biodiversity loss, and the destabilization of ecosystems are increasingly interpreted as processes approaching or exceeding planetary boundaries. In the Alps, warming rates exceed the global average, with accelerating glacier retreat, permafrost degradation, and increasing frequency of extreme events, highlighting the vulnerability of coupled natural and human systems. By juxtaposing these modern dynamics with deep-time crisis intervals, *CRITIS* addresses similarities and differences in drivers, rates, and system responses, providing a framework to better understand thresholds, resilience, and the potential irreversibility of ecological change.

The aim of the project is to translate research on tipping points and ecosystem changes into accessible and scientifically robust educational formats. *CRITIS* develops the transfer through close collaboration with teachers and pilot schools, including the co-creation of curriculum-aligned teaching materials, workshops, and guided field experiences. By combining scientific content with pedagogical approaches, the project seeks to make complex processes such as feedback mechanisms, regime shifts, and ecosystem reorganization comprehensible to a broader audience. This approach allows learners to engage with ecosystem trajectories before, during, and after crisis intervals, linking geological archives with present-day environmental challenges.

Keywords: Tipping points, Ecosystem changes, Geological archives, Present-day environmental challenges

A three-dimensional reconstruction of the skull of *Neusticosaurus pusillus*, the archetypal pachypleurosaur from Monte San Giorgio

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Pachypleurosaurs are a group of small-sized Triassic sauropterygians recorded from shallow marine settings across the Tethyan Realm. They are known from abundant exceptionally preserved fossils, which have yielded a wealth of information about their morphology and development. However, virtually all pachypleurosaur specimens are taphonomically compressed in a dorsoventral orientation, restricting the scope of anatomical observations – especially on the delicate skull – and limiting functional and phylogenetic interpretations. This notably contributes to ongoing uncertainty regarding the monophyly of the clade and its relationship to other eosauroptrygians. To overcome these preservational challenges, we employ X-ray μ CT to investigate one of the best known pachypleurosaurs from the Western Tethys, *Neusticosaurus pusillus*, based on two skulls from the early Ladinian of Monte San Giorgio. These data allow us to create the first 3D reconstruction of a pachypleurosaur skull, and unveil numerous previously inaccessible anatomical characters. The braincase, which is largely obscured externally, is exposed here in full, revealing the otic region, epipterygoid and parabasiphenoid. The mandible, in particular the poorly known medial surface, can also be reconstructed and notably features a small coronoid and a narrow splenial. Beyond the skull, one specimen also shows the first complete view of the atlas-axis complex in a non-plesiosaur sauropterygian, exhibiting a plesiomorphic configuration including paired proatlas and atlantal neural arches, as well as separate pleuro- and intercentra and short ribs for both vertebrae. This first 3D reconstruction will not only facilitate future similar endeavours and provide new phylogenetic characters that may help clarify the contentious relationships of eosauroptrygians, but will also serve as a basis for biomechanical investigation into the feeding ecology of these small but abundant early marine reptiles.

Keywords: Eosauroptrygia, Middle Triassic, Monte San Giorgio, Cranial anatomy, Microtomography

Virtual 3D dataset of temnospondyl pectoral girdles

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Due to the growing number of available computational modelling approaches, virtual 3D models of fossils are recognized as being of increasing importance in the study of the biomechanics and functional morphology of extinct animals, offering potentially deep insights into musculoskeletal function and having implications for paleobiological inferences. This is particularly pertinent when there is no adequate extant analogue to the skeletal structure of interest. Here we present the 3D models of the pectoral girdle elements of 13 species of Temnospondyli (*Dendrerpeton acadianum*, *Trimerorhachis insignis*, *Micropholis stowi*, *Cacops* sp., *Dissorophus multicinctus*, *Acheloma dunni*, *Eryops megacephalus*, *Lydekkerina huxleyi*, *Trematolestes hagdorni*, *Ninumbeehana dookoodukah*, *Gerrothorax pulcherrimus*, *Metoposaurus krasiejowensis*, and *Mastodonsaurus giganteus*) and of the stem-tetrapod *Whatcheeria deltae* and the stem-amniote *Orobates pabsti* for outgroup comparison. The Early Carboniferous to Early Cretaceous Temnospondyli were ecologically highly diverse and occupied a variety of niches in aquatic, semiterrestrial and terrestrial habitats. The choice of the taxa to analyze was made with the intention to cover most of their ecomorphological and phylogenetic diversity. The 3D models were obtained using different techniques, such as photogrammetry, structured light scanning, handheld surface scanning and micro-CT scanning and segmentation. The dataset will form the basis of a 3D geometric morphometric analysis to create a 3D phylomorphospace. Our aim is to quantify the diversity of shapes of the pectoral girdle elements of Temnospondyli and to investigate the correlation between morphology and ecological adaptation. Subsequently, we will use this dataset in computational modelling approaches to further explore the relationship between the form and function of the pectoral region of Temnospondyli, in order to gain insight into their locomotor mechanics.

Keywords: Temnospondyli, Pectoral girdle, Virtual 3D models, Dataset, Functional morphology

The “*Claraia wangi-griesbachi*” problem in the Mazzin Member

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The Lower Triassic Werfen Formation of the Dolomites is a key archive of the recovery from the end-Permian mass extinction. Its Griesbachian Mazzin Member contains small, weakly ornamented *Claraia* informally referred to as “*Claraia* gr. *wangi-griesbachi*” (Broglia Loriga et al., 1983). Their exact identification matters because different taxonomic treatments have an impact on the analysis of body size trends and their interpretation regarding a potential Lilliput effect (Foster et al., 2020, 2026). Published taxonomic opinions range from open nomenclature to inclusion in *C. aurita*, or to separation from *C. aurita* (Hofmann et al., 2015; Foster et al., 2020). Using selected specimens, this contribution highlights the taxonomic, stratigraphic and paleoecological dimensions of the problem through the analysis of shell outline, ornamentation, body size and stratigraphic occurrence. It asks whether conflicting interpretations reflect alternative taxonomic concepts applied to the same material, or whether more than one morphotype or taxon may be present in the Mazzin Member. This bears directly on Werfen biostratigraphy and on how earliest Triassic size trends in the Dolomites are interpreted.

References:

- Broglia Loriga C., Masetti D. & Neri C. (1983). La Formazione di Werfen (Scitico) delle Dolomiti occidentali. *Rivista Italiana di Paleontologia e Stratigrafia*, 88: 501–598.
- Foster W.J., Gliwa J., Lembke C., Pugh A.C., Hofmann R., Tietje M., Varela S., Foster L.C., Korn D. & Aberhan M. (2020). Evolutionary and ecophenotypic controls on bivalve body size distributions following the end-Permian mass extinction. *Global and Planetary Change*, 185: 103088.
- Foster W.J., Prinoth H., Kustatscher E. & Hautmann M. (2026). An unpredictable body size response to the Permo-Triassic climate crisis. *Biogeosciences*, 23: 1181–1198.
- Hofmann R., Hautmann M. & Bucher H. (2015). Recovery dynamics of benthic marine communities from the Lower Triassic Werfen Formation, northern Italy. *Lethaia*, 48: 474–496.

Keywords: *Claraia*, Werfen Formation, Taxonomic uncertainty, Body size evolution, End-Permian mass extinction

Origin and dispersal of Messapicetiformes and Vomerziphi (Ziphiidae): A paleobiogeographic perspective

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Beaked whales (Odontoceti, Ziphiidae) are extremely elusive and mysterious animals. Despite this, their family includes six genera and 24 valid named species, making it one of the most speciose groups among cetaceans. Currently found in both hemispheres, ziphiids are extraordinary deep-divers and include several cosmopolitan species. Thanks to the recent discovery of numerous fossil species, it has been possible to reconstruct in greater detail the paleobiogeographic history of these cetaceans and to better understand which factors have shaped their distribution and deep-diving habits. Here we focus on the events that influenced the spatial and temporal distribution of the two recently established clades Messapicetiformes, which show medially fused and pachyosteosclerotic premaxillae along the rostrum, and Vomerziphi, characterized by the mesorostral groove filled by the osteosclerotic vomer. Fossils recovered from seafloor deposits, especially in the North Atlantic and South Africa, and those found in the Ica Desert of Peru, have provided new insights into these two clades and their marked differences, both in morphology and in lifestyle. In our study, we performed a new paleobiogeographic analysis based on a newly reconstructed phylogeny of Ziphiidae, using distribution ranges defined based on those of extant species. Our reconstruction suggests that ziphiids originated in the North Atlantic, where the first Messapicetiformes also appeared in the Serravallian. The Vomerziphi, in contrast, emerged probably in the Late Miocene and subsequently colonized both high and low latitudes, thanks to their adaptations. Although recent discoveries have made it possible to propose new hypotheses regarding the radiation of these ziphiid clades, new fossil records will hopefully provide a more comprehensive picture of the origin and the paleobiogeographic processes that shaped the current distribution of these cetaceans.

Keywords: Paleobiogeography, Ziphiidae, Cetaceans

Climate cascades across time: a multi-scale synthesis of climate-driven extinction mechanisms

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Climate change is recognized as a major driver of biodiversity loss, yet the mechanisms linking climatic forcing to extinction remain complex and indirect. Cahill et al. (2013) found no straightforward relationship between extirpation and limited tolerance to high temperatures, but instead showed the importance of changing species interactions under climate change. Building on this work, we developed a conceptual framework of causal cascades, representing chains linked by inferred mechanisms through which climate change impairs populations, and reassess the generality of these mechanisms across temporal scales.

We conducted a systematic literature review, screening about 1600 neontological and paleontological publications for climate-related population decline, extirpation, or extinction across taxa. Studies were included if they provided information to reconstruct a clear mechanistic pathway, ensuring comparability of causal cascades across temporal scales. This resulted in a dataset of 164 individual cases spanning modern, near-time, and deep-time contexts. These cases were grouped into 54 causal cascades, each leading to population decline, extirpation, or extinction

Results show a strong dominance of temperature–thermal anomalies–physiological tolerance cascades in modern and near-time records. Temperature-driven biotic shifts occur in both datasets as second most frequent cascades. Deep-time cases are characterized by physiological limitation driven by temperature and ocean chemistry–oxygen availability cascades.

Overall, inferred paleo and neontological mechanisms show differences in their dominant cascade structures, reflecting variation in the relative importance of climate-driven pathways across temporal scales.

References:

Cahill A.E., Aiello-Lammens M.E., Fisher-Reid M.C., Hua X., Karanewsky C.J., Yeong Ryu H., Sbeglia G.C., Spagnolo F., Waldron J.B., Warsi O., Wiens J.J. (2013) How does climate change cause extinction? *Proc Biol Sci* 280: 20121890.

Keywords: Climate-driven extinction, Causal cascades, Paleoecology, Neontology

Rediscovery of invertebrate fossils from Italian geological expeditions of 19th and 20th centuries in the Earth Sciences Museum in Bari

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In the storage of the Museo di Scienze della Terra of the University of Bari two old boxes with over 200 fossil specimens, mainly invertebrates and some plants, and about 300 labels were found in 2026. A small quantity of them turned out to be part of historical collections: 2 Cretaceous bivalves from Figari's expeditions in Egypt in 1845–46; 3 Triassic ammonites from Martelli's expedition in Montenegro in 1902–03; 9 Permian brachiopods from De Filippi's expedition in the Karakoram in 1913–14; 3 foraminifers, 1 coral and 5 bivalves from Stefanini's expedition in Somalia in 1924; about 30 brachiopods and bivalves from Salomi's collection; additional bivalves and gastropods are from the Dainelli and Marinelli collections.

Whilst Liborio Salomi (1882–1952) lived and worked in Lecce, Olinto Marinelli (1876–1926) and Giotto Dainelli (1878–1968), who took part to De Filippi's expedition, Giuseppe Stefanini (1882–1938) and Alessandro Martelli (1876–1934) were students of Carlo De Stefani (1851–1924), former director of the Museo di Storia Naturale of the University of Florence (Cioppi & Dominici, 2010). Then, even if the recognition of all the specimens has not been completed yet, the origin of this material and Figari's specimens can be considered the Florentine Museum.

Most of the labels are handwritten and were probably produced in Bari between the 1950s and 1990s; however, 20 of them are clearly older and may be original. The recovery of this material enhances the historical significance of the museum's scientific and educational collections and may also be of considerable scientific value, as some specimens could represent type material.

References:

Cioppi E. & Dominici S. (2010). Origin and development of the geological and paleontological collections. In Monechi S. & Rook L. (eds), *The Museum of Natural History of the University of Florence. The Geological and Paleontological Collections*, 1st Edition, *Cataloghi e collezioni*. Firenze University Press, Firenze.

Keywords: Museology, Paleontological heritage, Malacology

Pliocene-Pleistocene planktonic foraminiferal biostratigraphy from ODP Site 967: western and eastern correlation

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A comparison in terms of planktonic foraminiferal genera between ODP Site-967 and data from western Mediterranean revealed significant longitudinal gradients in assemblage composition, reflecting distinct environmental settings of the two regions.

Within this framework, while Western Mediterranean provides a biostratigraphic standard scheme, the Eastern ones remain less explored. This study is a high-resolution quantitative analysis of planktonic foraminifera from ODP Site 967, providing the first western and eastern Mediterranean correlation.

This comparison revealed that while the LO of *G. puncticulata* (3,60 Ma) and FOs of *G. bononiensis* (3,65 Ma) and *G. crassaformis* (3,64 Ma) as well as the FCO of *G. bononiensis* (3.31 Ma) align with western records, allowing the identification of MPL4a and MPL4b subzones, upwards the strong discrepancies in planktonic foraminiferal abundances between the two areas suggested to emend for the eastern Mediterranean the standard planktonic foraminiferal scheme. This comparison suggested to adopt other species (i.e., *G. crassaformis*) to extend and emend to 2.3 Ma the planktonic foraminiferal scheme for the eastern Mediterranean.

This approach highlighted that from the Piacenzian to the Gelasian the two basins show distinct planktonic foraminiferal signatures for the long ranging taxa. A major faunal turnover is characterized by an increase in *G. ruber* white morphotype “b” and “d” and a sharp decline in morphotype “c” as long as *G. obliquus* (3,1 Ma). The Gelasian GSSP seems to be approximated by decrease in *G. obliquus* abundance, LCO *G. quadrilobatus* gr. (2,63Ma) and LO *Globorotalids* (2,42 Ma).

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Keywords: Biostratigraphy, Planktonic Foraminifera, Eastern Mediterranean Basin

New finds of basal sauropodomorph dinosaurs from the Late Triassic of Thuringia, Germany

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Terrestrial vertebrates have long been known from the German Late Triassic. Classic localities are mainly found in Baden-Württemberg in south-west Germany and, to a lesser degree, in north-central Bavaria (south-east Germany) and the area of Halberstadt in Saxony-Anhalt, north-central Germany. The middle to late Norian faunas of these areas are largely dominated by non-sauropodiform sauropodomorphs, often referred to the genus *Plateosaurus*, with rarer turtles, theropods and a few other vertebrate clades. From the Thuringian Basin in central Germany, the area connecting northern Bavaria and Saxony-Anhalt, only a few remains have been documented so far, all of which were referred to *Plateosaurus*. Recent fieldwork in the Obere Bunte Mergel of the Arnstadt Formation (Upper Norian) in the Drei-Gleichen-Area between Erfurt and Gotha resulted in the discovery of new vertebrate specimens. Vertebrate remains come from a strongly pedogenetically reworked mudflat facies deposited close to the shoreline of a large-scale playa system. Skeletons were obviously exposed over a longer time before burial, which accounts for partial disarticulation and missing elements. While bone shafts are generally well-preserved, articular ends of long bones often show signs of pre-burial weathering. The remains are furthermore affected by diagenetic and probably tectonic displacement of elements within the rock. Apart from fragmentary and isolated materials, at least three associated to partially articulated but incomplete skeletons were found. All three specimens represent basal sauropodomorphs. Marked differences in the morphology of the femur between two of the specimens indicate that at least two taxa are represented. The more complete specimen includes vertebrae, partial scapulocoracoids, an almost complete forelimb, ischia, a partial femur, and articulated stylopods and feet. This specimen shows distinct differences from the common *Plateosaurus* and probably represents a new taxon.

