2nd Palaeontological Virtual Congress

May 1st–15th, 2020

Book of Abstracts

Palaeontology in the virtual era

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A new way to make science

2nd Palaeontological Virtual Congress

Book of Abstracts

Palaeontology in the virtual era

From an original idea of Vicente D. Crespo

Published by Evangelos Vlachos, Esther Manzanares, Vicente D. Crespo, Carlos Martínez-Pérez, Humberto G. Ferrón, José Luis Herráiz, Arturo Gamonal, Fernando Antonio M. Arnal, Francesc Gascó, and Paolo Citton

Layout Evangelos Vlachos

Conference logo Hugo Salais

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ISBN 978-84-09-20283-6

Presentation

After the great success of the **1st Palaeontological Virtual Congress** (**PVC**) organised in December 2018, we are back with the 2nd edition of the first Palaeontological meeting completely developed in a virtual environment. The original idea of implementing this format in our discipline was the natural consequence of the emergence of new technologies, which allow the wider range of communication possibilities. The importance of this kind of initiatives, that allow communication among peers without being physically present, is even more evident with the dramatic changes and exceptional situation that our society has been experiencing in the last few months. Within this context, the origin of the PVC represented the first attempt in palaeontology to take advantage of these new possibilities, becoming nowadays the most important international palaeontological congress developed in the net. This online meeting offers an exclusively virtual-developed environment to researchers all around the globe. The novelty of this project is its simplicity, and one of our main goals is to give international projection to the palaeontological research carried out by groups with limited economic resources; allowing to save expensive registration fees, travel, accommodation and maintenance expenses.

The soul of our congress has not changed, and that is trying to combine the benefits of traditional meetings (i.e., providing a forum for discussion, including guest lectures, field trips or the production of an abstract book) with the advantages of online platforms. These allow reaching a high number of researchers along the world, promoting the participation of palaeontologists from developing countries and providing a comprehensive forum for the exchange of ideas and discussion with specialists in the target field. This abstract book is the best evidence of the success of the initiative, whose figures are increasing edition after edition.

At the moment of publishing this abstract book, more than **363** researchers on palaeontology from **44** different nationalities, and **six** continents (Europe, Africa, North and Central America, South America, Asia, and Oceania), have taken part in this initiative. It is important to highlight the numerous contributions from South America, Africa, Asia, Middle East and Eastern European Countries strengthening our main goal of a palaeontological congress without barriers.

The **2nd PVC** is organised in four general theme sessions (**Palaeozoic**, **Mesozoic**, **Cenozoic** and **General Palaeontology**), trying to span the whole variety of potential contributions. However, taking advantage of the flexibility that virtual platforms offer, **five** specific thematic sessions, encompassing topics such as **evolution and palaeobiodiversity in islands**, **fossil insects**, **palynology**, **outreach** and an specific session for palaeontologists in their **early career Stage** to present their works in an completely friendly environment. In total, **161** contributions are compiled in this Abstract Book, including **four key-notes** presented by Dr. **Michael J. Benton** "*Identifying the drivers of macroevolution – methods and pitfalls*"; Dr. **Anne-Laure Decombeix** "*Reconstructing the biology of Palaeozoic trees*"; Dr. **James Kirkland** and Dr. **Don DeBlieux** "*Constraining the Jurassic – Cretaceous terrestrial biota: new data from Utah helps close the gap across the atlantic basin*" and Dr. **Jesús Lozano-Fernández** "*The conquest of land by arthropods*". All those contributions presented in this volume, somehow, summarize the good health and multidisciplinary nature of our science.

Finally, we would like to thank all our colleagues for organising and coordinating the different workshops. We also want to thank all the authors for submitting their contributions and the numerous reviewers that have made this volume and congress possible. We would also like to give special thanks to all Palaeontological and Geological Societies, Editorials, Museums, and Universities, that have supported this initiative.

Thank you all,

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The Organising Committee of the 2nd PVC

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Please scroll down for Table of Contents

Click on the photograph to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Keynote Presentations

M. J. Benton

School of Earth Sciences, University of Bristol, Life Sciences Building, Tyndall Avenue, Bristol, BS8 1TQ

Identifying the drivers of macroevolution — methods and pitfalls

Michael Benton was elected Fellow of the Royal Society in 2014 for his fundamental contributions to understanding the history of life, particularly biodiversity fluctuations through time. He is fascinated by the transformation of palaeobiology from a speculative subject to testable science and led one of these discoveries — how to determine the colour of dinosaurs, rated as one of the top scientific discoveries of the 2010s. He works with fossils and rocks to interpret ancient environments, especially around the end-Permian mass extinction, the greatest loss of life on Earth, some 250 million years ago. He also works with fossils to build evolutionary trees and use them to date major events and rates and patterns of evolution, so helping us understand why some groups of animals are more successful than others. He is currently working on the Triassic, the time during which life recovered from the end-Permian mass extinction and when modern ecosystems arose; this was a time of arms races between major groups, and dinosaurs won. Michael Benton has written some 400 scientific papers and more than 50 books on a broad range of palaeontological topics. He has supervised more than 70 PhD students, and was founder of the Bristol MSc in Palaeobiology, which has welcomed 400 students since its foundation, in 1996. His latest books are new editions of the standard textbooks in palaeontology, *Cowen's History of Life* (Wiley, 2019) and *Introduction to Paleobiology and the Fossil Record* (with David Harper, Wiley, 2020), as well as a presentation on the transition of palaeobiology from speculation to science over the past 30 years, *Dinosaurs Rediscovered* (Thames & Hudson, 2019, 2020).

Read more on page 15

A.-L. Decombeix

CNRS –UMR AMAP, Montpellier, France

Reconstructing the biology of Paleozoic trees

Anne-Laure Decombeix is a paleobotanist working on the systematic diversity and the biology of fossil plants. She is currently studying anatomically preserved Paleozoic plants from Europe, Australia, and Antarctica. She is especially interested by morpho-anatomical characters that provide insights into the functioning of fossil plants and allow us to reconstruct different aspects of their biology, such as their growth habit, sprouting ability, hydraulic and mechanical properties, etc. Anne-Laure received her PhD from the University of Montpellier and was a postdoctoral researcher at the University of Kansas. Since 2011, she holds a permanent C.N.R.S. Research Scientist position in the interdisciplinary department "Botany and Modelling of Plant Architecture", in Montpellier, France.

Read more on page 16

J. Lozano-Fernandez

Institute of Evolutionary Biology (CSIC-UPF), Barcelona, Spain

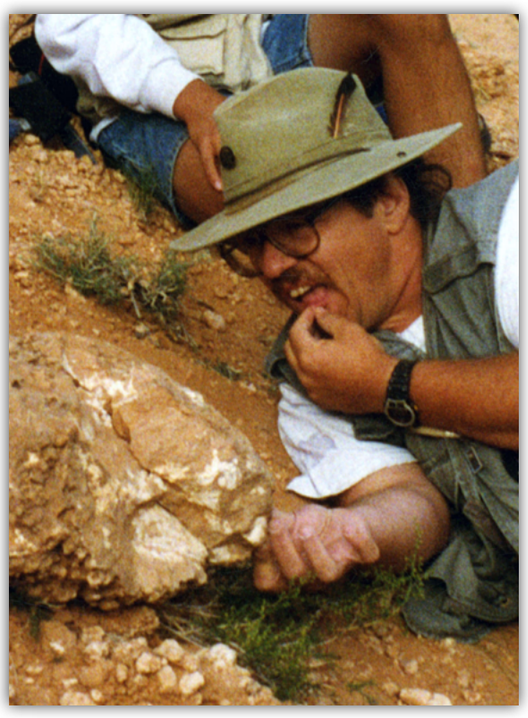
The conquest of land by arthropods

I am interested in understanding how biodiversity is generated, and how life has evolved along time. During my research career, I studied several evolutionary transitions that led to major developmental changes and had huge impact in past and present biodiversity. During my PhD carried out at the Institute of Evolutionary Biology of Barcelona I did research on the origin of insect metamorphosis, that allowed arthropods to conquer the air, using gene expression and knock-down techniques. Finishing it in 2014, I subsequently became Marie Curie Fellow at the University of Bristol and in collaboration with the Natural History Museum of London to investigate the ancient adaptations to land of arthropods using a molecular palaeobiological approach, a synoptic science where the evolutionary history of molecules and fossils are merged to understand and reliably assess the evolution. My interest on deeper nodes of the tree of life has been growing and I am currently back in Barcelona as a Beatriu de Pinós fellow investigating on the origin of animal and fungal multicellularity.