Keywords: Vertebrata, Dinosauria, Sauropodomorpha, Late Triassic, Thuringia Basin

A ‘control-treatment’ approach can unite neo- and paleo-biology to reveal how marine life responds to global warming

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Marine life is responding to anthropogenic warming, but conditions are exceeding the recent evolutionary experience of modern organisms. Models informed solely by recent historical observations may therefore fail to make successful predictions of the future, especially beyond 2100. To understand how marine life may respond to rapid, sustained, and severe warming, fossils can evidence the ecological responses over numerous hyperthermal events. Extinction responses may have the most faithful record and extinction rates vary greatly among clades. We address how patterns of extinction selectivity in the ancient past agree with modern hypotheses of organism vulnerability, which are often informed by controlled experimental manipulation or projections of niche models. We take inspiration from control-treatment comparisons in experiments and simulations and apply this to extinction selectivity, the differences in extinction rate among groups of organisms. Specifically, we quantify the differences in a group’s extinction selectivity between hyperthermal (treatment) events and non-hyperthermal (control) events. We show how these paleo “control-treatment” comparisons for clade, ecological trait, and thermal habitat correspond better to mechanism-based hypotheses of vulnerability at hyperthermal events than raw extinction selectivity. This suggests a new avenue to unleash the potential of fossil extinction patterns to inform future conservation strategies.

Keywords: Climate change, Extinction, Marine, Traits

Abstract (Oral communication)

Symposium: S10

The world's first molpadid holothurian body fossil (Echinodermata) – discovered at the Miocene Meljski hrib *Konservat-Lagerstätte* in Slovenia

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The evolutionary history of sea cucumbers (Holothuroidea) remains the most incompletely understood of the five modern groups of Echinodermata. Holothurians are very sparsely represented in the fossil record, as their skeleton usually consists of microscopic ossicles that decay rapidly after death. Isolated ossicles from the body wall and individual elements of the calcareous ring surrounding the pharynx are not uncommon as fossils since the Middle Ordovician. Only a dozen of *Lagerstätten* deposits worldwide are known to contain holothurian body fossils. Almost without exception, all of the sites are of Paleozoic and Mesozoic age. All holothurian body fossils found to date belong to species of the Apodida, Dendrochirotida and Holothuriida/Synallactida, as well as to various stem group representatives. Apparently, only a single post-Mesozoic site in Japan has yielded holothurian body fossils.

Here we present a new and unique find from the early Miocene Meljski hrib *Konservat-Lagerstätte* in Slovenia. The small specimen shows *in situ* preserved body wall ossicles and the ferro-phosphatic bodies typical of many taxa of the Molpadiidae (Molpadida). Since only one half of the part and counterpart slab could be recovered, the calcareous ring may have been located in the missing slab. Soft tissues such as tentacles could not be observed. The associated organisms within the yellowish marl ('ophiuroid bed') of the section consist mainly of ophiuroids, mollusks (bivalves, scaphopods) and various species of decapod crustaceans, as well as irregular sea urchins. This fauna suggests an outer shelf to slope depositional environment (150–250 metres water depth).

Keywords: Fossil-Lagerstätten, Invertebrates, Echinoderms, Holothuroidea, Miocene

Elasmobranch diversity across a newly identified Cretaceous-Paleogene boundary in the Tethyan Realm (Bavaria, Germany)

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The end-Cretaceous event (~66 Ma) represents one of the “big five” mass extinctions, resulting in the loss of numerous groups, including non-avian dinosaurs. Elasmobranchs (sharks, rays, and skates) constitute one of the most successful vertebrate lineages, having persisted through all major mass extinctions over the past 400 million years. However, knowledge on their immediate response to the end-Cretaceous extinction remains limited, largely due to scarce and poor accessibility of suitable sedimentary records spanning the event. In recent years, efforts have been made to establish an international research network dedicated to the identification of suitable K-Pg sections and conducting systematic bulk sampling targeting elasmobranch teeth. These studies have significantly contributed to our understanding of the effects of the K-Pg mass extinction in the Tethyan Realm. As part of these efforts, a newly identified section in Bavaria (Germany) has been recognized for its exceptional abundance in elasmobranch remains. A first test sampling of >1 ton of sediment yielded approximately 5000 ichthyoliths. Our preliminary findings indicate a high elasmobranch diversity, which is dominated by squaliform sharks. The observed pre-extinction diversity closely resembles those documented from the previously described K-Pg section in Waidach (Austria), but the post-extinction assemblages clearly differ from the Austrian section. The newly recovered elasmobranch assemblages highlight the potential of the Bavarian section to provide new insights into elasmobranch diversity and resilience across the K-Pg boundary in different environmental settings.

Keywords: Maastrichtian, Danian, Sharks, Diversity, Extinction

Taphonomy of microbial structures within alpine Triassic Black Shales

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Microbialites from black shales at Mt. San Giorgio (Cava superior beds, Ladinian) exhibit a dense network of filamentous microbes on the bedding surface, which resemble sheaths of SOX bacteria (e.g. *Thioploca*). These layers represent microbial mats containing microbes and framboidal pyrite, indicating the presence of sulfate-reducing bacteria (SRB). PMI and biphytanic isoprenoides show Archaea. Isorenieratene indicates anoxygenic phototrophic bacteria (Chlorobiaceae). Samples from the Prosanto FM (Ladinian) show no filamentous bacteria, but also carbonated microbes in microbial mats. In both cases, the preservation of bacterial cells is unusual and is attributed to high Ca^{2+} concentrations in the seawater, which resulted in a rapid collapse of the EPS function and led to Ca^{2+} toxicity. Black shales of the Seefeld FM (Norian) (Hopf et al. 2001) show only occasionally preserved microbial mats especially for areas where dolomite layers occur. Framboidal pyrite and autogenous dolomite indicate a strong activity of SRB, also confirmed by S-aromatic compounds such as thiophenes. The black shales of the Kössen FM (Rhaetian) are associated with the so-called T-Bank. The organic biomass consists mainly of algae (e.g. Haptophyta) (Pei et al. 2023). Taphonomic microbiological structures, such as those found in the Ladinian Black Shales, however, are not observed.

References:

- Pei, Y., Blumenberg, M., Duda, J.-P., Höche, N., Peckmann, J., Birgel, D., Luo, C., Kment, K., Reitner, J. (2023). Ecosystem changes through the Permian–Triassic and Triassic–Jurassic critical intervals: Evidence from sedimentology, paleontology and geochemistry. *Sedimentology*, DOI: 10.1111/sed.13088
- Hopf, H., Thiel, V. & Reitner, J. (2001). An Example for Black Shale Development on a Carbonate Platform (Late Triassic, Seefeld, Austria).-Facies, 45: 203–210.

Keywords: Triassic Black Shales, Taphonomy, Microbial mats, Organic geochemistry, Geobiology

The first fossil tube-eye fish (Teleostei, Stylephoriformes)

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The tube-eye fishes (Stylephoriformes) are morphologically bizarre deep-sea teleosts, today represented by a single extant species, *Stylephorus chordatus* (Regan 1924; Pietsch, 1978; Olney et al. 1993). The evolutionary origin of the peculiar body plan of this clade remains elusive, at least in part because of the absence of fossils in the record. The phylogenetic relationships of the Stylephoriformes have been extensively debated in the last two centuries. Recent genomic studies proposed a sister-group relationship with the Gadiformes (Miya et al. 2007). Here, we present the first known fossil representative of this clade from the Bartonian (around 40 Ma) sediments of the Pabdeh Formation in Iran. The fossil represents a new genus and species since it exhibits a distinctive set of osteological features, including premaxillae and dentary edentulous, maxillae with a straight ventral margin, expanded pterygoid bones, opercle reduced, long ribbon-like body with more than 63 vertebrae, eight pectoral-fin rays, basipterygia absent, and a complete series of well-developed lateral-line scales. The fossil described herein provides new insights into the evolution of the Stylephoriformes. In particular, the morphological similarity between the body plans of the living and fossil stylephoriform species indicates that only minor evolutionary changes occurred in this lineage over the last 40 million years.

References:

- Miya M., Holcroft N.I., Satoh T.P., Yamaguchi M., Nishida M., & Wiley E. O. (2007). Mitochondrial genome and a nuclear gene indicate a novel phylogenetic position of deep-sea tube-eye fish (Stylephoridae). *Ichthyological Research*, 54: 323–332.
- Olney J.E., Johnson G.D., & Baldwin C.C. (1993). Phylogeny of lampridiform fishes. *Bulletin of Marine Sciences*, 52: 137–169.
- Pietsch T.W. (1978). The feeding mechanism of *Stylephorus chordatus* (Teleostei: Lampridiformes): functional and ecological implications. *Copeia*, 1978: 255–262.
- Regan, C.T. (1924). The morphology of a rare oceanic fish, *Stylophorus chordatus*, Shaw; based on specimens collected in the Atlantic by the “Dana” Expeditions. *Proceedings of the Royal Society of London, Biological Sciences*, 3: 193–207.

Keywords: Bartonian, Iran, Pabdeh Formation, Paracanthopterygii.

Abstract (Oral communication)

Symposium: S1

Detailed neuroanatomy at the base of the crocodylian radiation provides new perspectives into the paleoecology of European eusuchians of the latest Cretaceous

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Allodaposuchidae (Crocodyliformes, Eusuchia) were among the most abundant crocodylomorphs in the Upper Cretaceous of Europe. This clade, recently established to encompass numerous Cretaceous eusuchian species described over the past decade, exhibits remarkable diversity that has generated ongoing systematic controversy. Here, we re-evaluate a historical allodaposuchid specimen from the lower Maastrichtian locality of Els Nerets, within the Tremp Group (Catalonia, Spain), in light of newly acquired micro-CT data. The specimen consists of a posterior skull table that, despite its small size, displays features indicative of an adult individual. It also exhibits a combination of distinctive characters that prevents referral to any eusuchian taxon currently reported from the lower Maastrichtian transitional deposits of the Tremp Group. CT segmentation enabled the reconstruction of internal cavities, including most brain and cranial nerve endocasts, as well as an almost complete pneumatic system and the entire inner ear. The exceptional preservation of these structures provides the most detailed account of the pneumatic system and inner ear in any allodaposuchid to date. Several internal features show marked similarities to some extinct terrestrial crocodylomorphs, including a dorsally elevated anterior semicircular canal and a well-developed 'dural peak' of the brain endocast. However, other traits are more consistent with extant semiaquatic crocodylians. Notably, the inner ear configuration differs from that of other known crocodyliforms, including *Allodaposuchus hulki*, another early Maastrichtian allodaposuchid from the Tremp Group, whose inner ear has been reconstructed in greater detail for this study. These findings provide new insights into neuroanatomical evolution at the base of the crocodylian radiation and raise questions about paleoecology and potential niche partitioning among eusuchians shortly before the K–Pg mass extinction event.

Keywords: Crocodyliformes, Late Cretaceous, Neuroanatomy, Inner ear, Cranial pneumaticity

Recurrent pedal paleopathologies affecting small bipedal herbivorous dinosaurs provide novel insights into the evolution of ornithopod locomotion

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Ornithopoda is a diverse clade of herbivorous dinosaurs that achieved global distribution from the Early Jurassic to the Late Cretaceous undergoing extensive adaptive radiation, particularly among iguanodontians. Locomotor strategies varied from large-bodied facultative quadrupeds to more gracile bipedal forms. Among the latter, *Dysalotosaurus lettowvorbecki* (Iguanodontia, Dryosauridae) is a taxon represented by thousands of mostly disarticulated remains from bonebeds in the Upper Jurassic of Tendaguru (Tanzania). We describe isolated pathological pedal elements of *D. lettowvorbecki* showing clear traumatic lesions. Micro-CT imaging of one specimen facilitated detailed assessment of internal structure. Differential diagnosis indicates that two first pedal phalanges were affected by multiple fractures, whereas a metatarsal shows a well-developed fracture callus. Notably, all pathological elements relate to digit III. In contrast, other bipedal, earlier-diverging taxa typically display traumatic lesions often affecting digit I, involving extensive damage and infection. These differences likely reflect the pedal anatomy of *D. lettowvorbecki*, where three digits contacted the ground: digit I is reduced and elevated, while digit III is elongated. The latter likely represents a cursorial adaptation, with the concentration of pathologies in this element suggesting repeated mechanical stress during locomotion. The functional loss of digit I may represent a key innovation in iguanodontian evolution, underpinning cursorial specialisation in dryosaurids such as *D. lettowvorbecki* and, along a distinct evolutionary pathway, the emergence of graviportality in the hadrosaurian lineage. Despite the likely painful injuries documented here, the advanced degree of healing indicates prolonged survival, possibly facilitated by gregarious behaviour. This interpretation is supported by bonebed taphonomy, preserving hundreds of individuals likely perished in a single mass mortality event.

Keywords: Ornithopoda, *Dysalotosaurus*, Paleopathology, Micro-CT, Dinosaurian locomotion

Understanding the frontier of molecular preservation of melanin in deep time using novel high pressure-temperature experiments

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Evidence of eumelanin pigments is known to persist in fossils from the Cambrian to the Neogene, but the molecular taphonomy of eumelanin is not fully resolved. Understanding this – especially signatures for very thermally altered melanins – is critical to assess their preservation in deep time. Here we present results from novel controlled maturation experiments on modern melanosomes, analyzed using scanning electron microscopy (SEM) and micro-Raman spectroscopy, coupled with multivariate statistical analysis. Experiments were conducted at a range of temperature and pressure conditions using a high-pressure instrument (250°C, 350°C and 380°C at 130 bar; and 380°C, 250 bar, each for 24h) to simulate various burial histories. Our results show that melanosomes persist across all experiments but in experiments at 350–380°C, melanosome preservation is limited to discrete "pockets" surrounded by amorphous carbonaceous matter. As expected, the Raman spectra of all samples show D and G bands at ca. 1350 and 1580 cm^{-1} , respectively. The most diagnostic spectral transformations emerge at temperatures of 350°C and above, where Raman peaks become sharper and shift slightly in position toward higher wavenumber. The saddle region between the D and G bands deepens, with the deepest point centred at ca. 1520 cm^{-1} . These features are not compatible with a kerogen origin, and are thus interpreted here as diagnostic of highly matured eumelanin. Multivariate statistical analysis shows that the differences in the spectral features of experimentally matured samples are maturation-specific. The integration of fossil data in the analysis reveals that the Raman signature of melanosomes exposed to higher temperature conditions closely resembles that recorded for melanosomes from fossils of the Mazon Creek *Lagerstätte* (300 Ma), providing powerful geological validation of our experimental results.

Keywords: Experimental taphonomy, Melanin, Molecular taphonomy, Vibrational spectroscopy, Melanosomes

The rise and fall of Miocene tragulids: recent advances in paleobiology

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Modern Tragulidae are a group of ten small-sized artiodactyl species, including the smallest living hoofed mammal. They live in thick undergrowth of disjunct areas in tropical Africa and Asia. Due to their specific character suite of artiodactyl plesiomorphies and apomorphies of pecoran ruminants (deer, buffaloes, giraffes, pronghorns, musk deer), they were interpreted survivors of the dawn of ruminants.

Increased research during the last 20 years on the widely distributed Afro-Eurasian Miocene tragulid record, not only surprised with a much larger phenotypic diversity than in the modern world, but also points to a complex, not straight, evolutionary history of the group, adjusting with ecological challenges arisen from the alpine orogeny. Though a Pliocene and Pleistocene record is largely missing, comparison with Recent tragulids demonstrates that there was a serious cut to the Miocene tragulids, which succeeded over pecorans. Europe was the last continent being populated by Miocene tragulids and the only with full extinction.

This presentation aims at summarising the recent achievements in understanding the rise and fall of Miocene tragulids, pointing out remaining gaps, and highlighting the proof that living tragulids did not conserve a plesiomorphic evolutionary state.

Keywords: Tragulidae, Miocene, Europe, Africa, Asia

Abstract (Oral communication)

Symposium: other topics

Island of ‘Dragons’: diversity of iguanodontian dinosaurs from the Lower Cretaceous Wealden Group of the Isle of Wight

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Iguanodontians are among the most iconic herbivorous dinosaurs and were highly successful during the Cretaceous, both in terms of species diversity and fossil abundance. Recent work on Lower Cretaceous deposits of western Europe has revealed a greater diversity of iguanodontian taxa than previously recognized, reshaping our understanding of the evolutionary history of this clade.

One hotspot for this diversity is the Wealden Group exposure on the Isle of Wight, which spans the Hauterivian–Barremian boundary (Wessex Formation) into the early Aptian (Vectis Formation). The island’s history dates back to the earliest days of dinosaur discovery when the Reverend William Fox, a prolific collector, called them his ‘dragons’. Alongside the iconic *Mantellisaurus atherfieldensis*, likely Aptian in age, several Barremian taxa have recently been described, including *Brighstoneus simmondsi*, *Comptonatus chasei*, and *Istiorachis macarthurae*. It remains unclear whether these taxa were broadly coeval or represent successive faunal assemblages reflecting vertical replacement through time.

Here we reassess the specimen OUMNH PAL-K.40631, housed at the Oxford University Museum of Natural History. This specimen was discovered by William Blows in the 1970s near Hanover Point and was previously referred informally to *Mantellisaurus atherfieldensis*. Stratigraphically, the specimen derives from deposits close to the Hauterivian–Barremian transition, making it among the oldest iguanodontian specimens currently known from the Wessex Formation exposed on the Isle of Wight.

Detailed re-examination reveals that OUMNH PAL-K.40631 possesses a unique combination of anatomical characters indicating that it represents a previously unrecognized taxon. Preliminary phylogenetic analyses place this specimen closer to other European iguanodontians than to its British counterparts. This result supports the hypothesis of temporal segregation and vertical faunal replacement within iguanodontian assemblages of the Lower Cretaceous Wealden Group.

Keywords: Dinosauria, Ornithischia, Systematics, Diversity, Cretaceous

Acanthodian dental diversity seen in erratic boulders of the Netherlands

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Extant chondrichthyans are characterized by a cartilaginous skeleton with tessellated calcified cartilage and highly diverse ecological feeding adaptations. Crown-chondrichthyans shed their teeth, whereas stem-chondrichthyans retain their teeth without shedding in tooth whorls and jaw bones with toothrows. A high disparity is indicated by well-preserved acanthodians from the MOTH locality (Blais, 2017) and tooth addition is evident from histologically well-preserved material (Rücklin et al., 2021). Silurian ischnacanthid acanthodian isolated remains are described from erratic boulders of the Netherlands (Vergoossen, 1993) using destructive sampling. To avoid destructive sectioning and fragmentation of elements we are using microCT scanning.

Preliminary studies reveal a variation of crushing dentitions with jaws showing lateral conical dentition and lingually triangular teeth. Tissue types in the lateral tooth row are x-ray dense indicating dentine and a hypermineralized superficial layer whereas lingual teeth show a less x-ray dense superficial layer interpreted as less mineralized. Additional material comprises teeth with ridges and the same less x-ray dense superficial layer and dentitions with lingually added odontodes. Similarities of the triangular dentition to a jaw with “*Acrodus*-like” teeth from Selenogradsk, Russia (Gross, 1947), and the ridged teeth unknown so far indicate new dental morphologies and new taxa, whereas other elements resemble *Nostolepis* and *Gomphonchus*.

Stem chondrichthyan dentitions from erratic boulders of the Netherlands therefore indicate a high disparity and diversity in the Silurian undescribed so far. Preliminary microCT data indicates a variation of tissue types. This opens new possibilities studying erratic boulders with microCT scanning avoiding destructive acid preparation and histological methods and opens discussions on early dental development and feeding adaptations in early jawed vertebrates.

References:

- Blais S.A. (2017). Precise occlusion and trophic niche differentiation indicate specialized feeding in Early Devonian jawed vertebrates. *Facets*, 2: 513–530.
- Gross, W. (1947). Die Agnathen und Acanthodier des obersilurischen Beyrichienkalks. *Palaeontographica Abteilung A*, 109: 91–158.
- Rücklin M., King B., Cunningham J.A., Johanson Z., Marone F., Donoghue P.C.J. (2021). Acanthodian dental development and the origin of gnathostome dentitions. *Nature Ecology and Evolution*, 5: 919–926.
- Vergoossen J.M.J. (1993). Viskaken in noordelijke Siluro-Devonische sedimentaire zwerfstenen: een oproep to vondstmeldingen. *Grondboor & Hamer*, 47: 108–112.

Keywords: Acanthodian, Vertebrates, Diversity, MicroCT, ErraticBoulders

Palynological insights from a Dinosaur *Fossil-Lagerstätte* (Villaggio del Pescatore, Northeastern Italy)

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The site of Villaggio del Pescatore represents one of the most important Upper Cretaceous fossil localities of the Tethyan area, documenting a diverse terrestrial and coastal settings, concentrated in a restricted lens of finely laminated rhythmites that preserves a diverse vertebrate assemblage, including, among others, several specimens of the hadrosauroid dinosaur *Tethyshadros insularis*. In this exceptional context of high preservation, we describe and characterize the palynological assemblages. Paleoenvironmental and paleoceanographic interpretation are carried out based on the association of dinocysts and UV-fluorescence analyses. The palynological assemblage from Villaggio del Pescatore is characterized by an allochthonous fraction, mainly represented by bisaccate pollen and trilete spore (e.g. *Appendicisporites* sp. and *Cyathidites* sp.) and the autochthonous fraction composed of heterotrophic peridinioid dinoflagellate cysts such as *Palaeoperidinium cretaceum*, *P. pyrophorum* and *Subtilisphaera* sp., and autotrophic gonyaulacoid such as *Coronifera oceanica*, *Cribroperidinium orthoceras*, *Oligosphaeridium pulcherrimum* and *Spiniferites* spp. Ceratioid dinocysts, including *Odontochitina operculata*, *Odontochitina* cf. *costata* and *Xenascus* sp., are particularly abundant. The occurrence of marker palynomorphs, such as *Cribroperidinium cooksoniae* and *Cribroperidinium orthoceras*, supports a Late Cretaceous (?Campanian) age of the site. The recovery of relatively high amounts of peridinioid and ceratioid dinocysts may indicate a productivity-enhanced marginal marine environment, while the high abundance of non-fluorescent amorphous organic matter may be interpreted as evidence of seasonal continental input. The combination of these results provides new paleoenvironmental constraints for understanding the conditions that characterized this important Italian fossil site.

Keywords: Late Cretaceous, Villaggio del Pescatore, *Fossil-Lagerstätte*, Dinocysts

Man and bears - preliminary results from fossil bear research at the paleolithic sites of Čertova pec Cave and Veľká ružínska jaskyňa Cave

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As a part of the interdisciplinary scientific project INTERCAVE, bear fossils from two caves with documented presence of ancient man are being studied. The Čertova pec Cave near Radošina in Považský Inovec Mts. (240m a.s.l.) is situated in western Slovakia, whereas the Veľká ružínska jaskyňa Cave is located in eastern Slovakia near Malá Lodina in Čierna Hora Mts. (614m a.s.l.).

The bear fossil remains from the first cave, previously studied by Hokr (1951) and Musil (1996) are currently under the revision. The majority finds belong to cave bears (*Ursus* ex gr. *spelaeus*) from the Last Glacial, which is also confirmed by radiocarbon data and supported by isotopic analyses ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$). A smaller portion of the revised material belongs to the arctoid bear, previously assigned by Musil to *U. cf. taubachensis*. However, based on the current level of revisory research, it would be more appropriate to designate them only as *U. ex gr. arctos*. From a taphonomic point of view, finds of ribs and long bones often show traces of the activity of biotic agents, such as cave hyenas, although the activity of other predators or humans is also not completely excluded.

The current archaeological research of the Veľká ružínska jaskyňa Cave yielded also bear remains from Pleistocene and Holocene deposits, belonging to cave (*Ursus* ex gr. *spelaeus*) and brown (*Ursus arctos*) bears. So far, more than 570 bear finds from at least 11 individuals (based on the record of m1 sin.) are preliminary dated to the Last Glacial (> 26 ka BP) and the Holocene (< 6 ka BP). In cave bear finds, the microstructure of dental cementum was analyzed to estimate age-at-death, along with pilot geochemical analysis of dental tissues using a CAMECA SXFiveTACTIS electron microprobe for the purpose of non-destructive chemical characterization of cementum and dentine. In connection with the discovery of a Paleolithic bone point, the hunting of cave bears is also not ruled out. The hunting of brown bears during the Mesolithic was already proven in 1990 from the nearby Medvedia jaskyňa Cave near Ružín (Ambros, 1990; Allard, 2025).

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References:

- Allard, P., Hromadová, B., Nemergut, A., Klaric, L. (2025). Slotted osseous points and pressure flaking technique for bladelet production in the Mesolithic in eastern Slovakia (Medvedia Cave, Ružín). *Bulletin de la Société préhistorique française*, 122(3): 389–404.
- Ambros, C. (1990). Osteologické nálezy z Medvedej jaskyne pri Ružíne. *Slovenská archeológia* 38(1): 31–38.
- Hokr, Z. (1951). Výsledky paleoosteologických výzkumů v ČSR za rok 1950. *Věstník Ústředního ústavu geologického*, 26: 35–38.
- Musil, R. (1996). Čertova pec a její fauna. *Slovenský kras*, 34: 5–56.

Keywords: *Ursus*, *Homo*, Paleolithic, Pleistocene, Holocene, Slovakia

Abstract (Oral communication)
Symposium: S8

Unsuspected diversity and ghost lineages in the fossil record of Cenozoic neotropical fishes

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To understand the evolution of the diverse freshwater fish fauna of Greater Amazonia, the fossil record is paramount. Our fieldwork, combining surface collecting, screenwashing, and the study of existing microvertebrate concentrations in collections, has yielded thousands of new samples from Neogene intervals in Colombia, Peru and Venezuela. The new data (e.g., 455 fossils of Lepidosirenidae) allow us to assess the systematic affinities and chronological context of diverse groups. Non-invasive imaging, paleohistology and morphometrics bring novel taxonomic markers that support robust assignments. The data reveal evidence of local extinctions, including fossils of clades now extinct west of the Andes (e.g., lungfishes). New fossils document unsuspected survival of species-poor clades, such as in vertebrae of Middle Miocene bowfins, a group previously last recorded in South America from Cretaceous marine units. A new, extinct form of holostean fish is represented by frontal and other cranial bones with well-characterized histology and internal anatomy. Morphometric analyses of tooth plates and selected cranial bones (dermal ethmoid, pterygoid and prearticular) provide strong evidence for a new extinct lepidosirenid and support the validity of two lungfish species inhabiting the Amazon and the Paraná Basins. Fossil evidence of bonytongues (Osteoglossiformes) is extensive and indicates a broader geographic distribution of some apex predators. The study of otoliths reveals the first fossil record of diverse cichlids. Comparative osteological studies of extant faunas, together with detailed documentation of even fragmentary fossils, allow us to reassess long-standing hypotheses on the Neotropics as both a cradle and a museum of diversity in Cenozoic fishes.

Keywords: Neotropics, Taxonomy, Amiiformes, Lungfish, Fieldwork

Serpulid bioconstructions as proxies of pre-evaporitic stress: insights from the Upper Miocene of SE Sicily

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A serpulid-dominated bioconstruction from the Upper Miocene Monte Carrubba Formation (Faro Santa Croce, SE Sicily) provides new insights into Mediterranean shallow-marine ecosystems during the pre-evaporitic phase of the Messinian Salinity Crisis. The lens-shaped build-up consists of a bafflestone-type 3D-framework formed by a dense aggregation of *Spirobranchus* tubes.

Serpulids act as primary builders forming a solid framework further stabilized by autochthonous micrite mediated by microbial metabolic activity. This architecture records pulsed colonization under variable environmental conditions, in which successive generations of gregarious serpulids trapped fine sediment and created cryptic microhabitats.

The build-up developed at the transition from coral–algal reefs to restricted shallow-water settings, recording a shift from fully marine to increasingly stressed conditions. Its position above an erosional surface and below oolitic shoals indicates development during environmental instability associated with relative sea-level oscillations.

Morphological and geochemical data reveal a relationship among framework growth, sediment trapping, and *in situ* micrite formation, with oxygenated open cavities accumulating detrital micrite and sheltered cavities hosting organic-rich micrite produced by heterotrophic bacteria in localized reducing niches.

The near-monospecific composition points to ecological filtering under fluctuating salinity, nutrients, and hydrodynamic regimes. In this context, *Spirobranchus* proliferation represents a signal of pre-evaporitic stress linked to the progressive restriction of circulation prior to the Messinian Salinity Crisis.

This bioconstruction records a transitional stage in Late Miocene carbonate systems and emphasizes the role of serpulid build-ups as proxy of environmental change in marginal marine ecosystems.

Keywords: Cenozoic, Mediterranean Basin, Paleoecology, Late Miocene, Pre-evaporitic phase

Comparison of mollusc living-dead assemblages: a case study from the northern Tyrrhenian Sea

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The comparison of dead shelly macrofauna ("dead assemblage", DA) with the living counterpart ("living assemblage", LA) can help in evaluating ecological shifts in marine ecosystems. Our study area is situated off the northern Tyrrhenian coast (Tuscany, Italy), between the mouth of the Arno River and one of its overflow channels, next to the town of Livorno. Samples were collected from seven stations, from 2.5 to 57 meters depth, along the pipeline connecting a floating regasification unit to the coast. DAs were collected in 2022 (2 replicates per sample) LAs comprise a time series from 2013 to 2022 (4 replicates per samples), allowing for a broader view of changes in the living benthic community.

Ordination analysis (nMDS) shows that samples are organized along a depth gradient and also shows a clear division between the LAs and DAs, pointing to differences in the faunal composition. In the DAs, at shallower (-2,5 to -5 m) and intermediate (-11,5 to -17 m) depths, herbivores are the second most abundant category of mollusks after suspension feeders. Gastropods of the genus *Bittium* (epiphytic grazers, often associated with *Posidonia oceanica* meadows) dominate in abundance. In the LAs instead, herbivores are absent, and deposit feeders are the second most abundant category after the suspension feeders. At the deeper stations (-35 to -57 m), overall, the LAs have a higher proportion of deposit feeders and chemosynthetic bivalves than the DAs.

The results suggest that, unlike in the past, present conditions at shallow and intermediate depths do not favour the development of vegetated soft bottoms. At deeper depths, however, we observe a progressive organic enrichment of the environment instead. The influx of organic matter and suspended sediment from the Arno River and its overflow channel may have caused such changes in historical times. Absolute dating of the DAs' shells would help to frame this process temporarily.