Read more on page 17

continues >

Constraining the Jurassic – Cretaceous terrestrial biota: New data from Utah helps close the gap across the Atlantic Basin



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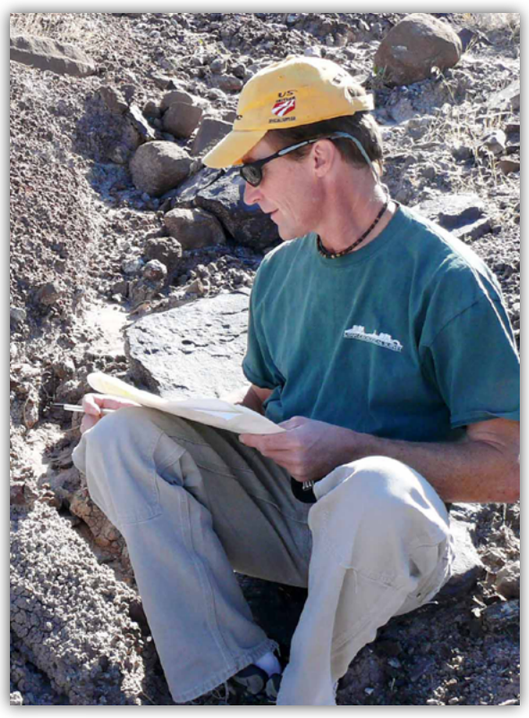
Dr. **Jim Kirkland** (born, August 24, 1954) has been the Utah State Paleontologist with the Utah Geological Survey over the past 20 years. He receives BS in Geology from New Mexico Institute of Techmology, his MS in Geology from Northern Arizona University, and his Ph. D. from the University of Colorado He issues permits for paleontological research on Utah state lands, keeps tabs on paleontological research and issues across the state, and promotes Utah's paleontological resources for the public good. An expert on the Mesozoic, he has spent more than forty-five years excavating fossils across the southwestern US and Mexico authoring and coauthoring more than 90 professional papers. The reconstruction of ancient marine and terrestrial environments, biostratigraphy, paleoecology, and mass extinctions are some of his interests. He and his team have discovered and described numerous new dinosaurs including several new armored dinosaurs including the first Jurassic ankylosaur from North America ***Mymoorapelta***, the primitive nodosaurids ***Animantarx*** and ***Europelta***, the basal ankylosaurid ***Cedarpelta***, and the most diagnostic polacanthine ankylosaur ***Gastonia***, several ornithopods such as ***Hippodraco***, ***Iguanocolossus***, ***Proa***, ***Eolambia***, ***Jeyawati***, and ***Velafrons***, and, the oldest truly horned-dinosaur ***Zuniceratops*** and the basal centrosaurine ceratopsian ***Diabloceratops***, the primitive ornithomimid ***Nedcolbertia***, the basal troodontid ***Geminiraptor***, North America's first sickle-clawed therizinosaurid ***Nothronychus*** and the most primitive therizinosauroid ***Falcarius***, a possible third North American therizinosaur or oviraptosaurid ***Martharaptor***, and the giant dromaeosaurine [raptor] ***Utahraptor*** together with recently described older and more primitive dromaeosaurine ***Yurgovuchia***. Most recently described the most primitive sauropod in North America; the turiasaur ***Mierasaurus bobyoungi***. Additionally, he has described and named many fossil mollusks and fossil fish and a skull of a large late surviving stem-mammal ***Cifelliodon*** with ties to Europe and North Africa. He notes that Grand County, Utah preserves not just the oldest Cretaceous dinosaur fauna in North America, but the two oldest dinosaur faunas. His researches in the lower and middle Cretaceous of Utah indicate that the full opening of the North Atlantic was about 115 million years ago and following 15 million years as an island continent, dated the origins of Alaska and the first great Asian-North American faunal interchange at about 100 million years ago.

Read more on page 18



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Don DeBlieux received his Masters Degree in Zoology from the University of Massachusetts at Amherst where he focused on vertebrate anatomy and paleontology. He spent 4 years as a research associate at the Duke Lemur Center working with Dr. Elwyn Simons in the Division of Fossil Primates. He has been with the Utah Geological Survey for the past 18 years where he serves as the Utah Assistant State Paleontologist. Don oversees the UGS field paleontology program and fossil preparation lab. He has authored and coauthored over 20 professional papers and helped to discover and name seven new dinosaurs and two new fossil mammals from Utah. Over the past 30 years, he has help to lead dozens of field expeditions searching for vertebrate fossils in the western U.S., Egypt, Madagascar, Namibia, and Tanzania.

Read more on page 18

Identifying the drivers of macroevolution — methods and pitfalls

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There has been a long history of 'wiggle-matching' in the Earth sciences, where empirical signals are matched either by correlation or by a linear model fitting algorithm. Linear model fitting can look convincing, but in many real examples, artefacts can generate false positives. For example, long time bins can bring peaks and troughs into apparent alignment when they are not aligned at more precise time scales. Further, of course linear model fitting will always find a convincing explanation for any time series by combining elements of whatever time series are presented.

Attempts to 'correct' data for sampling and other perceived inadequacies can generate even more confusion, as shown by published examples where the driver reverses its effect when data are massaged. It is likely that current methods are never going to provide reliable evidence of environmental drivers of macroevolution, at least on long time scales (regional-scale analyses, such as where fossil and environmental data come from a single section may be an exception).

New methods of stratigraphic estimation (e.g., **CONOP**) allow analysts to use continuous time scales of time, thus avoiding the pitfalls of time binning, and Bayesian approaches (e.g., **PyRate**, **BayesTraits**) allow uncertainties to be modelled in ways that need not subvert the results.

Macroevolution
Computation
Model-fitting
Correlation
Drivers of evolution

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Reconstructing the biology of Paleozoic trees

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The plant fossil record preserves a number of morphological and anatomical characters that, combined with our knowledge of extant plant biology, can be studied using structure-function relationships. This approach allows us to analyze the dynamics of plant diversity through a functional prism that complements classical taxonomic approaches. It makes it possible to understand fossil plants as organisms that were once alive and interacted with their environment. This approach is relevant for whole-plants but also to answer functional questions at the level of a single plant organ (e.g., stems, leaves, roots) or tissue (e.g., wood). Here, I will present results obtained on Devonian-Permian fossil trees in the last 10 years.

Some traits that are important to understand the biology of the plant are observable directly on the fossils. For example, the presence of a thick bark or of epicormic shoots that can repair the crown of the plant after a disturbance can indicate an ability to withstand stressful conditions. Interactions between plants and organisms such as fungi or insects can also be observed directly, in some cases in great detail.

More complex functional traits can also be investigated using a combination of observation and measurements on the fossils and models based on extant plants. I will present three examples of such studies focusing on **(1)** the biomechanical properties of unusual Permian roots, **(2)** the growth and amount of carbon stored in one of the oldest trees, and **(3)** the hydraulic properties of Paleozoic woods.

Paleobotany
Plant Anatomy
Modeling
Paleobiology
Paleozoic

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The conquest of land by arthropods

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Animal life has marine origin, with only few phyla completing their entire life cycle outside water. The process through which organisms adapt to life on land is known as terrestrialization, and it is one of the most extreme cases of adaptation.

Current arthropod phylogenies suggest that terrestrialization has occurred independently in the most recent commons ancestors of all extant myriapods, hexapods and arachnids. Genomic-scale analyses support the monophyly of myriapods and hexapods, but arachnid monophyly is just recovered under optimal conditions, implying a single origin of terrestrial adaptations shared by extant members of those groups.

Fossil-calibrated time trees recover Cambrian and Ordovician origins for major crow-group myriapod and arachnid lineages, coinciding with high rates of molecular and morphological evolution, and substantially predating the appearance of body fossils of these groups in the Silurian. This discrepancy may be driven by the extreme sparseness of terrestrial sediments in the rock record before the late Silurian.

The Cambrian–Ordovician trace fossil record partly fill that gap, as do amphibious stem groups present in the Cambrian. This pattern of ancient divergence estimates is mirrored in the molecular and fossil record of plants.

Arthropoda
Terrestrialization
Cambrian
Molecular dating
Diversification

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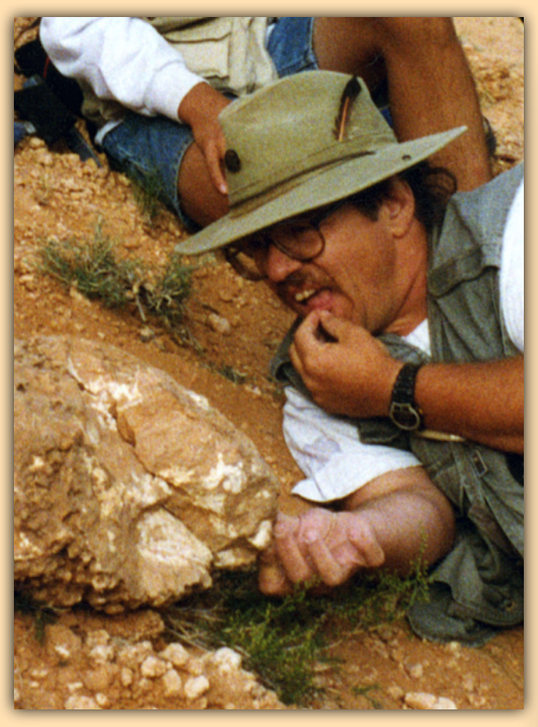
Constraining the Jurassic – Cretaceous terrestrial biota: New data from Utah helps close the gap across the Atlantic Basin



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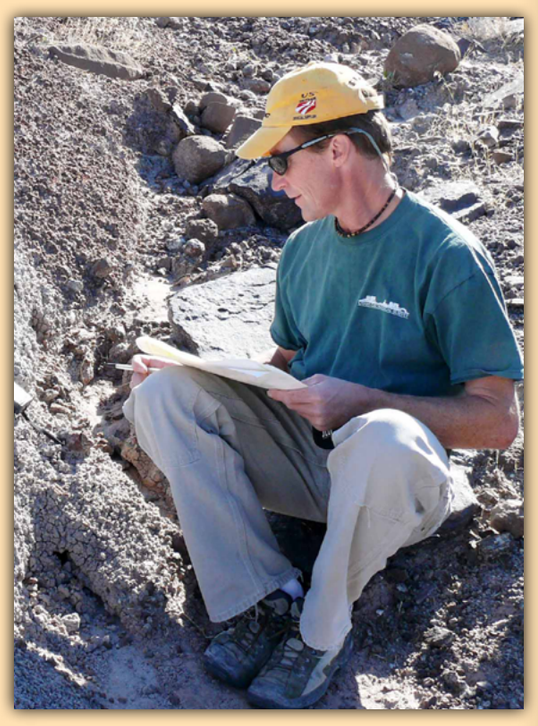