Keywords: Conservation paleobiology, Benthic marine mollusks, *Posidonia oceanica*, Taphonomy

Abstract (Oral communication)

Symposium: S4

When high live-dead agreement reflects sedimentary memory loss: molluscan assemblages along an acidification gradient off Panarea, Italy

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Marine ecosystems face increasing anthropogenic stressors, but ecological monitoring often lacks pre-impact data. Conservation paleobiology compares living communities with (sub-)fossil records to fill this gap, although acidified environments can hinder skeletal preservation, reducing the capacity of death assemblages to archive baselines. We explore this issue in the CO₂ vent off Panarea Island, Italy, as an analog for future ocean acidification. Molluscan live assemblages and associated death assemblages were analyzed using a 35 m transect along an acidification gradient. The transect included a vent-distal control site dominated by *Posidonia oceanica* seagrass, intermediate sites covered by *P. oceanica* and the alga *Ericaria brachycarpa*, and the vent-proximal, acidified sites, with unvegetated or microalgae-covered bottoms. Fourteen samples collected in 2024 and 2025 were used to assess environmental changes, α - and β -diversity trends, faunal density, and body-size trends. Both live and dead assemblages record a coherent faunal turnover along the transect, with the first Detrended Correspondence Analysis axis scores showing strong co-variation with pH and habitat type. In addition, standardized alpha diversity declined toward the vent, whereas the beta diversity was high across the entire gradient and mainly represented species turnover rather than nestedness, indicating that acidified sites are not merely simplified versions of the control but are compositionally distinct assemblages. Toward the vent, more tolerant taxa such as the small gastropod *Alvania acida* dominated. Shell size also decreased toward the vent. This decline likely reflects increasingly acidic conditions (Garilli et al., 2015) and taxonomic turnover, with small-sized species becoming increasingly dominant. Death assemblages retained the main ecological signal of the living communities, suggesting that the subfossil record can detect the direction of biological change. However, the number of shells per sample sharply decreased toward the vent, consistent with the reduced residence time of carbonate remains in acidified coarse-grained bottoms. Thus, acidification simultaneously restructures benthic communities and shortens the temporal window preserved in the upper sedimentary archive. The Panarea case study highlights a key challenge for conservation paleobiology: under acidified conditions (pH <7.9), dead assemblages may remain informative about recent living communities but become less reliable as pre-impact baselines. Ocean acidification not only alters marine biodiversity but also prevents the formation of the extensively time-averaged fossil assemblages that can archive the long-term history of local ecosystems.

References:

Garilli, V. et al., 2015. Physiological advantages of dwarfing in surviving extinctions in high-CO₂ oceans. *Nat Clim Chang*, 5: 678–682.

Keywords: Conservation paleobiology, Ocean acidification, Historical baselines, Diversity, Hydrothermal vents

Jadersdorf biota – an emerging Middle Triassic ‘Monte San Giorgio-type’ vertebrate Lagerstätte in southern Carinthia, Austria

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Vertebrate fossils from the Gailtal Alps of Carinthia, Austria, are known already since the mid-part of the 20th century. The first extinct reptile from the region was identified as a pachypleurosaur, small marine reptiles that flourished in the Middle Triassic as exemplified by hundreds of specimens of different species described from the UNESCO World Heritage site of Monte San Giorgio, Switzerland/Italy. The Carinthian finds were described from the localities Kellerberg, Silbergraben and Jadersdorf and were generally assignable to Eosauropterygia, whereas placodonts are presented so far only by a single tooth. It is only with the renewed collections efforts of few resident amateur paleontologists (incl. co-authors KW & GK), that since 2015 a more diverse vertebrate and invertebrate fauna became unearthed from the Jadersdorf locality. The bituminous limestone succession of Ladinian age yielded so far 10s of specimens of the small pachypleurosaur *Neusticosaurus* and a few larger nothosaurids described as *Carinthiasaurus kandutschii* (Klein et al. 2025), and one fossil of the archosauromorph *Macrocnemus*. While these specimens are often articulated and complete, one fragmentary rauisuchian skeleton was also unearthed. The reptile fauna is supplemented by various bony fish fossils including the taxa *Saurichthys*, *Birgeria*, and yet to be determinate smaller species, a new coelacanth, shrimp-like arthropods, and plant remains. While most faunal components need to be studied in detail, it is already apparent that there are many faunal similarities with the Monte San Giorgio locality, but also that there are some new taxa discovered. These faunal fluctuations are likely linked to restricted basins morphology in the Middle Triassic carbonate platform at the northwestern Paleotethys margin.

References:

Klein N., Furrer H., Dojen C., Lukeneder A. & Scheyer T.M. (2025). A new nothosaurid taxon from the Middle Triassic of Carinthia, Austria. *Austrian Journal of Earth Sciences*, 118: 141–155.

Keywords: Triassic, Sauropterygia, Pachypleurosauria, Nothosauria, Ecosystem

Reconstructing Sensory Ecology in Temnospondyli: Insights from the Osteological Correlates of Eyes and Lateral Lines

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Sensory systems in fossil vertebrates are inherently difficult to reconstruct because of the lack of soft tissue sense organs, yet certain osteological correlates provide robust proxies for sensory perception. In temnospondyls, the lateral line system, the scleral ossicle ring and overall orbit morphology represent such structures that can provide insights into ecology and lifestyle. The lateral line system is a mechanosensory structure found in fishes and aquatic early tetrapods and amphibians. It consists of neuromasts that may be located on the skin surface or be housed in sulci or canals within dermal bones and scales. Variation in sulcus and canal morphology in bony fishes, including width, depth, and course, has been linked to differences in hydrodynamic sensitivity, and is associated with ecological factors such as prey detection, predator avoidance and habitat use. Comparative studies of extant taxa suggest that the diversity of lateral line morphology observed in fossil forms is the result of a combination of functional demands and morphological variability. Similarly, the scleral ossicle ring, composed of a series of small dermal bones embedded within the sclera of the orbit, plays a role in maintaining the shape of the eyeball and in accommodation. The scleral ossicle ring and orbit are particularly reliable proxies for visual capacity because key eyeball parameters, including axial length and lens diameter, scale predictably with these bony structures. Consequently, variation in orbit size and scleral ossicle ring morphology can be used to infer differences in visual performance and environmental adaptation. This study aims to reconstruct sensory adaptations in Temnospondyli by integrating lateral line system morphology with scleral ossicle ring and orbit characteristics to assess how phylogeny and ecological factors (e.g. habitat) influenced the relative investment in vision and lateral line perception and their interaction with each other.

Keywords: Vertebrata, Tetrapoda, Temnospondyli, Morphology, Sensory systems

Palynology of the Siles Section, Jaén, Andalusia, Spain

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Triassic sediments in the Betic Cordillera were deposited unconformably over the Paleozoic Variscan Massif, marking the onset of a sedimentary cycle that continued until the Miocene. Later, the Alpine orogeny gave rise to an extensive but highly complex outcrop pattern. Several zones and domains can be distinguished within the Betic Cordillera, reflecting the diverse depositional history of the Triassic.

The External Zone represents a fold-and-thrust belt composed of sediments deposited along the South Iberian paleomargin, corresponding to the southeastern edge of the Variscan Massif. Within this zone, two main tectonostratigraphic domains are recognized: the Prebetic and the Subbetic. The Prebetic Domain records deposition in more proximal, shallow, and locally continental environments, whereas the Subbetic Domain reflects more distal marine settings.

The Triassic lithostratigraphy of the External Zone mainly consists of units corresponding to Muschelkalk and Keuper facies. In the Prebetic Domain, Muschelkalk facies are represented by thin-bedded limestones with marly and nodular intercalations, forming a stratigraphic succession approximately 35 m thick (Siles Formation). In this study, we present the palynological analysis of the Siles section, located in Jaén Province (Andalusia, Spain), where bivalve and ammonoid assemblages have been previously described.

Palynomorphs are moderately to well preserved. The overwhelming abundance of alete bisaccate pollen suggests conifer-dominated vegetation, while spores are very scarce. Aquatic palynomorphs include marine acritarchs (*Veryhachium* spp.) and *Plaesiodyctyon mosellanium*, a chlorococcalean alga indicative of freshwater influence. The taxonomic composition points to a Ladinian to early Carnian age, slightly younger than the previously proposed. The Siles section, therefore, provides an excellent opportunity to calibrate palynological data using ages based on ammonoid assemblage, a correlation that has not yet been thoroughly explored.

Keywords: Triassic, Palynology, Spain

Abstract (Oral communication)

Symposium: S2

A framework for species delimitation in fossil gastropods using machine learning

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How many species are actually present in a fossil assemblage? This is a classic question in paleontology and is not always straightforward to answer. Taxonomists regularly interpret morphological variation in quite different ways, depending on how narrowly they draw species boundaries. This study presents a framework that applies artificial intelligence and machine learning to the problem of species delimitation in fossils, exemplified by a case study on freshwater gastropods of the family Viviparidae from the Plio–Pleistocene paleo-lake Slavonia in southeastern Europe. Using photos from a related extant species flock as a reference set, neural networks learn patterns of biological variation, which are then transferred to fossil specimens through domain transfer. The resulting representation is explored by clustering and interpreted together with additional morphological and stratigraphic information, to evaluate whether the observed variation is better understood as a few broader groups or as several more narrowly defined ones. The first results suggest that this is a promising framework for examining variation in fossil assemblages. By combining learned representations with morphological and stratigraphic information, the proposed framework makes patterns of morphological similarity easier to identify and compare. At the same time, the results highlight the importance of data quantity and quality, as well as careful parameter choice and weighting, in shaping the resulting groups and their taxonomic interpretation.

Keywords: Species delimitation, Morphological variation, Machine learning, Artificial intelligence, Domain transfer

Abstract (Oral communication)

Symposium: S9

Carbon and Oxygen Isotope Trends of Upper Toarcian to Lower Aalenian Belemnite Rostra from the Mistelgau Clay Pit, Franconia, Germany

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This study investigates the stable isotope geochemistry ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) of belemnite rostra collected from the Mistelgau clay pit near Bayreuth, Southern Germany. During the Upper Toarcian, the study area was situated within the subtropical epicontinental Sea of the Western Tethys shelf, which was influenced by sea level changes and complex paleoceanographic current patterns.

The analyzed material comprises of calcitic rostra collected from the entire Jurensismergel Formation and the lowermost horizons of the Opalinuston Formation. To ensure high temporal resolution, a stratigraphic sampling approach was employed, with specimens collected at 10 cm intervals. This high-resolution sampling strategy allows for the detection of subtle environmental shifts across the Toarcian-Aalenian boundary.

The precise chronostratigraphic framework for this geochemical analysis is based on the foundational research conducted during the first author's diploma thesis in 1999 (Schulbert 2001) where the stratigraphy was examined using the distribution of ammonite taxa.

The succession at Mistelgau exposes a continuous sequence of argillaceous and marly facies, favoring a good preservation of the belemnite rostra. By utilizing the $\delta^{18}\text{O}$ signatures as proxies for paleotemperatures and $\delta^{13}\text{C}$ for investigating the carbon cycle, this dataset provides insights into the beginning change from the Warm to the Cold Mode of the Late Toarcian into the Early Aalenian.

While still in the phase of screening our material, the $\delta^{18}\text{O}$ data displays an approximate one permille negative excursion right at the Toarcian/Aalenian boundary which indicates a temporarily $\sim 4^\circ\text{C}$ seawater warming.

The results contribute to a deeper understanding of regional paleoenvironmental changes within the South German Basin and their correlation with global isotope trends.

References:

Schulbert, Christian. "Die Ammonitenfauna und Stratigraphie der Tongrube Mistelgau bei Bayreuth (Oberfranken)." *Berichte der Naturwissenschaftlichen Gesellschaft Bayreuth* 4 (2001): 1–183.

Keywords: Belemnites, Stable Isotopes, Toarcian-Aalenian, Paleoclimate, Mistelgau

Back to the water - mosaic evolution of the inner ear and cervical spine during the aquatic transition in carnivorans

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The return to an aquatic lifestyle is one of the most striking examples of convergent ecological transition seen repeatedly across tetrapod evolution. Such drastic ecological shifts require changes in body plan and physiology, yet the extent to which different anatomical systems are shaped by development, functional demands and evolutionary history can vary greatly. Here we use the secondarily aquatic transition of carnivorans (pinnipeds, mustelids, and ursids) as a framework for examining how multiple anatomical systems change in concert during ecological shifts. The inner ear labyrinth, involved in balance, equilibrium and the perception of body orientation in space is known to change its morphology in aquatic vertebrates and has been linked to stabilization of the neck region. However, the direct link has yet to be tested. We therefore investigate whether the cervical region and labyrinth have followed a coordinated or mosaic evolutionary trajectory across terrestrial-to-aquatic transitions in carnivorans.

We adopt a multi-element geometric morphometric approach to quantitatively characterize the craniocervical region, using CT imaging to reconstruct the inner ear labyrinths and seven cervical vertebrae of 58 extant and 4 fossil carnivorans. A novel landmark-free method was employed to capture whole-element shape variation, with each anatomical system analyzed both independently and within a consensus shape framework. Results reveal habitat-associated morphological divergence across aquatic, semi-aquatic, and terrestrial taxa, with otariids and phocids forming discrete clusters indicative of phylogenetic signal. Convergence in inner ear morphology between aquatic carnivorans and other secondarily aquatic tetrapods suggests a broadly consistent selective regime. Fossil taxa each retained distinct morphologies, highlighting the complexity of these transitions. Together, these findings advance our understanding of mosaic evolution during major ecological transitions.

Keywords: Carnivora, Geometric morphometrics, Morphology, Evolution

Abstract (Oral communication)

Symposium: S8

66 million years of evolutionary interactions in teleost fishes

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The fossil evidence of bony fishes consists of two, mostly independent data sets: articulated fish skeletons and isolated otoliths. Their preservation is the result of different types of taphonomic processes in different depositional environments. The two data sets complement each other and in combination greatly expand our knowledge of the evolutionary history of teleosts. Much progress has been achieved in expanding our knowledge of fossil fishes during the last two decades, particularly in the field of fossil otoliths. At the same time, substantial advances have been made in reconstructing past marine environments and changes thereof, based e.g., on multiple isotope analyses and different types of proxy models, plate tectonic reconstructions and complex computer modeling.

Changes over time of the geosphere, ecosphere and biosphere have greatly influenced the environment in which fishes evolved. In our presentation we discuss the influence of five specific events and phases of the last 66 Myr on the evolution and composition of marine bony fishes.

- 1.- Victims and survivors of the K/Pg boundary extinction event.
- 2.- Impact of the Paleocene-Eocene Thermal Maximum and the Early Eocene Climatic Optimum.
- 3.- Effects of the deep ocean circulation and climate changes during the Eocene-Oligocene transition.
- 4.- Impact of the Early-Middle Miocene reef bloom on the origin of modern fish communities.
- 5.- Influence of the Late Miocene-Early Pliocene biogenic bloom on oceanic fish life.

We believe that this kind of comprehensive approach offers great potential for future research.

Keywords: Teleosts, Cenozoic, Articulated skeletons, Otoliths, Evolutionary interactions

Holocene turnover of molluscan communities in the northeastern Adriatic Sea in response to post-glacial sea-level changes

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Understanding past biotic turnovers during the Holocene can reveal how modern biota responds to environmental change and inform us on the natural range of variability of ecosystems and their baseline states before the onset of anthropogenic impacts. We study ecological shifts in benthic communities in the Gulf of Trieste, a shallow (< 30m), semi-enclosed basin in the northeastern Adriatic Sea, which experienced major environmental changes during the Holocene driven by rapid sea-level rise following the last glacial.

We focus on molluscan assemblages from a sediment core collected off the coast of Koper (Slovenia) at 25.2 m water depth. Preliminary results of ¹⁴C-dating of bivalve shells revealed that the core covers the last ~7,000 years. The lower part of the core was deposited during the late transgressive phase up to the time of the maximum marine ingression, whereas the upper part represents the highstand phase after sea level stabilized. Preliminary results revealed an ecological turnover at the transition between these phases, as assemblages from the lower and upper part of the core are distinct in their taxonomic composition. We observed also shifts in relative abundances of life habits, including a decline in epifauna during the highstand phase.

The observed turnover could be related to the onset of modern circulation patterns in the northern Adriatic Sea. The modern climatic and oceanographic conditions predispose the Gulf of Trieste to the formation of hypoxic events, which could explain the decline in more vulnerable epifauna. While seasonal hypoxic events are a naturally occurring phenomenon in this region, their frequency and intensity increased due to anthropogenic eutrophication during the late 20th century. By revealing the response of marine communities to the natural environmental variability during the highstand phase in the Gulf of Trieste, this study provides a valuable baseline against which these anthropogenic impacts can be compared.