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Along the western Cordillera of North America, there is an extensive temporal gap between the Jurassic and the base of the Cretaceous (**JK** gap) spanning some 25–30 million years. Intensive field research on the terrestrial faunas in the Lower Cretaceous Cedar Mountain Formation (**CMF**) of the central Colorado Plateau of Utah has succeeded in significantly closing this gap. Along the most of the Cordillera of western North America the earliest Cretaceous fossills above the JK gap are latest Barremian – early Aptian (~125 Ma) overlying late, but not latest Jurassic Morrison Formation. The co-occurrence of ***Allosaurus***, ***Torvosaurus***, ***Ceratosaurus***, ***Supersaurus***, and ***Stegosaurus***, in Portugal support trans-Atlantic ties in the latest Jurassic. Pre-Barrimian terrestrial vertebrate fossils have only been recovered from the basal Yellow Cat Member in the Paradox Basin of Grand County Utah, where the member is divided into a lower and upper Yellow Cat by a massive multitiered paleosol. The calcrete separates two distinctive dinosaur faunas having continued biogeographic ties with Europe. Ferruginous paleosol facies (wet JK boundary interval) similar to those in the lower Yellow Cat are recognized elsewhere in Utah beneath the cliff-forming conglomerates previously used to mark the base of the Cretaceous, but only in the northern Paradox Basin are these strata thick and richly fossiliferous. Renewed salt tectonics during the Early Cretaceous caused local subsidence on either side of the Paleozoic Salt Valley anticline, which is responsible for the spectacular geological features of Arches National Park. Radiometric dating and microfossils have revised the age range of these strata to Berriasian-Valanginian

Upper Jurassic
Lower Cretaceous
Utah
Biostratigraphy
Paleobiogeography
Extinction
North Atlantic
Syndepositional tectonics

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continues >

Constraining the Jurassic – Cretaceous terrestrial biota: New data from Utah helps close the gap across the Atlantic Basin

to early Hauterivian (~140–133 Ma, based on detrital zircons), thus making these the two oldest Cretaceous terrestrial faunas in North America. The overlying Poison Strip Member has a similar Wealden "style" fauna but seems to correlate with the Lakota Formation in the Black Hills region of South Dakota. The Aptian faunal extinction markedly separates these three Wealden "style" faunas from the more endemic Aptian-Albian Cloverly "style" faunas.

A significant North American JK faunal turnover remains between the last occurrence in the Morrison Formation of ceratosaurs, basal carnosaurs (***Torvosaurus***) diplodocid and camarasaurid sauropods, and stegosaurids, and the first occurrences in the lower Yellow Cat Member of the CMF of haramiyid mammaliforms, therizinosaurs, ornithomimiforms, dromaeosaurids, turiasaur sauropods, and basal styracosternan iguanodontians. Groups that cross the JK gap include eileenontid sphenodonts, allosauroids, troodonts, titanosauroform sauropods, and polacanthid ankylosaurs. Although restricted to two dinosaurs the English Berriasian Purbeck Formation includes a heterodontosaur and camptosaur giving it a decidedly Jurassic flavor. Although new fossil taxa are still being discovered, the scale of the JK faunal turnover seems comparable to that in the Aptian, when slender-toothed titanosauriform sauropods replaced broad-toothed turiasaur and brachiosaurid sauropods, more primitive endemic tennontosaurid iguanodontids replaced basal styracosternan iguanodontians, and nodosaurine nodosaurid ankylosaurs replaced polacanthid ankylosaurs in North America. The recognition of a distinct European lineage struthiosaurine nodosaurid ankylosaurs with the description of ***Europelta*** replacing the European polacanthids with a continuation of European styracosternan iguanodontians (***Proα***) would seem to indicate that the last (if tentative) biogeographic connection between North America and Europe was in the lower Aptian.

Thematic Session:

Evolution and Palaeobiodiversity in Neogene and Quaternary Islands

The islands are natural laboratories where to study evolution live. Whether of volcanic or continental origin, flora and fauna have particular characteristics due to adaptation to the insular environment. Paleobiodiversity and its evolutionary history in the islands will depend on many factors such as its origin (volcanic or continental), size and environmental conditions among others. In this context, the study of the fossil record of the islands is of the utmost importance to understand the possible responses of organisms and ecosystems to biotic and / or abiotic changes (migrations, eruptions, sea level changes, climatic changes, etc.)

In this sense, the objective of this session is to present scientific advances in the insular field and promote the exchange of ideas and encourage interdisciplinary collaborations. For this, the 2nd Virtual Paleontological Congress is an unbeatable space for the exchange of ideas with colleagues who work in different lines of research in islands.

Organisers

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Please scroll down for Table of Contents

Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Taphonomic study, with 3D methodology,of a Holocene barn owl concentration from Tenerife (Canary Islands)

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The technique of photogrammetry is here applied to analyse the taphonomic processes undergone by a concentration of microvertebrates in Tenerife (Canary Islands, Spain). This concentration was formed in a paleobiological and geological context of active volcanic and oceanic islands. The site is located in the north of the island (Jover locality). Bone remains lie on a dune deposit. The relative abundance of the different bones and teeth from the concentration was compared to that in current pellets from barn owls, and it was ascertained that this concentration was produced by this animal. It was thought that, due to its situation, being at a hole in a wall near a ravine, which is the typical habitat of the barn owl in the Canary Islands, and since there was no organic matter, the concentration could be associated to gastric pellets. The radiometric dating performed on these bones gave a Holocene age. Currently, this fossil deposit is being affected by different biostratinomic agents (wind, rain, etc.), whose action has been analysed by comparing the 3D models of the substrate generated over several seasons (autumn, winter and spring). Among the effects observed, we can highlight the displacement and partial burial of some bone remains, and the accumulation of garbage of anthropic origin. This work contributes to the knowledge of the ancient diet of the barn owl and provided a test for the use of photogrammetry as a technique for analysing taphonomic processes in pellets concentrations.

The authors would like to thank the Fundación CajaCanarias and Fundación Bancaria “La Caixa” (2017REC20) for the support provided.

Microvertebrate concentration
Taphonomy
Photogrammetry 3D
Canary Islands

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The oldest record of the genus *Gallotia* in Tenerife (Canary Islands, Spain)

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The Canary Islands are a volcanic Atlantic archipelago with a large amount of endemisms and very fragile island ecosystems. In the current situation of climatic emergency in which the Canary archipelago finds itself, it is very important to know the response of organisms (in the form of evolutionary plasticity) to variations in their environment related to rapid climatic changes. Due to the inherent geological characteristics, volcanic ecosystems offer essential paleobiological information for understanding the response of organisms to rapid changes. In this context, we present a fossil remain (PCCRULL1194) of ***Gallotia*** preserved between two cycles of a paleosol-paleodune system at the site of Milán. PCCRULL1194 is an almost complete left dentary preserved inside a sandstone matrix. The dentition is pleurodont and heterodont. Its osteological characters would fall within the range of the giant fossil species ***G. goliath*** of Tenerife island and ***G. auaritae*** of La Palma island, the two biggest species of the genus. This fossil remnant is associated with an Ar-Ar radiometric dating of feldspar in a pumice fall deposit on the paleodune at the site of Milán, yielding a Middle Pleistocene age (Quaternary). This age makes PCCRULL1194 the oldest record of a lizard belonging to the genus ***Gallotia*** with a radiometric dating, representing a milestone in the evolution of the giant lizards in relation to environmental changes during the Quaternary through to today.

The authors thank the Fundación CajaCanarias and Fundación Bancaria “La Caixa” (2017REC20) and Gobierno de Canarias (PROID2017010136) for the support provided.

Giant lizard
Gallotiinae,
Middle Pleistocene
Paleodune
Isotopic dating

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Dental morphology of extant bats from the Canary Islands

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The Canary archipelago is situated in the Atlantic Ocean off the African coast. The archipelago is made up of eight oceanic and volcanic islands and islets. Seven species of bats are known to inhabit the archipelago: six of which belong to family Vespertilionidae (***Plecotus teneriffae, Hypsugo savii***, ***Pipistrellus maderensis***, ***Pipistrellus kuhlii***, ***Barbastella barbastellus*** and ***Nyctalus leisleri***) and one to family Molossidae (***Tadarida teniotis***). The presence of these species among the islands of the archipelago is variable, so the western islands (Tenerife, La Gomera, La Palma and El Hierro) have the greatest diversity of species, Tenerife being the island with the largest number of species (six of the seven). In comparison, the eastern islands show lower species richness, with three species in Gran Canaria and a single species in Lanzarote and Fuerteventura. In this study, we describe morphologically the teeth of 31 specimens from the different extant species of bats from the archipelago. These results allow us to differentiate them when any isolated dental remains are found associated with a paleontological or archaeological site. The identification of these fossils will increase what is known of the paleodistribution and paleobiology of this group in the Canary Islands.

The authors would like to thank the Alumni ULL program, and the Spanish Ministerio de Ciencia, Innovación y Universidades-Fundación Española para la Ciencia y la Tecnología (project FCT-17-12775) for the support provided.