Keywords: Holocene, Mollusks, Marine, Paleoecology, Sea-level rise

Morphology, preservation and machine learning in vertebrate ichnology

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Track morphology is central in vertebrate ichnology and how we utilize a track's morphology is based on "preservation", a concept whose definition and treatment remain contested. In current usage, it carries two meanings: (i) post-formation alteration (e.g., Falkingham & Gatesy, 2026), and (ii) morphological/ anatomical fidelity and diagnostic quality as applied in ichnotaxonomy (e.g., Marchetti et al., 2019). Even where these have been formally separated into physical and morphological preservation (Marchetti et al. 2019), ichnotaxonomic practice still blends track formation with the morphological quality. This can lead to misinterpretation and obscure meaningful track variation.

A single trackmaker can produce a range of morphologies under varying behavioral and substrate conditions, generating morphotypes that may be behaviorally significant yet ichnotaxonomically ambiguous. Machine learning offers a valuable framework for addressing this challenge by integrating high-dimensional geometric information with probabilistic classification. Such approaches can enable reproducible comparison of tracks across the spectrum of preservation conditions rather than relying on discrete qualitative categories. Thus, quantifying morphological variability, separating preservational overprint from biologically meaningful signals, and standardizing identification across heterogeneous preservation states. Recent work shows that classification performance is influenced by preservation variability and improves when taphonomic information (i.e., depth information) is retained (Marques et al. 2026).

Here, we critically examine "preservation" as an ichnological concept and propose a reframing of how tracks are described and variability is treated when using data-driven approaches. These include our standard approaches, combined with probabilistic classification, that explicitly incorporates both ichnotaxonomic and preservational variation. These build on established methodology and may assist in distinguishing track morphology formed during registration from modification by subsequent processes, improving comparability and interpretability in vertebrate ichnology.

References:

- Falkingham P.L. & Gatesy S.M. (2026). Formation, preservation, and interpretation of dinosaur tracks. *Palaeontology*, 69: e70040.
- Marchetti L., Belvedere M., Voigt S., Klein H., Castanera D., Díaz-Martínez I., Marty D. & Xing L. (2019). Defining the morphological quality of fossil footprints. *Earth-Science Reviews*, 193: 109–145.
- Marques C. S., Castanera D., Belvedere B., Díaz-Martínez I., García-Cobeña J., Malafaia E., Mota, A., Pereira S., Santos V. F., Sciscio L., Dufourq E. (2026). Machine learning methods for studying bipedal dinosaur tracks: Integrating different ichnological data to strengthen paleoecology [Manuscript submitted for publication].

Keywords: Ichnology, Trace fossils, Trackway, Methods, Formation, Preservation, Digitisation, AI

Abstract (Oral communication)

Symposium: other topics

Preliminary study of the ungulate remains (Artiodactyla and Perissodactyla) from the Eocene of Mallorca (Balearic Islands, Western Mediterranean)

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The localities of Selva, Lloseta and Binissalem (Mallorca, Balearic Islands) were once mining areas where various Eocene fossils were excavated. Numerous faunal and floral assemblages were recovered from those historical coal mines. These remains originate from a lacustrine unit within the Peguera Formation, dated as Bartonian-Priabonian (upper Eocene). Despite all the research conducted, no updated systematic or taxonomic studies have been carried out on the artiodactyls and perissodactyls recovered from those localities since the 19th century. Here, we reexamine the craniodental material from the collection housed at the MUCBO | Museu Balear de Ciències Naturals (MBCN, Sóller), and confirm the presence of four mammal taxa. The artiodactyls, *Anoplotherium* and *Diplobune*, are anoplotherids that belong to the suborder Tylopoda (a group that includes modern camels). The perissodactyls, *Plagiolophus* and *Lophiotherium*, correspond to paleotherids that belong to the suborder Hippomorpha (which includes modern hippopotamuses). Preliminary studies on this fauna are beginning to provide us with insight into the faunal composition and ecosystems of Mallorca during the Eocene, potentially influenced by incipient insularity. One of the most significant findings is the distinction between the Mallorcan *Plagiolophus* and *Plagiolophus fraasi*, the species to which it was attributed in previous studies. This assemblage of mammals of different body sizes gives us an understanding of ecological interactions and potential niche partitioning within the insular context of Europe during the Eocene. These findings contribute to a better understanding of the Paleogene biodiversity and paleobiogeography in southern Europe.

Keywords: Balearic Islands, Eocene, Artiodactyla, Perissodactyla, Ecosystems

Light availability controls multi-decadal trends in crustose coralline algal cell elongation

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Crustose coralline algae (CCA) are globally distributed calcifying macroalgae that can grow as free-living rhodoliths, act as ecosystem engineers by creating complex three-dimensional habitats, and contribute to the carbon cycle. As both extant and fossil components of marine ecosystems, they provide a valuable archive for understanding algal responses to environmental change across timescales. While environmental controls on growth and geochemistry are well studied, responses of functional skeletal traits such as cell dimensions remain poorly resolved.

This study quantifies multi-decadal variability in skeletal cell dimensions of the rhodolith-forming CCA *Sporolithon nodosum* from New Zealand and evaluates the relative importance of sea surface radiation (SSR), sea surface temperature (SST), and sea surface CO₂ partial pressure (*p*CO₂) as potential drivers. The length and width of 2975 cells were measured along a 38-year transect (1985–2022) using stitched scanning electron microscope images.

Cell length declined significantly over time, whereas cell width remained stable. Among the environmental variables, SSR was the strongest predictor of cell length, while SST and *p*CO₂ explained comparatively little variance. These results identify light availability as a primary correlate of cell elongation in *S. nodosum*, consistent with a role for irradiance-driven changes in photosynthetic energy supply.

Because cell dimensions influence rhodolith structural integrity, light-driven changes may affect their function as ecosystem engineers and resilience under climatic stress. Given spatial heterogeneity in recent irradiance trends, these responses are likely to vary not only through time but also regionally. This study highlights the importance of light in shaping algal functional trait responses and demonstrates the potential of CCA to link modern observations with long-term algal–climate interactions.

Keywords: Crustose coralline algae, Rhodoliths, Functional traits, Time series analysis, Sea surface radiation

Unusual Guests at the Antena Banquet: hidden theropod diversity in the Huincul Formation

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Isolated theropod teeth are a primary source of evidence for reconstructing past faunal diversity, yet taxonomic resolution is often limited by crown incompleteness. This study analyses 43 isolated teeth (lot MMCh Pv 10) from the La Antena site, Huincul Formation (Cenomanian–early Turonian), Argentina, associated with the titanosaur *Choconsaurus* and the rebbachisaurid *Cienciargentina*. An integrated framework combining qualitative morphology and Principal Component Analysis (PCA) was applied to improve taxonomic resolution in fragmentary assemblages. To mitigate preservational constraints, multiple dataset strategies were tested. As most specimens lack the apex and base, analyses focused on consistently preserved morphometric variables of the central area of the crown, ensuring a robust and reproducible framework. The assemblage identifies eight morphotypes and three theropod clades: Abelisauridae, Megaraptora, and Dromaeosauridae. Abelisauridae dominate and likely reflect positional variation within the dental arcade. Megaraptora represent the earliest confirmed occurrence of this clade in South America and indicate dental similarities with Australian forms persisting at least until the Cenomanian–Turonian interval. Dromaeosauridae, here reported for the first time from the Huincul Formation, exhibit morphologies distinct from the typical unenlagiine condition, suggesting previously unexpected small-bodied theropod diversity. Beyond taxonomic attribution, these results indicate that fragmentary dental records may underestimate theropod diversity unless analysed through targeted, position-aware morphometric frameworks, with implications for diversity reconstructions in fragmentary fossil assemblages.

Keywords: Isolated theropods teeth, Principal Component Analysis (PCA), Abelisauridae, Megaraptora, Dromaeosauridae

Suid dispersals into the Vallès-Penedès Basin around the Aragonian/Vallesian transition

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The Vallès-Penedès Basin (VPB; NE Iberian Peninsula) is the type area of the Vallesian land mammal age, defined by the first appearance datum of hipparionins at Creu de Conill 20 (CCN20; 11.18 Ma). The faunal turnover across the Aragonian/Vallesian boundary is densely sampled and accurately dated in the VPB, owing to the Abocador de Can Mata (ACM) composite sequence (~12.6–10.9 Ma; authors' unpublished data), and several earliest Vallesian localities roughly coeval with CCN20. Suines originated in Asia during the Middle Miocene and eventually dispersed into Europe, but their oldest record is controversial. We revise the published and unpublished VPB suid remains around the Aragonian/Vallesian transition and discuss their biochronological implications. Several typically Aragonian suids (*Listriodon splendens*, '*Paracheuastochoerus*' *valentini*, and *Versoporcus steinheimensis*) persist well into the Vallesian; the first two are last recorded from Can Llobateres 1 (9.8 Ma) and the latter from Castell de Barberà (11.2 Ma). *Albanohyus pygmaeus* is replaced by *A. castellensis* at Castell de Barberà, but the timing of such replacement cannot be currently determined based on the ACM record. In contrast, no small-sized species of *Parachleuastochoerus* is recorded before the Vallesian, with its first local appearance datum corresponding to *Pa. cf. kretzoi* from CCN20 (based on recent finds). Finally, *Propotamochoerus palaeochoerus* is first recorded from ACM at 11.23 Ma, slightly before the onset of the Vallesian. Taxonomic uncertainties about *Parachleuastochoerus* spp. preclude deciphering if *Pa. kretzoi* originated from an eastern dispersal event at the onset of the Vallesian, while evidence from the VPB and elsewhere in Europe is consistent with *Pr. palaeochoerus* dispersing from Asia roughly synchronously with, or slightly before (~11.3–11.2 Ma), hipparion horses.

Keywords: Suidae, Biochronology, Faunal Turnover, Late Miocene, Spain

The Rise and Fall of the Old-World Savanna Paleobiome through Tragoportacin Bovids

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At its maximum extent, the Old-World Savanna Paleobiome (OWSP), covered most of Eurasia and Africa, forming a continuous belt of seasonal, open to semi-open habitats from India to Spain and South Africa between ~9 and 6 Ma. By the end of the Miocene, the connection between its Eurasian and African branches was severed, likely due to increasing climatic heterogeneity and regional differentiation. The contraction of these open habitats, together with reforestation in parts of Europe and Asia, led to the decline of OWSP faunas, with residual elements persisting mainly at lower latitudes.

Bovids of the *Miotragocerus–Tragoportax* complex (Tragoportacini) represent a characteristic component of the OWSP. First appearing in southern Asia during the early Late Miocene (ca. 14 Ma), this group rapidly dispersed across Eurasia and Africa. Their decline followed OWSP fragmentation, with local persistence into the latest Miocene in Myanmar and Spain and the earliest Pliocene in Ethiopia and South Africa. Therefore, the rise and fall of Tragoportacini reflect how habitat connectivity drives the expansion of widespread clades, while fragmentation constrains them and shapes their decline.

In Europe, where open habitats contracted earlier, tragoportacin bovids were progressively replaced by more derived lineages (e.g., Bovini, Caprini), better suited to increasingly heterogeneous and seasonal environments. In contrast, in lower latitudes such as Africa and South Asia, where open habitats persisted, they were gradually replaced by more specialized grazing clades (e.g., Alcelaphini, Reduncini, Hippotragini), reflecting increased ecological partitioning and the emergence of the modern savanna community.

This contrast highlights a macroevolutionary pattern: the transition from a widely connected system dominated by broadly distributed herbivores to regionally structured faunas shaped by environmental filtering in the North or increasing ecological specialization in the South.

Keywords: Biogeography, Neogene, Bovidae, Eurasia, Africa

Revisiting a classic: The visceral skeleton of the Early Jurassic chondrichthyan *Hybodus hauffianus*

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Hybodontiformes represent a major clade of extinct chondrichthyans and are regarded as the sister group to modern sharks and rays. They likely originated in the Early Carboniferous, reached peak diversity during the Jurassic, and persisted until the end of the Cretaceous. Hybodontiforms possessed variably shaped teeth and a shark-like body plan, with two dorsal fins, each supported by a prominent spine. Limited morphological change in Mesozoic hybodontiforms has been inferred but is constrained by a fossil record dominated by isolated teeth. Compounding this limitation, even taxa known from well-preserved skeletal material may remain incompletely understood and subject to alternative interpretations, as exemplified by *Hybodus hauffianus* from the Early Jurassic Posidonienschiefer Formation of Germany. While its multicuspid dentition has become better understood since its original description in 1895, its skeletal anatomy remains incompletely known, being based on only a few specimens described over a century ago. More recent work has revisited the skeletal anatomy of *H. hauffianus* but has relied largely on historical descriptions rather than direct examination of original fossil material, leading to conflicting interpretations of the visceral skeleton and the incorporation of features that likely represent taphonomic artefacts rather than genuine morphological traits. This presentation aims to clarify the visceral skeleton and jaw suspension of *H. hauffianus*. By revisiting previously unstudied and re-examined fossil material, we seek to resolve long-standing uncertainties associated with historically derived interpretations and to provide a more robust anatomical framework for the species. In doing so, we assess the taxonomic and systematic implications of our findings, contributing to a more refined understanding of its evolutionary relationships.

Keywords: Chondrichthyes, Hybodontiformes, Taxonomy, Systematics, Mesozoic

Abstract (Oral communication)

Symposium: S9

Non-random extinction restructured the bivalve tree of life during the end-Permian mass extinction: evidence from taxonomic distinctness

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Mass extinctions may redirect macroevolutionary trajectories by selective extinction, but quantitative studies that demonstrate such effects through deep time are scarce. Here we quantify changes in the structure of the taxonomic tree of bivalves in the Permian and Triassic using taxonomic distinctness, which includes the average taxonomic path length between any two randomly chosen species of a sample (AvTD) and its variance (VarTD). Bivalve AvTD was relatively high during the entire Permian and declined significantly during two successive stages to its Permian-Triassic minimum in the Olenekian. It increased thereafter but did not reach its pre-extinction level until the end of the Triassic. We assessed the question whether the end-Permian mass extinction was random or selective by two alternative extinction models to establish null expectations. In the first model (independent species extinction), extinction is fully stochastic, with species lost independently across the taxonomic tree. In the second or "fixed proportion extinction model," extinction magnitude is stable, but the identity of extinct taxa varies. Both models predict an increase in AvTD and a decrease in variation in VarTD, which is opposite of the observed pattern. We therefore reject the null hypothesis of random extinction. Post-extinction communities became taxonomically more clustered and structurally more uneven than expected, characterized by declining AvTD and increasing VarTD during the Early Triassic. Our results further reveal an ongoing increase of AvTD until the Norian, suggesting a stepwise diversification process in which recovery initially occurred within surviving genera before expanding to higher taxonomic levels. Based on TD metrics, bivalve recovery from the PTME may not have been completed until the end of the Norian, nearly 50 Myr after the crisis.

Keywords: Mass Extinction, Bivalves, Selectivity, Recovery, Taxonomic Distinctness

Ecological niche modelling of *Fagus sylvatica* L. in Italy at the Last Glacial Maximum: climatic potential and microrefugial landscapes

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European beech (*Fagus sylvatica* L.) is a key taxon for Quaternary forest history in southern Europe, where paleobotanical evidence indicates multiple glacial refugia. We assessed its Italian niche at the Last Glacial Maximum (LGM, 21 ka BP), separating climatic potential from plausible refugial landscapes. An ensemble species distribution model based on present occurrences was projected to the LGM and refined post hoc by excluding glaciated areas and retaining sectors compatible with documented refugia and dispersal. Fossil pollen records from 18–25 ka BP were used for validation. A second analysis tested whether *Fagus* L. sites were associated with a topographic warm-refugia proxy, riparian tree cover, or river proximity. The model identified 331,936 km² of climatically suitable area for *Fagus* during the LGM, compared with 185,818 km² under the present climate. However, after excluding glaciated areas and areas not connected to known refugia, the plausible refugial area decreased to 157,738 km². Topoclimatic data suggested a weak warm-refugia signal, whereas riparian corridors showed no direct association in Italy. These results suggest that LGM persistence of *F. sylvatica* in Italy was mainly linked to topographically buffered microrefugia. This is consistent with modern refugial examples: in the Euganean Hills in Italy, local topoclimatic variability sustains isolated beech populations, whereas along the Ciron River in France, in exceptional cases, riparian corridors and microtopography function as lowland climate refugia (Ogée et al., 2024). Overall, these cases highlight the key role of small, climatically buffered landscapes in species persistence and conservation.