Chiroptera
Dental morphology
Holocene
Canary Islands

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Palaeoenviromental reconstruction of a Neogene deposit on the island of Fuerteventura (Canary Islands) using the mollusk fauna

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The Canary Islands, a volcanic archipelago emerged in the early Miocene, facing the coasts of the Sahara. The island of Fuerteventura is geologically the oldest one, with an approximate age of 22 Ma, although it contains Jurassic oceanic sediments. The deposit of Playa del Aljibe de la Cueva, located on the northwest coast of the island, is one of the largest in lateral extension. It consists of several levels of conglomerates and sandstones, of both marine and terrestrial origin, deposited on volcanic materials from 17 Ma ago. The sedimentary sequence allows us to observe a transition from the marine environment, formed by rounded clasts and very abundant in marine gastropods (specimens of the family Hipponicidae or Trochidae mainly, like ***Rothpletzia rudista*** Rothpletz & Simonelli, 1890 and ***Oxystele rotellaris*** (Michelotti, 1847), bivalves (specimens of the family Tellinidae or Ostreidae mainly, like ***Peronaea planata*** (Linnaeus, 1758) and S***accostrea cucullata*** (Born, 1778) and rhodoliths, to levels from terrestrial environments made up of altered palaeosoils and palaeodunes with remains of terrestrial gastropods and insect ichnofossils. In general, the fossil remains are fragmented and altered by processes of partial or total dissolution of the shells and mollusk shell molds are abundant. At some levels, the presence of bioerosion is observed in the shells of mollusks and articulated bivalves in life position. This work contributes to the interpretation of the Neogene coastal environments of the Canary Islands, through the palaeoecological and palaeoenvironmental characterization of this deposit, based on its association of fossil marine mollusks.

Neogene
Fuerteventura
Canary Islands
Mollusk
Paleoecology

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Unravelling the biology of giant pikas: the case of *Prolagus* spp. from Gargano's paleoarchipelago (Late Miocene, Italy)

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The fossil insular biotas are composed by exceptional giants and dwarves. However, relatively little is known about their biological traits (body mass, life history or locomotion), especially in small mammals. In the Late Miocene – (?Early Pliocene), the extant Gargano peninsula (Italy) was part of a paleoarchipelago in the Abruzzi-Apulian paleobioprovince. Two endemic ***Prolagus*** species (Ochotonidae, Lagomorpha) dwelled there: ***P. apricenicus*** and ***P. imperialis***, whose postcranium has never been described. The first species is present in all fissure infillings, while the latter only in the youngest ones. The present study aims at shedding light on the body size and locomotion of these endemisms assessing femora (N= 241), humeri (N= 842) and tibiae (N=304) from several deposits. Epiphyseal diameters and total lengths were taken, and inferential and multivariate statistics were applied. The postcranial assessment allows to identify the first occurrence of ***P. imperialis*** in the F9 fissure, an older deposit than estimated by teeth remains. The body mass of ***P. apricenicus*** is constant over time (ca. 150–225 g), and the coexistence with a congeneric species did not entail any significant variation. ***Prolagus imperialis*** weighed around half a kilo on its first record, and experimented a drastic size increase in the youngest fissures (ca. 700–750 g). In a first approach to their locomotion, the morphology of their postcranium is linked to the non-burrowing talus-dwelling species of ***Ochotona***. These new evidences might shed light on the biology, ecology and phylogeny of ***P. apricenicus*** and ***P. imperialis***, but also on the paleoenvironment of the Gargano archipelago.

Body mass
Lagomorpha
Ochotonidae
P. apricenicus
P. imperialis

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Interspecific variation among Canary giant lizards (*Gallotia*) based on X-ray microcomputed Tomography of the mandible

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The genus ***Gallotia*** includes omnivorous lizards of small to giant size, all of them endemic to the Canary Islands. There are six giant species, four of them extant (***G. simonyi***, ***G. stehlini***, ***G. bravoana*** and ***G. intermedia***) and two extinct (***G. goliath*** and ***G. auaritae***). They are distributed naturally throughout all the islands of the archipelago except Lanzarote and Fuerteventura (in the latter, ***G. stehlini*** was introduced by human activity). The species extinctions were most probably caused by anthropic action, and three of the extant species (all except ***G. stehlini***) are seriously threatened. In this work, mandibles belonging to the six extant and fossil giant lizard species from the Canary Islands are studied. X-ray microcomputed tomography is performed, generating high-resolution 3D models of each mandibular bone. A morphological description and detailed osteological comparison has been undertaken. The main objective is to establish key features and characters in order to clarify the taxonomy of the ***Gallotia*** species. Potential interspecific diagnostic features have been identified, such as the form and direction of the retroarticular process, the presence/absence of an S-shaped crest in the coronoid and the degree of fusion between the surangular and the articulate, among others.The data obtained are the first step towards combining paleontological and biological information to perform phylogenetic analyses as well as (paleo-)ecological studies and to assess their implications for the management and conservation of the canary giant lizards.

The authors would like to thank the Gobierno de Canarias (PROID2017010136) for the support provided.

Quaternary
3D model
Gallotiinae
Lacertidae

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Fossil tortoise eggshells of the Canary Islands

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The Canary Islands are an archipelago of volcanic origin located 97 kmnorthwest of the African coast in the Atlantic Ocean. The archipelago presents an interesting fossil record of tortoises, including osteological (Tenerife and Gran Canaria islands) and oological remains (Gran Canaria, Lanzarote and Fuerteventura islands).Two extinct tortoise species haven been described: ***Geochelone burchardi*** from the Pleistocene of Tenerifeand ***Geochelone vulcanica*** from the Pliocene of Gran Canaria. Although previous microscopy studies in eggshells have confirmed their chelonian origin, little is known about the oodiversity in the islands. Using Scanning Electron Microscopy and Polarized Light Microscopy, we re-examined the eggshells from Gran Canaria island as well as new material from Lanzarote and Fuerteventura islands in order to verifying the assignment to Testudines group and determine the diversity of ootaxa within the samples. Furthermore, eggshells of the live African species ***Centrochelys sulcata*** were used as the comparative material. All the specimens show radial aragonite ultrastructure and subcylindrical tightly-packed shell units, with eggshell thickness of 390–670 µm and shell unit height/width ratio of 2/1, so they can be assigned to the oofamily ***Testudoolithidae***, oogenus ***Testudoolithus***. The eggshells also present a structure similar to ***Centrochelys (Geochelone) sulcata***, a living taxon related to the extinct tortoises that inhabited the Canary Archipelago during the Neogene and Quaternary. Small differences in eggshell thickness range and shell unit proportions can be observed between the samples from the different localities, but more data is needed to precise if one or two ***Testudoolithus*** oospecies are represented in the Canary Island fossil record.

Testudoolithidae
Lanzarote
Gran Canaria
Fuerteventura
Centrochelys (Geochelone) sulcata

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Thematic Session:

Fossil insects, their record, ecology and evolution

Palaeoentomology started in the late 18th century, shortly after the 10th edition of Linnaeus' *Systema Naturae* (the foundation of modern taxonomy), when papers on the curiosities of insects entombed in fossil resins were published. Since its beginning, palaeoentomology covered not only descriptive aspects of terrestrial arthropods (including Insecta, Chelicerata and relatives) but also reconstructions of ancient environments, ecology, evolution and phylogenies.

Over half of all described species, at least one million species worldwide, are insects. This make them one of the major ecological and evolutionary radiations on Earth. Insects evolved into a hyperdiverse lineage that currently occupies almost every ecological niche, thanks to great diversity of life forms and developmental strategies. Insects possess a surprisingly extensive fossil record, documented back more than ~410 million years ago. Nowadays, we know better their fossil record and phylogenetic relationships, our understanding of the reasons for this diversity is growing, but still is insufficient.

Despite retreat and impediment in taxonomic research, palaeoentomological papers are now flooding the journals, due to thousands of new fossils recorded in the mid-Cretaceous Burmese amber and in other fossil insects sites. However, more attention is nowadays, and should be given in future to present the fossils in wider context, with interpretation of their palaeoecological and evolutionary role and importance.

The main goal of this thematic session is to point out the needs in both descriptive (taxonomic) and interpretational (palaeoecological, evolutionary, etc.) aspects of palaeoentomological research. We wish to discuss these issues, search for the new ways of data accumulation and elaboration, finding the solutions for better understanding of ecological and (co)-evolutionary processes. We would like also discuss the ways to share and distribute the palaeoentomological data and information.

Organiser

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Please scroll down for Table of Contents

Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

New Psocodea from the Albian Spanish amber and a review of the psocids in Cretaceous ambers

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Psocodea is an insect order including the parasitic lice (Phthiraptera) and the psocids ('Psocoptera'), counting more than 10,000 living species known to date. The oldest representative dates from the Moscovian (Carboniferous), but their diversification occurs during the Cretaceous, the amber being the main source of this knowledge. Up to now, four Albian amber-bearing outcrops in the Iberian Peninsula have yielded psocids, providing information about their diversity. They are Peñacerrada (109 psocids) and El Soplao (17 psocids) from the Basque-Cantabrian Basin and San Just (8 psocids) and Ariño (6 psocids) from the Maestrazgo Basin. The Spanish record of Cretaceous psocids includes five species belonging to four fossil genera, all of them described from specimens of Peñacerrada I. Until now and considering the global record of Cretaceous psocids, 54 species in 41 fossil genera and one fossil species in one living genus have been described from amber deposits of Spain, France, Lebanon, Myanmar, Russian Federation, United States and Canada. The 52% of these species correspond to the suborder Trogiomorpha, which is the less diverse of the three psocid suborders nowadays. The knowledge of the diversity of Psocodea during the Cretaceous keeps increasing, but the information about their palaeobiology and palaeoecology is still little known. Most of the psocids from Spanish amber are waiting to be studied and here we present previously undescribed new specimens, so one of our main goals is to address their taxonomical determinations which could provide new information about the Cretaceous Psocodea.