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References:

Ogée J., Walbott M., Barbeta A., Corcket E. & Brunet Y. (2024). Decametric-scale buffering of climate extremes in forest understory within a riparian microrefugia: the key role of microtopography. *International Journal of Biometeorology*, 68: 1741–1755.

Keywords: European beech, Paleobotany, Species distribution model

Decoupling long-term climate forcing and event-scale disturbance in coralline algae skeletal archives

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Crustose coralline algae (CCA) produce annually-banded carbonate skeletons that constitute an underutilized archive of environmental variability with strong relevance for paleontological applications. We investigate the proxy potential of the CCA *Sporolithon nodosum* from northern New Zealand by integrating skeletal geochemistry with growth metrics across multiple coeval individuals. To isolate reproducible environmental signals, we apply empirical orthogonal function (EOF) analysis, a multivariate approach widely used in climate science but rarely implemented in biogenic carbonate archives. This framework allows extraction of coherent modes of covariation among elemental ratios and calcification parameters, including both established and exploratory tracers.

Two dominant modes appear. The first represents a low-frequency, persistent trend expressed as declining calcification performance coupled with systematic shifts in skeletal chemistry. This signal is consistent with progressive environmental forcing and likely reflects the integrated effects of climatic warming, ocean acidification, and changing nutrient regimes. From a paleontological perspective, this mode defines a baseline trajectory against which shorter-term variability can be evaluated. The second mode captures a discrete, high-amplitude perturbation characterized by a transient enrichment in lithogenic elements. This signal is consistent with an episodic sedimentary input, plausibly linked to volcanoclastic deposition, and attenuates through time as material redistributes within the coastal system. Such signatures provide a mechanistic analogue for recognizing event-beds and short-lived disturbances in fossil CCA frameworks.

Our results demonstrate that CCA skeletons preserve separable signals of long-term forcing and abrupt events, supporting their use as annually resolved paleoenvironmental archives and offering a pathway for improved attribution of environmental change in shallow marine carbonate systems.

Keywords: Climate change, Crustose coralline algae, Disturbance, Geochemical proxies, New Zealand

Late Triassic ichthyofaunas from the Alps: state-of-the-arts

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Late Triassic fishes have been known for over 200 years, since firstly reported from the Norian of Seefeld (Austria). Soon after, an early Carnian assemblage from Raibl (now Cave del Predil, Italy) was described. For the following 100 years, just a few finds were added until the late XX century, when the Norian *Lagerstätten* of the Zorzino Lmst. in Lombardy, and of the Forni Dolostone (Preone Fauna) in Friuli were exploited. In the meantime, the early Carnian fishes from Polzberg (Austria) were finally described. More recently, a large collection was found in the Norian Hallein site (Salzburg) and new early Norian fish sites were discovered north of Brescia (Lombardy) as well as near Pordenone (Friuli). Except for a very small early Carnian fauna from Guanling (China), all the large marine Late Triassic ichthyofaunas come from the Alps, at the time situated in the western Tethys. So far, the assemblages have been considered quite homogeneous both in the Carnian and in the Norian.

On the basis of more recent studies on Carnian faunas, we assume now that the assemblages from Raibl are quite different from the somewhat younger Polzberg assemblages. Only few genera are found in both sites (*Saurichthys*, *Thoracopterus*, *Peltopleurus*). Furthermore, while Polzberg fishes are concentrated in a thin level, the Raibl Fauna is clearly made by three different assemblages, starting from around the Ladinian/Carnian boundary.

The two early Norian fish assemblages are the least known. They are apparently quite similar, but the observation of most Lombardian material is far from being completed. The comparison among the Middle Norian ichthyofaunas is a challenging task. The richest Zorzino Fauna shows similarities, even at species level, with the Seefeld and Hallein ichthyofaunas although much poorer in taxa. The Preone fauna instead has not much in common with the Zorzino one. A remarkable number of its peculiar taxa have never been recorded in any other assemblages of similar age.

Keywords: Alps, Late Triassic, *Lagerstätten*, Ichthyofaunas

Cracking the enigma: ancient proteins reveal the identity of Early Pliocene fossil eggshells from Lanzarote

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Thick fossil avian eggshells discovered in Early Pliocene deposits on Lanzarote (Canary Islands) have long presented a taxonomic enigma. Morphological assessments have traditionally suggested affinities with ratites (Palaeognathae), specifically with Struthionidae (ostriches) and Aepyornithidae (elephant birds). However, the presence of these large flightless birds on a volcanic island, far from mainland Africa, raises a biogeographical paradox. This issue is compounded by uncertainties stemming from the parataxonomic framework employed to classify fossil ratite eggshells, based on pore morphology and thickness. The affinities suggested by these traits with Aepyornithidae conflict with their known fossil record, which is at present limited to the island of Madagascar. Such ambiguities produce interpretations that may not reflect true phylogeny, leaving the taxonomical status of the Canarian fossils unresolved.

Fossil eggshells are an excellent substrate for ancient protein preservation in timeframes such as the Early Pliocene where DNA recovery is no longer feasible. Palaeoproteomics was applied to the Lanzarote specimens and endogenous peptides were recovered. Their sequences were reconstructed and subsequently compared against a reference database of extinct and extant ratites sequences, which identified the eggshells as belonging to *Struthio*, thus resolving the taxonomic enigma surrounding the Canarian fossils. Beyond identification of the Lanzarote specimens, our data suggest that fossil eggshells morphologically resembling Aepyornithidae likely belong to an extinct stem-Struthionidae, with broader implications for our understanding of ratite diversity and dispersal across Africa and Eurasia.

Keywords: Palaeoproteomics, Fossil eggshell, Palaeognathae, Struthionidae

Functional morphology of Pleistocene and Holocene brown bears (*Ursus arctos*): a 3D geometric morphometric approach to masseter biomechanics and evolutionary ecology

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The brown bear *Ursus arctos* is currently the most widespread bear species in the world and has inhabited Europe since the Middle Pleistocene (Galdies, 2022), but its fossils are not very abundant (Villaluenga, 2009) limiting knowledge about its paleoecology. To assess its ecological adaptations, the mandibular morphology of fossil *U. arctos* was analyzed using 3D geometric morphometrics and compared to that of closely related Ursini.

Landmarks for 3D digitisation of the mandible were chosen to reflect functional morphology relating to the *musculus masseter*. Extant and extinct Ursini of the species *U. deningeri*, *U. spelaeus*, *U. arctos* and *U. maritimus* were digitised or surface scanned. Generalised Procrustes superimposition was performed on the coordinates and allometry corrected for using a regression analysis pooled by species. Principal component analysis (PCA), Canonical Variate Analysis (CVA) were conducted, and a multivariate analysis of variance (MANOVA) was performed.

PCA and CVA differentiate between species and subspecies in extant Ursini. Fossil *U. arctos* is similar to the extant Eurasian brown bear (*U. a. arctos*). The mandibular morphology of fossil brown bears from cold periods displays similarities to extant bears living in high latitude and high altitude environments, whereas the mandibular morphology of fossil brown bears from warm periods is significantly different to those from cold periods regardless of geological age. The masticatory differences between warm and cold adapted fossil brown bears, found in the present study, indicate that evolutionary flexibility may have played an important role in the survival of brown bears into the Holocene.

References:

- Galdies, J. (2022). The bears of the European steppe: A review. *Quaternaire. Revue de l'Association française pour l'étude du Quaternaire*, 33: 47–62.
- Villaluenga, A. (2009). Yacimientos del Pleistoceno superior en la Península Ibérica con presencia de restos de oso. *Munibe Antropologia-Arkeologia*, 60: 17–33.

Keywords: *Ursus arctos*, Pleistocene, Geometric morphometrics, Mandible, Functional morphology

Abstract (Poster)

Symposium: other topics

Fossil echinoids from Cuba: a hidden legacy housed at the Academy of Natural Sciences in Philadelphia.

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The Department of Invertebrate Paleontology at the Academy of Natural Sciences of Drexel University houses one of the oldest and most extensive collections in the Americas (Spamer, 1997). Among this material is a collection of echinoderms from the Antilles, largely studied and collected by Dr. P. J. Bermudez, Dr. Dorothy K. Palmer, and Dr. R. H. Palmer, whose descriptions remain unpublished (Cutress, 1980). These records represent an important contribution to the scientific community and preserve a legacy that reflects a period when national and international collaboration continued despite the historical difficulties of the time. Preliminary observations indicate the presence of taxonomic inconsistencies and potential reassignments within the studied material. In this context, we seek to clarify the taxonomic identity of these organisms after decades without continued study, revisiting the work of Palmer and collaborators, whose research contributed significantly to the understanding of the geological history of the Greater Antilles. This study presents a taxonomic update of fossil echinoids from Cuba based on the examination of specimens, archival notes, and comparisons with current taxonomic literature. It also highlights the importance of historical collections as active sources of research and promotes their integration into contemporary paleontological research studies.

Keywords: Cuba, Collections, Echinoids, Paleontology

The diversity of Late Miocene squamates in the eastern Alps: new occurrences from three understudied localities in Austria

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Miocene squamates were highly diverse in Central Europe, as exemplified by localities from e.g. the Early and Middle Miocene in southern Germany and Czechia. Austria also plays a significant role in understanding reptile faunas from this part of the Neogene, with rich localities such as Kohfidisch (MN11), which yielded about 16 different squamate taxa. In this contribution, we report previously unstudied squamate remains from three additional Austrian Late Miocene localities, Richardhof-Wald (early MN10), Schernham (late MN10), and Eichkogel (MN11), to further expand our knowledge of the herpetofaunas inhabiting this part of the Alpine area at the time. The richest locality is Schernham, with 15 taxa identified from 379 fossils: *Lacerta* sp., a second small lacertid, two indeterminate anguines, *Bavarioboa* sp., *Eryx* sp., *Falseryx* cf. *petersbuchi*, *Macrovipera* cf. *gedulyi*, "*Micrurus*" *gallicus*, cf. *Naja* sp., *Natrix* cf. *merkurensis/sansaniensis*, "*Coluber*" *dolnicensis*, "*Coluber*" *pouchetii*, *Zamenis* aff. *kohfidischi*, and potentially an additional small colubrid snake. Richardhof-Wald yielded a similar amount of remains (349), but only eight taxa: an indeterminate lacertid, a potential scincid, two indeterminate anguines, a possible natricid, the colubrid *Platycephalus planicarinatus*, and two additional indeterminate small colubrids. In Eichkogel, seven taxa were identified, based on a smaller sample (108 remains): an indeterminate lacertid, cf. *Pseudopus* sp., a second indeterminate anguine, *Natrix* cf. *rudabanyaensis*, and three indeterminate small colubrids. These localities confirm the rather high squamate diversity observed in the Austrian Late Miocene, even though only Schernham reaches numbers comparable to those of other localities such as Kohfidisch. Ongoing comparisons with the known record of Austrian Miocene squamates and new data from other peri-Alpine areas will allow in the near future to better frame the Neogene history of these reptiles in the eastern Alps.

Keywords: Neogene, Reptiles, Central Europe, Lizards, Snakes

Sharks, rays and skates in deep time: phylogeny, divergence times and rates of morphological evolution in crown elasmobranchs

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Elasmobranch fishes represent one of the most outstanding success stories in vertebrate evolution, with a fossil record spanning more than 400 million years and a remarkable capacity to survive multiple mass extinction events, including the Permian–Triassic mass extinction (~252 Ma), the most severe biotic crisis in Earth history. Only two lineages, hybodontiforms and neoselachians, thrived in its aftermath, ultimately giving rise to the extraordinary diversity of modern sharks, rays, and skates. Despite their undeniable relevance, persistent phylogenetic ambiguities still hamper our understanding of the evolutionary history of Mesozoic elasmobranchs. Here we present a comprehensive phylogenetic and macroevolutionary framework based on a newly assembled matrix of 74 taxa and 211 characters. This matrix that includes an extensive dataset, includes representatives of all neoselachians orders together with a broad outgroup comprising several Paleozoic and Mesozoic taxa. Partitioned relaxed morphological clock Bayesian inference, with tip calibrations anchored exclusively to articulated skeletal material, were used to estimate divergence times and partition-specific rates of morphological evolution considering the anatomical regions (neurocranium, visceral skeleton, appendicular skeleton and axial skeleton). Our results reveal widespread stabilizing selection across most lineages, broken by mosaic rate acceleration concentrated in specific body regions along branches associated with major ecological transitions. This demonstrates that morphological innovation in elasmobranchs is spatially and temporally localised rather than coupled to the broader pattern of taxonomic diversification across the radiation.

Keywords: Chondrichthyes, Elasmobranchii, Comparative anatomy, Cladistics, Phylogeny, Evolution

Abstract (Oral communication)

Symposium: S7

Cave bears and humans, inhabitants of the western Pyrenees caves

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During the Pleistocene, the western Pyrenees were inhabited by human groups and large mammals. In some of the 3000 cavities of the region humans and animals found refuge. Since the beginning of the 20th century, archaeological and paleontological studies have been conducted in this region. Today it is possible to reconstruct a rich paleoenvironment and understand the existence of mobility patterns across a wide territory, from the Ebro Valley to Aquitaine (Arrizabalaga et al., 2016). The abundant bear remains, along with evidence of their activity in the caves (ichnology) demonstrate a recurrent presence (Villaluenga et al., 2024). The development of the amino acid racemization (AAR) method allows us to reconstruct a precise chronological framework (Torres et al., 2014). Thanks to this line of research, it is possible to identify different sorts of sites. First, caves with purely paleontological presence, in which bears, along with other taxa (carnivores and ungulates) are the main representatives. Second, alternating occupation sites between bears, humans and carnivores and finally natural traps. Nevertheless, from the beginning of the Upper Paleolithic (>40 ka), the presence of bears and carnivores gradually decreased until their extinction around 25 ka (Villaluenga, 2016).

References:

- Arrizabalaga, A., Prieto, A., Garcia-Ibaibarriaga N., Calvo A., Dominguez Ballesteros, E., Ochoa, B., Ordoño, J., Romero A.J., Villaluenga, A., Tapia, J., Ayerdi M., Echazarreta, A., Hernández Belouqui, B., Medina M.A., Bradtmöller, M., Suarez Bilbao, A., Sarasketa Gartzia I. & Iriarte-Chiapusso, M.J. (2016). En la ruta occidental del poblamiento de la Península Ibérica. *Munibe Antropologia-Arkeologia*, 67.
- Torres, T., Ortiz, J.E., Fernández, E., Arroyo-Pardo, E., Grün, R., Pérez-González, A. (2014). Aspartic acid racemization as a dating tool for dentine: a reality. *Quaternary Geochronology*, 22, 43–56.
- Villaluenga, A. (2016). Úrsidos en medios kársticos de la Cornisa Cantábrica (País Vasco y Navarra). Estudio tafonómico de conjuntos arqueológicos y paleontológicos del Pleistoceno Superior y Holoceno. *BAR International Series*, 1–356
- Villaluenga, A; Vanara, N; Bigot, E.Y; Bramoullé, Y; Rabanit, M. & Camus, H (2024). Étude Ichnologique Des Grottes D'isturitz Et Oxocelhaya: Les Úrsides. En, Garate Maidagan, D; Rivero Vilá, O. & Normand, C.: Isturitz Et Oxocelhaya. L'art Pariétal des grottes de la colline de Gaztelu (Pays Basque). *Munibe Monographs. Anthropology and Archaeology Series*, 2: 331–343.