The first author has a grant funded by the Secretary of Universities and Research of the Government of Catalonia and the European Social Fund (2019FI_B 00330). This study is a contribution to the Project CRE CGL2017-84419 (Spanish AEI/FEDER, UE).

Psocodea
Cretaceous
Amber
Iberian Peninsula
Palaeodiversity

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Taphonomy of Baltic amber inclusions

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Taphonomical studies are the background stories of fossils either in rocks or those sunk in resin ages ago. When most of the research is focused on regular fossils, taphonomical studies of ichnofossils (trace fossils), cover not only the place or cause of death, but also the history of fossils themselves, up to the day they were dug out. This information, gathered in substrate covering the specimen, can answer those questions, which are puzzling when research is focused only on the fossilised organism itself. This presentation aims to shed light on the backstory of Baltic amber, Eocene, ca. 37–48 m.y.o. from Central Europe.

In this study, quaternary deposits of Baltic amber were used, comprised of three samples of raw material, collected in the city of Gdańsk or near–Gdańsk area. Each amber piece was examined to see is there is occurrence of the ichnofossils at its surface before grinding. The next steps were grinding, cutting and polishing selected material with inclusions spotted before.

Both, ichnofossils and ichnoinclusions in the amber were studied. Faecal pellets, spider webs, silk-web nests and larval cases, with no particular ichnotaxonomical designation belong to the ichnoinclusions group. In case of the ichnofossils, three different ichnotaxa were recognized: ***Teredolites***, ***Gastrochaenolites*** and ***Petroxestes***.

Paleontological, taphonomical and palaeoecological researches can benefit from the awareness of the occurrence of ichnofossils in fossil resins. This knowledge leads to a better understanding of the past biocoenosis, preserved in those yellow-green gems.

Baltic amber
Ichnofossils
Teredolites
Gastrochaenolites
Petroxestes

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Tardigrades and the evolutions of terrestrialisation: exploring ancient questions with a poor fossil record

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The Tardigrada are a charismatic clade of Ecdysozoa, well known for their robustness and ability to resist extreme temperatures and pressures by entering a dormant 'tun' state. The evolutionary history behind the tun state, which varies across species of tardigrades, has been a source of speculation for tardigrade biologists for many years. However, the tardigrade fossil record is poor, and as such, answering questions about the natural history and evolutionary development of these organisms is often incredibly difficult.

Desiccation is one of the environmental stimuli that can initiate a tardigrade tun state, and multiple gene families associated with desiccation tolerance have been identified. As aridity is primarily a concern of terrestrial, rather than marine, organisms, it should be expected that an increase in the number of these desiccation tolerance genes should be observed in terrestrial relative to marine species.

Here, by combining analyses of fossil arthropods and tardigrades with phylogenetic analysis of multiple gene families that aid in the regulation of the tun state, we are able to better understand the history of desiccation tolerance within Tardigrada, and with that, tardigrade terrestrialisation.

Tardigrada
Divergence Time Estimation
Molecules and Fossils

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The oldest representative of the rove beetle tribe Pinophilini (Coleoptera: Staphylinidae) from Upper Cretaceous Burmese amber

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The subtribe Procirrina comprises eight extant genera with a predominately (sub)tropical distribution. Molecular and total-evidence phylogenies consistently recover Procirrina sister to the subtribe Pinophilina, which together form the tribe Pinophilini of the rove beetle subfamily Paederinae. Nothing from the fossil record of the tribe has ever been described, although compression fossils are known from the Eocene Insect Limestone, Isle of White and Green River Formation and Miocene Dominican and Mexican ambers. In our paper we described †***Cretoprocirrus trichotos*** Jenkins Shaw & Żyła, the first and oldest fossil representative of the tribe Pinophilini from Upper Cretaceous Burmese amber. Phylogenetic analyses of morphological data allow its unambiguous placement in the subtribe Procirrina based on the presence of the following morphological characters: securiform maxillary palpomere 4; protarsomeres 1–4 inflated; and abdominal segments IV to VII without paraterg-ites. The new genus is unique in having in having the metatibia almost equal in width along its entire length (apically expanded in all other Procirrina genera). Together with two species †***Diminudon*** (Zyla et al. 2019) from Lathrobiini, †***Cretoprocirrus trichotos*** is the third species of Paederinae described from Burmese amber and provides an important insight into the evolution of the subfamily.

Procirrina, Mesozoic, amber, new genus and species

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Insight into the planthopper family Mimarachnidae (Hemiptera: Fulgoromorpha) from Burmese amber

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Mimarachnidae Shcherbakov, 2007 is one of the extinct families of planthoppers (Fulgoromorpha), which was originally characterized by its simplified venation, setigerous metatibial pecten, the spider-like dark silhouette, and black eyespots of its tegmina. Species of the family Mimarachnidae have been discovered dating as far back as the Early-to-mid Cretaceous, and are well known from the compressed fossils and fossilised impressions in sedimentary deposits of Buryatia (Russia), Japan and Spain. Some not formally described taxa come from Mongolia and, probably, from Brazil also. In addition, mimarachnids are known from inclusions in the mid-Cretaceous Burmese amber, spreading from the high latitude region to tropical palaeoequatorial region.

From Burmese amber, more than seven new species and five genera of the family Mimarachnidae have been erected by now. The taxonomic diversity and morphological disparity of these species exceed far beyond the known richness of Mimarachnidea or even Fulgoromorpha fossils already known. The recently described genera have already displayed great morphological disparity, with elongated heads like that of ***Jaculistilus*** sp. Zhang, Ren & Yao, 2018, giant in size like ***Dachibangus*** sp. Jiang, Szwedo & Wang, 2018, and rostrums reaching beyond the abdomen like in ***Burmissus*** sp. Shcherbakov, 2017. Furthermore, some species present morphological camouflage flatoidinisation, like ***Mimaplax*** sp. Jiang, Szwedo & Wang, 2019. These findings reshaped also the definition of the family.

The taxonomic diversity of these fossils allows us to erect a number of new taxa of specific, generic and even higher taxonomic levels and offers us an unprecedented opportunity to observe morphological adaptations for sophisticated camouflage, as well as several eco-morphological traits. Moreover, a set of new concomitant questions on the relationships of the Mimarachnidae within the Fulgoromorpha clade, with the potential to be addressed in future studies, arised from this study.

planthoppers
Mimarachnidae
Burmese amber
morphological disparity

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Fossil *Ephedrus* species (Hymenoptera, Braconidae, Aphidiinae): from Sakhalinian amber

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Aphidiinae (Hymenoptera, Braconidae) is a subfamily of specialized aphid parasitoids distributed worldwide. Their published fossil record includes 26 species of 14 genera. ***Archephedrus stolamissus*** Ortega-Blanco, Bennett, Delclòs & Engel, 2009 is the oldest known aphidiine, from the late Albian of Spain (Álava amber). Most fossil species have been described from the early Oligocene (Alsace potash field, Anna pit). They are very common in middle Eocene Sakhalinian amber, but have been previously little known below the subfamily level. A few are known from the late Eocene Baltic and Rovno amber.

In our previous studies of Sakhalinian amber Aphidiinae, most specimens belong to the genus ***Ephedrus***. This genus is the least specialized among recent aphidiines and is characterized by their most complete forewing venation and 11-segmented antennae in both sexes, consistent in both extant and extinct species. Two fossil species of ***Ephedrus*** have been described: ***Ephedrus primordialis*** Brues, 1933 from Baltic amber and ***E. mirabilis*** Timon-David, 1944 from early Oligocene Camoins-les-Bains marls near Marseille. Here, we report three new species of the genus from Sakhalinian amber. They differ from known species by the shape and proportions of their petiole and ovipositor sheaths.

Aphidiinae
Sakhalinian amber
Eocene
Fauna

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Insect pollinator diversification during the Cretaceous

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Terrestrial vegetation, dominated by gymnospermous seed plants for much of the land-plant history, suffered a turnover during the Cretaceous in favour of the flowering plants (angiosperms), currently the ecologically dominant and most diverse plant group. Apart from already-known possible factors such as small size, fast growth, wildfire opportunism, and short life cycles in the first angiosperms, the Cretaceous fossil record is lately providing key evidence to further understand such a profound replacement. Pollination relationships between diverse insect and gymnosperm groups since the late Paleozoic have been suggested by substantial yet indirect paleontological evidence together with entomophilous features of the fossil pollen such as size, shape, ornamentation, quantity, and clumping ability. Entomophily has been widely regarded as the plesiotypic condition for angiosperms. Direct evidence for Mesozoic pollination was absent until the last years, when a relatively high number of insects with pollen grains attached was reported from Spanish (Albian) and Myanmar (Cenomanian) ambers. These direct records spanned six insect orders with four different pollination modes during the mid-Cretaceous, showing distinctive patterns of extinction, survival, and origination coincident with the angiosperm radiation. Thus, early angiosperms evolved in ecosystems where insects were largely feeding on (and thus pollinating) a variety of seed-plant lineages until multiple gymnosperm to angiosperm plant-host shifts occurred during the middle of the Cretaceous. Mandibulate pollinators, including beetles, probably made the transition from gymnosperm to angiosperm hosts with greater ease than long-proboscid, or other highly specialized, insect pollinators, which became more prone to extinction.

Thanks to the Alexander von Humboldt Foundation and to the project UE CGL2017-84419.