Keywords: Western pyrenees, Paleontology, Archaeology, Alternative occupations, AAR

Bears and humans: an approach to the interactions between cave inhabitants through ichnology

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The presence of humans, bears and other mammals (ungulates and carnivores) in caves throughout Europe has long been documented.

From the beginning of the 20th century, Prehistoric Archaeology discovered that humans not only inhabited the entrances of caves but also explored and modified their interiors by constructing structures or producing graphic evidence. The evolution of speleology has driven the exploration of large areas in various regions in search of new caves. The combination of these factors has led to the discovery of caves where evidence of both human and animal occupation coincides. While paleontological and archaeological remains found in karst environments have been studied for decades, modifications to cave walls and floors have only recently been analyzed. Ichnology offers great potential for understanding the nature of human and animal occupations and interactions within caves. Karstic systems as relatively stable environments have allowed the preservation of bedding, claw marks, and tracks. In this communication, we present preliminary data from the ichnological study of three sites where the presence of human groups and bears left a wealth of important evidence. Bruniquel cave (Tarn-et-Garonne, France), contains one of the oldest human constructions produced by Neanderthals belonging to 176,500 years ago (Jaubert et al., 2016). Cussac cave (Dordogne, France) clearly shows the links between the evidence left by the ursine presence and Gravettian (>29 ka) human occupation (Ledoux et al., 2017). Finally, Isturitz & Oxocelhaya caves (Pyrenees-Atlantiques, France). The presence of *Ursus deningeri* and *Ursus spelaeus*, as well as human groups has been documented since the Middle Pleistocene, either using the cave as a habitation- hibernation and as decorative space (Villaluenga et al., 2024).

References:

Jaubert, J., Verheyden, S., Genty, D., Soulier, M., Cheng, H., Blamart, D., Burlet, C., Camus, H., Delaby, S., Deldicque, D., Edwards, R. L., Ferrier, C., Lacrampe-Cuyaubère, F., Lévêque, F., Maksud, F., Mora, P., Muth, X., Régner, E., Rouzard, J.N. & Santos, F. (2016). Early Neanderthal constructions deep in Bruniquel Cave in southwestern France. *Nature*, 534: 111–115.

Ledoux, L., Fourment, N., Maksud, F., Delluc, M., Costamagno, S., Goutas, N., Klaric, L., Laroulandie, V., Salomon, H. & Jaubert, J. (2017). Traces of human and animal activity (TrAcs) in Cussac Cave (Le Buisson-de-Cadouin, Dordogne, France): Preliminary results and perspectives. *Quaternary International*, 430: 141–154.

Villaluenga, A; Vanara, N; Bigot, E.Y; Bramoullé, Y; Rabanit, M. & Camus, H (2024). Étude ichnologique des grottes d'Isturitz et Oxocelhaya: les úrsides. In, Garate Maidagan, D; Rivero Vilá, O. & Normand, C.: Isturitz et Oxocelhaya. L'art pariétal des grottes de la colline de Gaztelu (Pays Basque). Munibe Monographs. Anthropology and Archaeology Series, 2: 331–343.

Keywords: Paleontology, Archaeology, Ichnology, Bruniquel, Cussac, Isturitz & Oxocelhaya

Paleoecological insights into the giant deer (*Megaloceros giganteus*): the Italian Peninsula as a glacial refuge

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The Irish elk (*Megaloceros giganteus*) is an iconic cervid of the Eurasian Pleistocene megafauna. In the Italian Peninsula, its earliest occurrence is recorded at Torre in Pietra (RM; MIS 9), while the last occurrence is dated back to 17 ka cal BP at Ex Cava a Filo in the Bolognese gypsum outcrops.

The Italian Peninsula is recognized as a key glacial *refugium* for several mammal species during the Last Glacial Maximum (LGM), highlighting its importance for Late Pleistocene megafauna. Notably, this period corresponds to a gap in the European fossil record of the Irish elk, whereas evidence from Ex Cava a Filo and Cava I.E.C.M.E. (BO) indicates its persistence in Italy, supporting the hypothesis of a refugial role prior to the regional extinction of the species.

Despite a relatively rich fossil record, particularly during the Late Pleistocene of Northern Italy, the Italian Irish elk remains poorly studied. In this work, we characterize its paleoecology by investigating paleodiet at different temporal scales through dental mesowear and microwear analyses. Dental remains from several institutions, such as the Museo Civico di Storia Naturale di Milano, the Kosmos – Museo di Storia Naturale dell'Università di Pavia and the Museo della Preistoria L. Donini provide a robust dataset to infer dietary adaptations. We assess how Pleistocene paleoclimatic and paleoenvironmental changes influenced dietary variations in Italian populations and evaluate interspecific competition with other cervid species that co-occurred within the same herbivore paleocommunities. Furthermore, specimens dated to the LGM are particularly relevant to identify the main drivers of its regional extinction. Overall, this study aims to clarify the paleoecology of the Irish elk across Italian Late Pleistocene fossil assemblages.

Keywords: Irish elk, Extinction, Dental mesowear, Dental microwear, Italy

Circalittoral benthic foraminiferal and ostracod assemblages from the Gulf of Pozzuoli (Tyrrhenian Sea, Italy)

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From the analysis of 11 sediment samples collected between 45.1 and 100 m water depth in the Gulf of Pozzuoli (Tyrrhenian Sea), upper circalittoral benthic foraminiferal and ostracod assemblages were investigated to assess relationships between meiofaunal composition, abundance, diversity, and sediment contamination from industrial and residential sources. The bay has been affected by chemical pollution for over a century, and high contaminant concentrations are still preserved in the sediments, as highlighted by previous studies on the same sample set.

Some species, such as the benthic foraminifer *Nonionella turgida* and the ostracod *Cytheroma variabilis*, showed positive correlations with geoaccumulation indices, suggesting tolerance to elevated contaminant levels. However, both groups displayed high abundance and diversity, indicating that in the oligotrophic and well-oxygenated bottom waters of the central Tyrrhenian Sea, calcareous meiofaunal assemblages are mainly controlled by natural factors rather than anthropogenic pressures.

Comparison with previously investigated infralittoral assemblages (Aiello et al., 2021) provided a clear definition of taxonomic distribution across the infralittoral–circalittoral transition and improved the understanding of ecological gradients in the Gulf of Pozzuoli. This transition is marked by taxa absent above 40 m water depth, including the benthic foraminifera *Quinqueloculina viennensis* and *Q. padana*, and the ostracods *Bosquetina tarentina*, *Buntonia dertonensis*, *Henryhowella parthenopea*, *Krithe praetexta*, and *Rectobuntonia subulata*, together with an increase in the genus *Cytheropteron*, rare in shallow waters.

References:

Aiello, G., Barra, D., Parisi, R., Arienzo, M., Donadio, C., Ferrara, L., Toscanesi, M. & Trifuoggi, M. (2021). Infralittoral Ostracoda and Benthic Foraminifera of the Gulf of Pozzuoli (Tyrrhenian Sea, Italy). *Aquatic Ecology*, 55: 955–998.

Keywords: Ostracoda, Benthic Foraminifera, Shelf environment, Anthropogenic pressure, High diversity assemblages

Ammonoid ecospace occupation in the upper Sinemurian (Lower Jurassic)

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In the upper Sinemurian (Oxynotum and Raricostatum zones), ammonoid assemblages from the NW European province are predominantly composed of representatives of Echioceratidae, Oxynoticeratidae, and Eoderoceratidae. Toward the uppermost part of this interval, from the base of the Raricostatum Zone, the Sinemurian–Pliensbachian Boundary Event (SPBE) begins. This event represents a crisis episode lasting approximately one million years, linked to a negative carbon isotope excursion and a likely rapid sea-level rise, which caused the extinction of Echioceratidae and enhanced the evolutionary competitiveness of the Eoderoceratoidea.

Based on morphospace models, and building on previous studies supported by extensive taxonomic and temporal datasets, the distribution of these families within morphospace and their correspondence with theoretical ecospace are analyzed to infer ecological roles and assess their response to environmental changes associated with the SPBE.

Characterization of the ecospace occupied by these ammonoids allows the identification of the most affected ecological strategies during this event. Preliminary results indicate a negative impact on ribbed forms associated with higher drag and lower stability (Echioceratidae, serpenticone morphologies), contrasted with a relative advantage for forms exhibiting greater stability, particularly within benthic boundary layers (Eoderoceratidae, subdactilicone morphologies). Smooth forms, associated with lower drag and higher swimming efficiency (Oxynoticeratidae, oxycone morphologies) appear to be less affected.

These results provide a first approximation to the ecological reorganization associated with the ammonoid turnover at the Sinemurian–Pliensbachian boundary. Future work will expand the dataset to include lower Pliensbachian specimens in order to better constrain variations in morphospace and ecospace across this critical interval.

Keywords: Morphospace, Functional morphology, Hydromechanics, Evolution, Extinction

Arrowhead-shaped structures in late Paleozoic sedimentary rocks: Organic or inorganic origin?

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About 299 Ma old mudstones of the Pennsylvanian-Permian Remigiusberg Fm. at the Remigiusberg quarry near Kusel, Rhineland-Palatinate, SW Germany, yield enigmatic arrowhead-shaped structures of unknown origin. These structures, colloquially called arrowheads, are exclusively preserved as impressions and resemble isosceles triangles of 1–2 cm in height. The long sides of the triangles are usually sharply defined, while the bases are always blurred. A conical, longitudinally striated structure that tapers evenly toward the tip forms the central part of the arrowheads. The slender triangular wings extending laterally of the central structure lie in the same plane and display closely spaced parallel ornamentic lines forming acute angles (40–50°) with the central axis. Arrowheads are usually found in pairs, with the two isosceles triangles touching just at the tip (like an hourglass), lying in the same plane, and their central axes forming an exactly straight line. Paired arrowheads are found parallel or inclined to the bedding. They are only known from finely bedded to massive (= bioturbated) mudstone that formed on the lower slope of a very gently sloping, kilometer-wide lacustrine delta with seasonal exposure. Common associated features include root traces, macrophytic remains, bivalves, tetrapod tracks, and desiccation cracks. The consistent shape of the arrowheads (with over 50 collected specimens) and the opposing ornamentic lines exclude a tectonic origin of the structures, while the slightly varying angles and the conical central part argue against mineral deposits. If these structures are of organic origin, there is as yet no interpretation that accounts for all the observed characteristics. With this contribution, we aim to draw attention to these enigmatic structures hoping for a convincing genetic explanation by the paleontological community.

Keywords: Remigiusberg, Enigmatic structures, Arrowhead, Lacustrine delta, Unknown origin

Micro-CT assisted osteological analysis of the extant dwarf goby *Corcyrogobius* Miller 1972 (Teleostei: Percomorpha)

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The extant dwarf gobiid genus *Corcyrogobius* Miller 1972 (Teleostei: Percomorpha) is among the smallest vertebrate genera on earth. The genus comprises three cryptobenthic species that inhabit natural crevices and bivalve burrows in underwater caves. *Corcyrogobius pulcher* Kovacic *et al.* 2020, native to Senegal, has been resolved as a sister group to the more closely related *C. liechtensteini* (Kolombatović 1891) from the Mediterranean and *C. lubbocki* Miller 1988, native to the Gulf of Guinea. Historically, many extant and fossil gobiids, including *Corcyrogobius*, were assigned to the genus *Gobius* Linnaeus 1758. Their later discernment from *Gobius* and identification of its three species both relied exclusively on externally visible meristic and soft-tissue characters, such as the number, coloration and morphology of scales and the arrangement of facial sensory papillae. Such criteria are largely inapplicable to fossil material.

We integrated a paleontological approach to identify extant species using micro-CT scans. Our analyses reveal 23 previously undocumented species-identifying characters within their skeletons, supporting an alternative phylogenetic and paleobiogeographic history for the genus. These findings highlight the importance of osteological characters in resolving taxonomic relationships and offer a better reference framework for the systematic placement of gobiid fossils.

Keywords: Paleoichthyology, Micro-CT, Gobiidae, Osteology, Phylogeny

The impact of speciation mode on macroevolutionary rates through time

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Many questions in macroevolution require reliable estimates of diversification rates. The two primary sources used for estimating these rates are phylogenetic trees and fossil occurrences. Rates of species origination and extinction recovered using paleontological data are often higher than those estimated from trees. The birth-death chronospecies model shows that this discrepancy can be partly explained by differences in how each approach incorporates assumptions about speciation mode (budding, bifurcation, anagenesis). But through time, the prevalence of different speciation modes might be influenced by different biological, ecological, or geological processes. In this project, we use simulations to explore the potential impact of changes in speciation mode on estimates of origination and extinction rates, using Paleozoic ammonoids and global warming scenarios as a case study. In addition, we examine the effects of incomplete fossil sampling, incorporating aspects of Paleozoic stratigraphy into our simulation framework. Our objective is to stimulate discussion around the role of speciation mode in colouring our understanding of events over macroevolutionary timescales.

Keywords: Speciation, Origination, Mass extinction, Ammonoids

Paleogene hymenopteran insects: diversity and interactions with flowers

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Hymenopteran insects comprise well-known groups like bees, ants and wasps, as well as numerous groups that are less known to the general public. Especially bees are well-known for being important pollinators, but many other groups visit flowers to feed on nectar and pollen. In this project we study selected groups of Hymenoptera from the Eocene of Messel and the Oligocene of Enspel and compare them with their extant relatives. One focus lies on scoliid wasps (Scoliidae) which are parasitoids and generally very rare as fossils but surprisingly abundant in Messel. Among the 28 fossil scoliids from Messel, more than 70% bear pollen on or in their bodies. Stephanidae, also called crown-wasps, are another group of parasitic wasps from Messel that are being investigated. Their fossil record is also limited, and we discovered four specimens, three of which document interactions with different families of angiosperm flowers. For Enspel, a focus lies on investigating the pollen loads of fossil honey bees (*Apis henshawi*, Apidae) and comparing them with extant species of *Apis*. From both fossil sites the diversity of wood wasps (Siricidae) is studied, and a much higher paleodiversity and wider distribution is documented in comparison with the modern wood wasp fauna. This research allows unique insights into past biodiversity and insect-flower-interactions.

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Keywords: Paleodiversity, Paleoecology, Insect-plant-interactions, Insects, *Konservat-Lagerstätten*

Digitization of Fossils at the SNHM in Brunswick, Germany as part of the project DigiVerS

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The collections of Natural History Museums remain among the most important sources of information on our planet's biological diversity, both past and present. The proper cataloguing and documentation of these extensive collections is and will stay crucial for current, upcoming and future research projects and should therefore be a top priority for the relevant institutions. For this reason, the State of Lower Saxony has launched the pilot project "DigiVerS", in which its six state museums are participating. The aim of the project is to process and consolidate individual databases into a single, shared, publicly accessible database portal. Each digital record for an object will link all of its available information from any of the state museums, including provenance, cultural heritage, associated contemporary art and publications.

The focus of the State Museum of Natural History in Braunschweig (SNHM) lies on its extensive paleontological, zoological, geological and mineralogical collections, which are supplemented by the archeozoological/botanical and Quaternary paleontological collections of the palaeon Research Museum in Schöningen. Data processing and acquisition at the SNHM is carried out on a large scale, and the objects will be digitized first using the technology best suited to their primary purpose. This includes methods such as 3D laser scanning, photogrammetry, digital microscopy or SEM, enabling all important details of the digital replicas to be captured for research purposes and for educational and public outreach work. As several multiple technologies are available, objects can and are digitized using different methods. Photogrammetric models can therefore also be enriched with SEM or 3D scan data.

The SNHM wishes to use this opportunity to make its collections available to researchers who are unable to visit the museum in person and examine the objects (including type specimens and figured material), and to grant them access to as much information as possible from the outset. In the future, it may then also be possible to digitize objects on request, using methods tailored to the requirements of the requesting researcher.