Amber
Plants
Insects
Evolution

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Scientific Potential of the collection at the Museum of Amber Inclusions, University of Gdańsk

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The scientific collection of amber and its inclusions is a natural history collection that stores and shares research materials. Since the establishment of the Museum of Amber Inclusions (MAI) at the University of Gdańsk, we have been collaborating with scientists in Poland and abroad by conducting joint research projects and organising workshops and conferences. The collection consists of different types of material, which allows for undertaking various scientific projects. The main focus of the collection is Baltic amber, including unsorted and unselected material taken directly from deposits. The material available for study includes raw amber pieces, amber already prepared for identification, and pieces that are partly polished and identified to various taxonomic levels (ca. 16,000 specimens in total). The laboratory associated with the museum and its equipment offers all necessary tools for working with amber and its inclusions. Moreover, MAI is also co-operating with the Amber Laboratory of the International Amber Association and the Gdańsk University of Technology, enabling physical and chemical analyses of amber. Therefore, the MAI collection can be used in taphonomical, palaeoecological and taxonomical studies. Thanks to the collection supporting programme SPUB, we can offer accommodation and access to all facilities, collections and equipment for visiting scientists.

W

Quaternary
3D model
Gallotiinae
Lacertidae

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New Specimens of †Hexagenitidae (Ephemeroptera) from the Crato Formation (Aptian, Lower Cretaceous), Brazil

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Among Ephemeroptera, Hexagenitidae was dominant during the Middle Jurassic – mid-Cretaceous. We analyse three new Hexagenitidae adult specimens and redescribe AMNH-34399, previously placed in the Oligoneuriidae. We also examine 16 nymphal specimens (***Protoligoneuria limai***), all from the Crato Formation Lagerstätte of Brazil. Two specimens (MPSC-763 and LPU-1144) were identified as ***Protoligoneuria*** cf. ***limai***, doubling the alate specimens number known for the genus. These new specimens provide new information on the genus variability and allowed to amend the taxon's diagnosis. MPSC-1559 and AMNH-34399, for now, are considered Hexagenitidae *incertae sedis*. The specimens have approximately the same size of nymphal individuals from the Crato Formation, but other than that, are not comparable. As the stages of development of nymphs are unknown in fossils, we strongly recommend describing winged stages under separate names, as it is commonly accepted in paleoentomology. Likewise, the relatively large hind wings of MPSC-1559 and AMNH-34399 are plesiomorphic features within mayflies, and therefore, the specimens are worthy of further study. We also consider that ***Cratohexagenites minor*** could be synonymous with ***P. limai***. ***C. minor*** is known only from one specimen, and the characters used to erect the taxon were the size and shape of the seventh gill, but we considered the later a dubious character, and found that the size is within the variation expected for ***P. limai***. Lastly, we modified some taxa diagnoses (***Protoligoneuria*** and ***Cratohexagenites***) by removing non-diagnostic characters, like: "C, Sc and RA not branched", as these are vein features present in all known Ephemeroptera.

Arthropoda
Mayfly
Taxonomy
Araripe Basin

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The oldest representative of Paederini (Coleoptera, Staphylinidae) from Late Cretaceous Burmese amber and its systematic position

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The family Staphylinidae, commonly known as rove beetles, contains over 65,000 described species, making it the largest family of animals. Among all subfamilies of rove beetles, the Paederinae are one of the most diverse, with more than 7500 described extant species and 35 fossil species. The subfamily is currently divided into four tribes, Lathrobiini, Paederini, Pinophilini, and Cylindroxystini. Recent molecular, total-evidence, and morphological phylogenetic analyses of the group improved their classification and provided the first morphological matrices for the subfamily. So far, there are two fossil genera of Paederinae known from the early Late Cretaceous Burmese amber from northern Myanmar (Kachin amber), which is one of the most diverse insect amber deposits in the world. The genera were classified within the tribes Lathrobiini and Pinophilini based on the results of phylogenetic analyses. Paederini is the second largest tribe within Paederinae and it is further divided into four subtribes, namely Paederina, Cryptobiina, Dicaxina, and Dolicaonina. Up to date, the only known fossil representatives of the tribe belong to the subtribe Cryptobiina, but they have never been formally described. Almost all of these fossils, however, come from Cenozoic deposits, mostly of the Eocene age.

Here, we present the oldest undisputed representative of the tribe Paederini from the Burmese amber. Bayesian inference phylogenetic analyses of morphological and molecular data allowed its unambiguous placement in the tribe, as well as finding its systematic position within Paederini. This newly described Paederinae genus from the Burmese amber provides important insight into the evolution of the subfamily.

Phylogenetics
Paederinae
Fossils
Morphology
Molecular data

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Thematic Session:

Palynology as a tool in stratigraphic and paleonvironmental research: advances and perspectives

In this session we intend to assess the progress of current research and the rapidly growing role of palynology (pollen, spores, dinocysts and other NPPs) as an important field of geological and stratigraphical researches. Participants are invited to present methodological approaches and significant case histories useful in the Palaeoenvironmental and Paleoclimate reconstructions.

Subjects based on Climatostratigraphy, Cyclostratigraphy, Sequence stratigraphy, Palynostratigraphy are also welcome. Moreover, contributions on classic continental and marine sedimentary successions are appreciated but also new evidence from more unusual archives for palynology such as terrestrial carbonates (travertines, calcareous tufas, speleothems), (packrat) middens, coprolites, etc.

We would like to encourage contributions in order to promote the exchange of the knowledge but especially the virtual meeting among researchers and students from different parts of the world.

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Please scroll down for Table of Contents

Palynology as a tool in stratigraphic and paleonvironmental research : advances and perspectives

Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Palynofacies, palynology, and plant macroremains from Arroyo del Vizcaíno site (Pleistocene, Uruguay)

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The Arroyo del Vizcaíno site is a fossil-rich 30-ka-old megafaunal locality near Sauce, southern Uruguay that is one of the very few Late Quaternary extra-Andean palynological records of South America. Sediment samples collected at 38, 35, 24, and 6 cm depth were processed for palynofacies, palynomorphs, and plant macroremains analyses. No significant differences were observed among samples. Palynofacies were characterized by the abundance of degraded organic matter, mainly amorphous products and degraded translucent phytoclasts, and fungal remains, which indicate an important aerobic degradation by bacterial and fungal attack. However, the presence of pyrite crystals even in fungal spores and hyphae indicates subsequent dysoxic-anoxic conditions. Among palynomorphs, fungal spores dominated the assemblages, with ***Glomus*** sp. and ***Tilletia*** sp. as the most frequent types. ***Spirogyra*** was the only algal element recorded. A total of 33 pollen types were identified. All samples were characterized by high percentages of herbs, co-dominated by Poaceae and Asteraceae subf. Asteroideae, associated with low proportions of Liliaceae, Amaranthaceae and other herbaceous taxa. ***Myriophyllum*** had a low frequency and was the only indicator of aquatic vegetation. Woody taxa were represented by taxa such as ***Cephalanthus***, ***Sebastiania*** and ***Myrsine***. Pollen assemblages suggest an open grassland vegetation landscape with few or distant woody species growing near a stream and scarce aquatic vegetation at the site. Regarding plant macroremains, the most frequent seeds corresponded to ***Soliva sessilis***, and secondarily to ***Portulaca papulosa***, ***Aphanes parodii***, ***Chenopodium*** sp., and ***Amaranthus*** sp. Other abundant plant remains recovered corresponded to Poaceae sp.

W

Degraded organic matter
Fungal remains
Pollen
Palaeovegetation
Palaenvironmental conditions

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Ecological disturbances in the latest Permian reflected in palynomorphs from the Dolomites

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In the Dolomites (Southern Alps; Northern Italy), the Lopingian (late Permian) and Early Triassic are represented without a major hiatus by shallow-marine sediments. The region is consequently of great interest for the study of the end-Permian mass extinction. Palynomorphs from the Dolomites have been studied occasionally in this context as well, but a recent project produced new data from several localities that provide a clearer picture.

Near the boundary, spores and spore tetrads, primarily of lycophytes, occur with a drastically increased frequency. Similar signals have been reported from across the globe. The frequent occurrence of permanent tetrads suggests an ecological disturbance that disrupted the plants' reproductive abilities. The general increase in spores compared to pollen — a so-called "spore spike" — is considered to indicate the collapse of the gymnosperm-dominated Permian flora, although gymnosperm pollen continues to be present.

A previously mostly overlooked, but important component of the late Permian palynofacies in this region are unidentified organic-walled microfossils of possible algal or fungal origin. In the Laurinswand section (Rosengarten Massif), high abundances of these microfossils coincide with impoverished ostracod faunas indicating a stressed environment. They disappear near the Permian–Triassic boundary. The demise of the Permian flora has been linked to the mass occurrence of the problematic organic-walled microfossil ***Reduviasporonites***. This mass occurrence has also been used as a marker for the Permian–Triassic boundary. However, we found increases in ***Reduviasporonites*** in the Dolomites to occur locally in different stratigraphical positions, in at least one case postdating the "spore spike".

End-Permian
mass extinction
Southern Alps
Algae
Fungi
Spores

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SW European vegetation and climate dynamics in a cooler world: insights from MIS 13 Interglacial

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Marine Isotope Stage (MIS) 13, ~500 ky ago, has received particular attention due to the unexpected intensification of monsoon systems under a cool climate characterised by lower CO2 and larger ice volume than the Holocene. Yet, due to the paucity of studies, key questions remain about the regional expression of this interglacial in other important areas of the Northern Hemisphere, such as southern Europe. The SW Iberian vegetation and terrestrial climate is directly compared here with oceanic temperature changes by using sediments from IODP Site U1385. To assess the impacts of orbital and ice-sheet forcing on the regional vegetation and climate we also performed a suite of experiments with the LOVECLIM Earth system model.