Keywords: 3D-Imaging, Photogrammetry, Museum Collection, Digitization

Towards a Complete Phylogeny of the Superfamily Stromboidea

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The superfamily Stromboidea comprises 13 families (MolluscaBase, 2026). Recent molecular studies have proposed new phylogenetic hypotheses (Irwin et al., 2024), but these are limited to extant taxa, as molecular data are generally unavailable for fossil lineages. Therefore, fossil representatives must be analyzed primarily through morphology.

Approximately 2,000 stromboidean species have been described, of which only about 5% are extant (Wieneke et al., 2026). This imbalance highlights the importance of integrating paleontological data to understand their evolution.

This study identifies morphological features in extant species and evaluates their distribution to apply these insights to fossils. Similar characters within genetically related groups are interpreted as homologous and used to infer shared ancestry, while differing traits are treated as phylogenetically informative. Special attention is given to distinguishing true homology from convergent similarity.

The resulting phylogenetic hypotheses are analyzed for macroevolutionary patterns, including possible punctuated equilibrium and diversification events. The quality and completeness of the fossil record are also critically assessed and incorporated into these interpretations.

References:

Irwin, A. R., Bouchet, P., Crame, J. A., Harper, E. M., Kronenberg, G. C., Strong, E. E. & Williams, S. T. (2024). Molecular phylogenetics of the superfamily Stromboidea (Caenogastropoda): New insights from increased taxon sampling. *Zoologica Scripta*, 53(6): 818–838.

MolluscaBase (2026): MolluscaBase. Accessed at <https://www.molluscabase.org> (accessed: March 3, 2026).

Wieneke, U., Stoutjesdijk, H., Simonet, P. & Liverani, V. & Heitz, A. (2026): *Gastropoda Stromboidea*. URL: <http://www.stromboidea.de> (accessed: March 3, 2026).

Keywords: Gastropoda, Phylogeny, Stromboidea, Macroevolution

New volcanic lake *Fossil-Lagerstätten* from the Late Cretaceous of Northern Cape, South Africa

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The Late Cretaceous fossil record is scarce on the southern hemisphere and almost completely absent in Sub-Saharan Africa. A notable exception is provided by South African crater lake infills deposited above ultramafic intrusions. Since the preliminary study of Stompoor in the 1980s, it is known that the mudrocks in these pipes can contain abundant and diverse floral and faunal remains, sometimes with exceptional soft tissue and color preservation. However, an in-depth study has long been hampered by massive overburden in most pipes consisting of younger Kalahari Group sand up to 40 m thick.

Recently, a team of South African, American and German paleontologists discovered new *Fossil-Lagerstätten* on farms in Bushmansland and Namaqualand, Springbok region, Northern Cape Province. Fieldwork revealed a tantalizing plethora of fossils. Crater lake sediments associated with several pipes in the area yield not only fossil wood, but also a rich diversity of well-preserved angiosperms such as leaves, seeds, fruits, flowers, and pollen. Some pipes also yield invertebrates (ostracods, gastropods, insects) and vertebrates (fish, frogs & tadpoles, crocodilians, ornithopods & theropods). One site is a lag deposit with abundant fossil bones; most of which can be assigned to elasmarian ornithopods with affinities to *Kangnasaurus*. All specimens are curated at the Iziko South African Museum in Cape Town.

Dating the pipe deposits are ongoing efforts. Radiometric dating is difficult due to exclusively Proterozoic-age zircons within the samples. Promising pollen samples are currently being studied. Biostratigraphy of the vertebrate fossils points to a Late Cretaceous age, while other pipes with fossil plants indicate a slightly younger, early Paleocene age. The new finds have great significance not only for biostratigraphy, but also for reconstructing paleoenvironments, paleoclimate, paleocommunities, paleobiogeography and paleolandscapes in continental sub-Saharan Africa.

Keywords: Late Cretaceous, Lake deposits, Angiosperms, Dinosaurs, Paleoenvironment

Paleoichthyological Discoveries in the Tethyan Himalaya Region of the Mesozoic era

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With the 'conveyor belt'-like paleogeographic evolution of the Tethys Ocean and its associated continental blocks, the Tethyan Himalaya region drifted from the Southern Hemisphere to its present-day position. This region preserves critical information on the diversity of marine vertebrates in the mid- to high-latitude Tethyan ocean of the Southern Hemisphere from the Late Paleozoic to the end of the Mesozoic, particularly after the end-Permian mass extinction. It holds special significance for reconstructing marine ecosystem evolution before and after major geological and environmental events, comparing global marine faunas in the context of Tethyan evolution, and understanding latitudinal gradients in marine biodiversity.

During the Triassic, the Tethyan Himalaya region lay along the northern margin of the main Gondwana landmass. Known marine fishes from this region include the chondrichthyans *Sinohelicoprion qomolangma* (a helicoprionid), hybodont sharks, and certain lower actinopterygian fishes (*Birgeria* and *Saurichthys*). These fishes were high-level predators in the marine ecosystem of the time. Combined with available information of other marine vertebrates, the following can be inferred for the Triassic fishes from the Tethyan Himalaya:

(1) Early Triassic: Eugeneodontid predators (the group to which helicoprionids belong) developed tooth sets that combined sawing and cracking functions, enabling more efficient feeding than their Paleozoic relatives. Similar eugeneodontids with comparable dentitions also occurred in South China, which occupied mid-low latitudes at that time. *Saurichthys* species were present in both regions, suggesting some faunal connection. However, due to the lack of marine reptile information, it remains unclear whether new predators such as ichthyosaurs that entered the sea in South China during the Early Triassic had already spread to high-latitude southern oceans.

(2) By the Late Triassic: A complex marine ecosystem characterized by giant ichthyosaurs and large predatory fishes was established in the Southern Hemisphere Tethyan region. This fauna shared vertebrates of the familiar or even generic level with contemporaneous mid-low latitude northern faunas, such as the Guanling biota in NW China.

During the Jurassic, most of the Tibetan region had risen above the pelagic environment, with coastal settings developed only locally. For example, in the Qamdo area in SE Tibet (Xizang), hybodont sharks, and lungfish and pycnodonts (e.g., *Tibetodus*) among the osteichthyans (bony fishes) were found. These fishes likely served as prey for contemporary dinosaurs and aquatic reptiles (e.g., marine crocodiles and plesiosaurs), and also played a role as shapers of the benthic community.

Keywords: Tethyan Himalaya, Marine fishes, Mesozoic era

The origin and early evolution of endemic snow carp (Cyprinidae, Schizothoracinae) in the Qinghai-Tibet Plateau

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Understanding the evolutionary history of the endemic fishes in the Cenozoic Qinghai-Tibet Plateau (QTP) contributes to revealing the processes and mechanisms behind the formation of modern East Asian freshwater fish fauna and the biodiversity of the plateau. Schizothoracines (snow carp) are a group of fishes endemic to the QTP, and the history of their evolution is closely associated with tectonic activities and climatic changes across the QTP. This study focuses on a rich collection of schizothoracine fossils from Oligocene deposits in the western Qaidam Basin, northeastern QTP, using a combination of morphological and phylogenetic analyses. The revised phylogenetic result based on total-evidence dating using MrBayes with the fossilized birth-death process suggest that the divergence timing of schizothoracines is remarkably congruent with the global cooling event during the Eocene-Oligocene Transition. On the other hand, we re-examined *Plesioschizothorax* from Lunpola Basin (northern Tibet), the first reported Cenozoic fossil fish from the QTP in the 1980s. New phylogenetic result suggests that *Plesioschizothorax* is the sister group to *Percocypris*, a kind of cyprinid only inhabiting Mekong River, Salween River, and Upper Yangtze River today. Our new ancestral range estimation based on the time-calibrated Bayesian phylogeny suggests an ichthyic dispersal from the central QTP to the paleo-Mekong and paleo-Salween rivers during the late Oligocene to early Miocene. This discovery provides new insights into the narratives of the history of the internal drainage system in the modern central QTP.

Keywords: Schizothorax, Qinghai-Tibet Plateau, Qaidam Basin, Fossil fish

Abstract (Oral communication)

Symposium: S17

A forgotten giant: anatomy, taphonomy, and history of a *Temnodontosaurus platyodon* skull from Dorset housed in Padua, Italy

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A large ichthyosaur skull from Dorset, England, displayed at the Museum of Nature and Humankind of the University of Padua, has been investigated for the first time. The specimen measures 151 cm in length and is three-dimensionally preserved, although it lacks the distal portion of the rostrum and exhibits significant deformation in the postorbital region. Its anatomy, taphonomy, age, and historical context were investigated. The specimen is referred to the genus *Temnodontosaurus* based on its diagnostic features, and more specifically assigned to *T. platyodon* based on its dental morphology consistent with recent descriptions. Several bivalves of the genus *Plagiostoma* associated with the skull enabled a biostratigraphic assessment, indicating an age ranging from the Hettangian to the upper Pliensbachian, with a likely origin from the Sinemurian of the Lyme Regis area. Taphonomic evidence suggests a post-mortem, headfirst impact with the seafloor. Supporting features include fracturing of the rostral bones and differential preservation between the anterior and posterior portions of the skull. The collection history of the specimen remained unclear for decades; however, recent archival research indicates that it formed part of a large private collection acquired by the University of Padua in 1925.

Keywords: Temnodontosauridae, Lower Jurassic, Nose-dive, Historical collection, Morphometry

Benthic foraminifera assemblages in the Grotta Lu Lampiune Cave (Adriatic coast of Apulia, southern Italy): environmental significance

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Marine caves are sensitive environments, influenced by the interaction between marine and terrestrial processes. Due to their biological, geological, and geomorphological peculiarities, they represent a unique habitat and biodiversity hotspots, playing a role in supporting broader marine ecosystem health and biodiversity. They are also included in the list of natural habitats of community interest to be preserved and protected (Council Directive 92/43/EEC, Habitat type 8330).

Over the last decade, increasing attention has been devoted to the study of benthic foraminifera (BF) as proxies for environmental quality in these settings, recognizing possible environmental stress induced by both natural and anthropogenic factors. In this context, we present preliminary data on benthic foraminiferal assemblages from Lu Lampiune Cave (Cape of Otranto, SE Italy), aimed at defining their distribution in terms of ecozones, considering the chemical and physical features of both cave sediments and waters.

The cave consists of two main chambers with a horseshoe-shaped plan, developed 108 meters. It opens along a rocky coast in Late Cretaceous limestones. Starting from the cave entrance, 5 sampling stations were positioned at 10 m intervals along the southern chamber. An additional station was located outside the cave and used as a reference. BF assemblages display an ecological gradient from the entrance to the inner cave. Living assemblages are dominated by hyaline (*Gavelinopsis praegeri*) and porcelaneous species (*Miliolinella subrotunda*), whereas dead assemblages show high abundance of the opportunistic *Spirillina vivipara* and of the deep-water species *Lagenammina difflugiformis*, both already found in other Mediterranean marine caves. The distribution of BF is discussed in relation to short- and long-term physico-chemical variations in sediment and water parameters, as well as to the hydrodynamic conditions.

Keywords: Benthic Foraminifera, Marine caves, Ecozones, Biomonitoring, Ecological assessment

Diving capacities of an extinct marine turtle: comparative study on bony elements of *Psephophorus polygonus* with finite elements analysis and biological implications.

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Dermochelyids differ from all other turtle families because of the unique structure of their carapace composed by thousands of ossicles of dermal origin articulated with one another, and a strong reduction of the plastron (that is only represented by a marginal ring). This configuration makes the shell both strong and flexible and it is believed that this structure allows these turtles to perform deep dives during which the shell deforms under hydrostatic pressure, returning to its original shape upon ascent (Chen et al 2015). The only living dermochelyid is *Dermochelys coriacea*, the largest existing sea turtle, capable of diving to depths of up to about 1.200 meters, more than any other existing reptile.

During the evolution of dermochelyids, the thickness and size of ossicles were progressively reduced. According to Delfino et al. (2013), the more massive structure of the ossicles observed in fossil dermochelyids such as *Psephophorus polygonus* Meyer 1846 would have resulted in a more rigid shell and a reduced diving capacity, influencing the trophic behavior. However, no experimental tests have so far been conducted to validate this hypothesis. Here, we present preliminary results from the first comparative study based on finite elements analysis (FEA) on 3D digitally modelled ossicles of *P. polygonus* and *D. coriacea*. The present study sheds new light on the physical capabilities of the fossil species and improves our understanding of the biology of *P. polygonus* and the evolutionary dynamics within the Dermochelyidae.

References:

Chen I. H; Yang W; Meyers M. A. (2015). Leatherback sea turtle shell: A tough and flexible biological design. *Acta Biomaterialia*, 28: 2–12

Delfino, M; Scheyer, T. M; Chesi, F; Fletcher, T; Gemel, R; MacDonald, S; Rabi, M; Salisbury, S. W. (2013). Gross morphology and microstructure of type locality ossicles of *Psephophorus polygonus* Meyer, 1847 (Testudines, Dermochelyidae). *Geological Magazine*, 150(05): 767–782.

Keywords: Virtual paleontology, Biomechanics, Herpetology

Abstract (Poster)

Symposium: S17

The discovery of a new dinosaur tracksite as an opportunity for the regeneration, valorization, and educational development of the peripheral urban district of San Paolo (Bari, Italy) towards a community-based strategy.

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Peripheral urban areas, geographically and socially disconnected from city centres, are often perceived as marginal and undervalued. Rehabilitation efforts in these contexts are common, yet they rarely harness the potential of local natural heritage to drive requalification. Recently, a dinosaurs tracks preserved in Mesozoic limestones was discovered in a municipal semi-natural area at the boundary between the industrial zone and the San Paolo district in Bari. At the site, calcarenite deposits referable to Pleistocene and characterized by an abundant assemblage of marine invertebrate fossil remains are also exposed; in addition, the area hosts modern plant species of conservation interest. This combination of paleontological, geological and ecological assets, located within an urban area with schools and residential buildings, offers a significant opportunity to design a project for the requalification of the area and the cultural development of the district through a community-based strategy, as already demonstrated in other contexts (Cobos et al., 2020). The first step was *in situ* cleaning and geolocation of the footprints. 3D photogrammetry was carried out on the best-preserved specimens for morphological analysis. In addition, a thematic map was produced highlighting the paleontological and naturalistic features of the site, as well as their relationship with the urban context. The present study illustrates how scientific findings can support valorization strategies. The final goal of this project is to engage institutions, schools and the wider community in order to promote civic identity and raise geocultural awareness in one of the city's most marginalized neighborhoods.

References:

Cobos, A., Alcalá, L., & Royo-Torres, R. (2020). The Dinosaur Route in El Castellar (Teruel, Spain): Palaeontology as a factor of territorial development and scientific education in a sparsely inhabited area. *Geoheritage*

Keywords: Ichnology, Education, Geoheritage

New finds of wood-associated beetle larvae

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Fossilised wood-associated insect larvae have traditionally been considered rare in the fossil record, largely due to presumed taphonomic biases and their generally small and soft-bodied nature. However, based on several years of systematic work on amber inclusions from multiple deposits, this assumption appears to be misleading. Larvae of beetles and other lineages of Holometabola are frequently overlooked or misidentified in museum collections, likely reflecting both their high morphological diversity and the challenges associated with identifying immature stages.

Here, I present a series of newly identified wood-associated beetle larvae from museum collections, with a focus on specimens preserved in Baltic and Myanmar amber. The newly documented material highlights the previously underestimated diversity of morphological characters of these larvae and their ecological roles within in-wood habitats.

Many of these larvae exhibit distinct morphological adaptations today, including specialized mouthparts, reduction of appendages, as well as presence of specialized lateral or dorsal processes. Comparable morphologies are observed in fossil specimens, allowing functional interpretations of lifestyles in ancient ecosystems.

These findings demonstrate that wood-associated larvae are more common and morphologically diverse in the fossil record than previously assumed. They further provide new insights into the structure of past wood-associated communities and contribute to our understanding of the evolutionary history of in-plant lifestyles.

Keywords: Beetle larvae, Fossil, Wood-associated, New reports

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