We show for the first time that MIS 13 stands out for its large forest expansions with a reduced Mediterranean character alternating with muted forest contractions, reflecting a temperate climate with high levels of humidity. Results of the data-model approach demonstrate the importance of combining insolation and ice-sheet forcing to explain the regional vegetation and climate imprint of MIS 13. We find that dominant effect of insolation over the SW Iberian region is amplified by the relatively large extent of the ice-sheets of MIS 13. We propose that the interactions between ice-sheets and major atmospheric circulation systems may have resulted in the persistent influence of the mid-latitude cells over SW Iberia. This would have led to increased rainfall in both summer and winter seasons, and, in turn, to strong forest development but with weak Mediterranean character.

Interglacial MIS 13
Mediterranean
vegetation
Model-data
comparison

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A multi-method approach for the reconstruction of climate changes at Lake Ohrid (Balkan Peninsula) between 160 and 70 ka

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High-resolution pollen results obtained from the DEEP site sequence recovered from Lake Ohrid (Albania/FYROM) for the period ranging from 160 to 70 ka, from the last part of Marine Isotope Stage 6 (MIS 6) to the beginning of MIS 4. The Last Interglacial Complex (LIC) covers the period between 130 and 70 ka. LIC starts with the Eemian (Last Interglacial, LI) and continues with the succession of stadial and interstadial phases of the Early Last Glacial. In order to reconstruct climate changes a multi-method approach, including the "Modern Analog Technique" and the "Weighted Averaging Partial Least-Squares Regression", was applied in a region where accurate climate reconstructions are still lacking for this time interval. Our results for the penultimate glacial show cold and dry conditions, while the onset of the LI is characterized by wet and warm conditions, with temperatures higher 2°C than today. The Eemian also shows the well-known climatic tripartition in the Balkans, with an initial pre-temperate phase of abrupt warming (128–121 ka), a central temperate phase with decreasing temperatures associated with wet conditions (121–118 ka), followed by a post-temperate phase of progressive change towards cold and dry conditions (118–112 ka). After the Eemian, an alternation of four warm/wet periods with cold/dry ones, likely related to the succession of Greenland stadials and cold events known from the North Atlantic, occurred. The Lake Ohrid climate reconstruction shows greater similarity with climate patterns inferred from northern European pollen records than with southern European ones.

Palynology
Climate reconstruction
Lake Ohrid
LIC-Last Interglacial Complex
Central-western Mediterranean

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Recent and past environmental changes in the Central Basin (Ross Sea - Antarctica)

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We present preliminary diatom study results from a gravity core KI13-C1 collected in the Central Basin, located at the mouth of the Joides Basin (western Ross Sea, Antarctica). This area represents the main shelf of the Ross Sea carved by a major ice stream that drained the East Antarctic Ice Shelf (EAIS), during the last glacial expansion.

This study is part of the STREAM Project (Late Quaternary evolution of the ocean-ice sheet interactions: the record from the Ross Sea continental margin - Antarctica), financed by the Italian Ministry of Foreign Affairs and International Cooperation between Italy and Rep. of Korea (2019–2021 years). The chronological framework obtained combining ^{14}C radiocarbon dating on organic matter matrix, paleomagnetic measurement and diatom biostratigraphy indicates that the investigated sedimentary sequence covers the last geomagnetic reversal, i.e., the Matuyama–Brunhes transition. Based on the distributional pattern of diatom and foraminiferal assemblages we recognized and characterized different environments as well as we reconstructed the oceanographic dynamics in this area. Additionally, we observed the near synchronism between the magnetic signal and the LAOD of ***Actinocyclus ingens*** bioevent (0.65 Ma).

The study underlines the importance of the diatoms as indicators of environmental changes and chronological tool in the Antarctic region.

Diatoms
Biostratigraphy
Paleomagnetism
Ross Sea
Antarctica

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Thematic Session:

PalaeoVC Early Career Session

The creation and consumption of digital media has been growing exponentially for the past 10 years; in particular access to video streaming sites is becoming a daily activity for many people across the globe. The benefits of using videos in an academic setting are numerous, with their convenience and versatility make them an asset to students, teachers and educational institutions alike. Video streams are also very accessible to anyone with internet access, both to watch and to produce. We believe that this format of spreading ideas is going to dominate the foreseeable future of information distribution. With the versatility of this format, its speed and accessibility it is only a matter of time before it becomes common place within the scientific community.

We would like to take this opportunity to help take the first step and make the production digital scientific material more common place. The aim of this workshop is to promote the work of early career scientists and provide them with a space to present their work and engage with other farflung researchers in a stimulating environment. Alongside this we have created a panel of judges to review the works and provide feedback in the form of a small review of each submission with a number of prizes to be distributed at the end of the conference.

Organisers

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Please scroll down for Table of Contents

Table of Contents

continues >

PalaeoVC Early Career Session

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Campanian rudist and oyster longevity, daily growth rates and photosymbionts

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Bivalves document their response to environmental and climatic changes in their shells. Each individual species has different growth rates and life-strategies, which are reflected in their morphology, incremental banding and geochemical shell composition. During the Late Cretaceous rudist bivalves became diverse and very abundant thus their shells can be used as potential paleoenvironmental archives. Rudists could secreted their shells with rhythmic pattern of both tidal and daily increments, and the growth rate was synchronized with the surrounding environmental conditions, like tides and temperature. Also, photosymbionts might have played an important role in their shell precipitation and explain their unusual shapes. This sheds light onto their evolutionary success during the Cretaceous, potentially also outcompeting the growth of other organisms like zooxanthellate corals. Four bivalve species, comprising the rudists ***Macgillavryia*** sp., ***Vaccinites*** sp., and ***Torreites*** sp., as well as the oyster ***Oscillopha figari***, have been obtained in life position from the Campanian Samhan Formation in the central part of Oman. Internal banding has been assessed to indicate their individual growth rates and to estimate their longevity. The correlation between $\delta^{13}C$ and $\delta^{18}O$ in the rudist Torreites sanchezi has previously been attributed to photosymbiotic relationship with dinoflagellates. Based on that the current research aims to: **(1)** Test the presence of $\delta^{13}C$ and $\delta^{18}O$ correlation within the rudists ***Macgillavryia*** sp., ***Vaccinites*** sp., and ***Torreites*** sp., arguing for the presence or absence of symbiosis, using the oysters as non-symbiontic control group; **(2)** assess the individual growth character of each bivalve species with respect to the presence or absence of symbiotic interaction and phylogenetic differences. While combining sclerochronology and geochemistry, we also test for their pristine mineralogical shell composition and possible diagenesis with micro-Raman spectroscopy and cathodoluminescence techniques.

Bivalves
Sclerochronology
Daily growth rate
Photosymbionts

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Preliminary analysis of conchostraceans from Rio do Rasto Formation, Permian of Paraná Basin, Brazil

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The Rio do Rasto Formation is composed of shales, siltstones and sandstones deposited during the Lopingian, where several fossils are found, among them conchostraceans. The conchostraceans are small crustaceans with chitinous or calco-chitinous bivalve shells, formed by a series of concentric bands and growth lines. The classification of conchostraceans is based on the characteristics of their bivalve carapaces, which present varied ornaments, making them excellent for palaeoecological, palaeoclimatic, palaeoceanographic and biostratigraphic studies. The objective of this contribution is to carry out a bibliographic survey and analyze the morphological characters used in the taxonomy of conchostraceans found in the Rio do Rasto Formation. The Laboratory of Paleontology (**LABPALEO**) at UFPR (Universidade Federal do Paraná) houses ten well-preserved samples of these organisms, which will be analyzed in order to be taxonomically identified, based on the specialized bibliography. Currently 12 species are reported from the Rio do Rasto Formation (Rohn, 1987): ***Asmussia regularis*** (Reed, 1929) Mendes, 1954, ***Palaeolimnadiopsis subalata*** (Reed, 1929) Mendes, 1954, ***Leaia pruvosti*** Reed (1929), ***Monoleaia unicostata*** (Reed, 1929) Tasch, 1956, with subspecies ***M. unicostata micropolygonata*** Rohn, 1987 and ***M. unicostata timboensis*** Rohn, 1987, ***Cyzicus (Euestheria) langei*** (Mendes, 1954) Rohn, 1987, ***Paranaleaia supina*** Rohn, 1987, ***Asmussia*** sp., ***Cyzicus (Euestheria)*** sp., ***Cyzicus (Lioestheria)*** sp., ***Cyzicus*** sp., cf. ***Palaeolimnadiopsis*** sp. and ***Palaeolimnadia (Palaeolimnadia)*** sp. The material is being described, and it could be referred to already erected taxa or represent new ones that maybe will help on paleoenvironmental and biostratigraphical reconstructions.

Conchostraceans
Permian
Paraná Basin
Rio do Rasto Formation

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Total-evidence Bayesian inference of past diversity: the Occurrence Birth-Death Process

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Major goals of macroevolutionary analysis include inferring the phylogenetic relationships, the phylodynamic parameters (origination and extinction rate), and the species richness through time for clades of interest. The total-evidence approach aims to combine molecular and morphological data from extant and fossil species to achieve all these objectives in a unified Bayesian inference framework. Even fossils lacking morphological data, i.e., occurrences characterised only by their sampling time, provide invaluable information to reconstruct past diversification processes. Here, we build on recent methodological developments around the Fossilized Birth-Death Process enabling to **(i)** efficiently incorporate abundant occurrence data while remaining computationally tractable and scalable; and **(ii)** reconstruct the past species richness, with or without knowledge of the underlying tree. We implement this as a new prior called "**Occurrence Birth Death Process**" in the RevBayes environment, allowing its use on a large set of models of molecular and morphological evolution. Using simulations, we show that our approach recovers reliable estimates of species richness under a range of conditions. We then present an empirical case study of Cetaceans and highlight the benefit of using a phylodynamic framework to jointly integrate molecular data, morphological data, as well as fossil occurrences. This model-based approach creates the potential to explicitly take into account key features of clades' macroevolutionary history, so we conclude by discussing ongoing developments that aim to identify diversity-dependence in the diversification process.

Diversity
Occurrence Birth-Death Process
Total-evidence
Bayesian inference
Fossil record

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Paedomorphic traits related to neurocranial ossification in two Devonian lungfishes species (Givetian *Pentlandia macroptera* and Frasnian *Scaumenacia curta*)

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Lungfishes, the living sister-group of tetrapods, originated more than 410 million years ago. They are one of the few early vertebrate clades with a rich fossil record allowing morphological, paleoecological and evolutionary studies. Lungfishes are characterized by a low evolutionary rate associated with paedomorphosis since the Upper Devonian. These evolutionary conditions had crucial impacts on many anatomical features that make us consider recent lungfishes as “living-fossils”. Lungfish paedomorphic trends include a reduction of the number of cranial dermal bones, reduction of the number of median fins, and reduction of neurocranial ossification. This neurocranial trait has evolved from heavily ossified in Devonian species to completely cartilaginous in Carboniferous and recent species. Conditions among derived Devonian lungfishes is necessary to have a better understanding of paedomorphosis as a driving force during lungfish evolution. The neurocrania of two closely related Devonian species, ***Scaumenacia curta*** (middle Frasnian, Escuminac Formation, Miguasha, eastern Canada) and ***Pentlandia macroptera*** (Givetian, Orcadian Basin, Scotland), have been scanned using a micro CT scanner. Although detailed anatomy was not retrieved, ***Pentlandia*** is now recognized to have an ossified neurocranium which contrasts from previous assumptions. On the other hand, juvenile and adult specimens of ***Scaumenacia*** have cartilaginous neurocrania. Pyrite filled neurocranial cavities preserving some endocranial structures (e.g., olfactory bulbs, semi-circular canals) allowing us to code for phylogenetic endocranial characters in ***Scaumenacia***. ***Scaumenacia*** is considered to be more derived than ***Pentlandia***. Paedomorphosis had already resulted in ossification reduction between ***Pentlandia*** and ***Scaumenacia*** at least for the neurocranium supporting the hypothesis of decoupling heterochrony.

Pyritization
Heterochrony
Ontogeny
Neurocranium

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A surprisingly diverse assemblage of freshwater pycnodont fishes (Actinopterygii, Pycnodontiformes) from the mid-Cretaceous, Kem Kem beds of south-east Morocco

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The continental mid-Cretaceous Kem Kem Group of southeast Morocco is partially known for its highly diverse ichthyological assemblage of chondrichthyan, sarcopterygian and actinopterygian fishes. However, one particular group, the pycnodonts (Actinopterygii, Pycnodontiformes) were only recently described from this unique freshwater assemblage. Pycnodonts are recognised in the Kem Kem from rare remains consisting of isolated vomerine and prearticular dental elements. Four pycnodont genera are recorded: ***Agassizilia erfoudina***; ***Neoproscinetes africanus***; ***Coelodus*** sp. and ***Macromesodon*** sp. Pycnodonts are predominantly marine fishes and therefore the presence of a diverse assemblage in a freshwater sequence is abnormal. Here we discuss the palaeogeographic and ecological significance of the surprisingly high pycnodont diversity in the Kem Kem Group of the Tafilalt region. Specimen taphonomy and biostratinomy is also discussed in the context of a predominantly freshwater river systems. Comparisons are made with European and South America pycnodont taxa, of which a faunal interchange is believed to had occurred within the Moroccan Kem Kem river system.

Pycnodontomorpha
Mid-Cretaceous
Kem Kem beds
Morocco

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The inner ear of *Champsosaurus* (Diapsida: Choristodera) and its phylogenetic and ecological implications

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Champsosaurus was a genus of gharial-like reptiles that lived from the Late Cretaceous to the Paleocene in what is now western North America. Little is known about their inner ear anatomy, primarily due to poor preservation of their skulls, yet clarification of this structure promises to inform phylogenetic and ecological reconstructions. Our research describes the inner ear of ***Champsosaurus lindoei*** and ***Champsosaurus natator*** using computed tomography (**CT**) scanning of two well-preserved skulls housed at the Canadian Museum of Nature. The CT data were segmented to produce 3D models of the inner ear. The phylogenetic position of Choristodera within Diapsida is uncertain, so inner ear segmentations of 61 members of Lepidosauromorpha and Archosauromorpha were included to bracket ***Champsosaurus***, with ***Youngina*** as an outgroup. The semicircular canals of these species were landmarked and projected in morphospace using Principal Component Analysis (**PCA**) and Canonical Variates Analysis (**CVA**). The CT segmentations demonstrate that the semicircular canals of ***Champsosaurus*** are approximately orthogonal, and circular in outline. The PCA indicates a phylogenetic signal in semicircular canal shape, where taxa cluster into three groups: lepidosauromorphs, non-avian archosauromorphs, and avians. ***Champsosaurus*** and ***Youngina*** plot among the non-avian archosauromorphs, suggesting that ***Champsosaurus*** and archosauromorphs have retained the ancestral morphology. The CVA demonstrates that ***Champsosaurus*** is most similar to other aquatic taxa, suggesting that ***Champsosaurus*** was adapted for sensing movement in an aquatic environment. Overall, these data represent the first morphometric analysis of semicircular canals across Diapsida, and are consistent with the hypothesis that ***Champsosaurus*** was a specialized aquatic predator.

Champsosaurus
Morphometrics
Computed
Tomography

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Biostratigraphy, age, and the paleoenvironment of the Pliocene Beaufort Formation on Meighen Island, Canadian Arctic archipelago

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The Neogene Beaufort Formation, Canadian Arctic Archipelago, records Arctic environments and amplified temperatures at approximately modern atmospheric CO_2. Meighen Island is a key locality for studying this formation because of the marine sediments interbedded with terrestrial fossiliferous sands. The stratigraphic succession, fossils from the marine beds, and paleomagnetic data from the Bjaere Bay region of the island suggest the studied exposure was likely deposited ~3.1 Ma. The sequence probably encompasses the last warm interval of the Pliocene and an eustatic high stand of sea level.

Fossils of plants and arthropods are abundant in the alluvial sands exposed in the Bjaere Bay region. The lower part of the terrestrial sequence, beneath most of the marine sequence, contains taxa that have not been seen above the marine beds such as ***Epipremnum crassum***, ***Abies*** and ***Cepheus***. Sediments below the marine beds also seem to be dominated more by fossils of trees such as arboreal ***Betula***, whereas the organic debris from above marine beds contains many fossils of plants, such as dwarf ***Betula***, and arthropods characteristic of open or treeless sites. Regional tree line probably occurred on Meighen Island during deposition of the upper sediments, implying mean July temperatures at least 9°C warmer than present. Foraminifera in the marine unit suggest that near shore water temperatures did not fall below 0°C during deposition; hence at ~3.1 Ma the Arctic Ocean probably lacked perennial ice cover. This confirms recent modelling experiments that have found the removal of sea ice key to resolving proxy-model mismatch.

Magnetostratigraphy
Marine incursion
Macroflora
Microfauna
Macrofauna

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Neogene plant macrofossils from Alaska and Arctic/ Subarctic Canada: new data, intercontinental comparisons and correlations

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Macrofloral remains are valuable for correlating Arctic Neogene sites, especially where the application of absolute dating methods is not possible. A new correlation scheme primarily comparing macro-remains of bryophytes and vascular plants is presented. This scheme uses the updated and expanded taxon lists we provide, with over 380 taxa identified to varying levels, collected from 26 Neogene sites and over 50 florules in Alaska and northern Canada. These fossils clearly differentiate Neogene from Quaternary deposits in the North American Arctic. Recently published absolute dating by cosmogenic nuclides provides tie-points for these macroflora-based correlations and tends to confirm earlier dates achieved by relative and correlative methods.

Our knowledge of North American Arctic/Subarctic floras and faunas is now sufficiently detailed to allow inter-regional comparisons. This work comprises the first attempt to compare and contrast Neogene macrofloras from the entire circum-Arctic region. In addition, the floras are valuable for understanding the evolution of the boreal realm, from the qualitatively different composition of the communities of the Neogene Arctic, to those of the more southerly modern boreal region. These differences may be due to the warm climate of the Neogene Arctic combined with the long dark of polar winter — a phenomena with no modern analogue. This highlights the need for a comprehensive understanding of species' ecology to predict species ranges under near future climate conditions analogous to our Neogene past. Many of these sites present rich opportunities for future cross-disciplinary study.

† This work is dedicated to the memory of **Alice Telka**, a wonderful friend and valuable research partner

Biostratigraphy
Correlation
Neogene
Arctic
Palaeoflora

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A bony fish (Osteichthyes: Teleostei) skull from the Upper Cretaceous Snow Hill Island Formation of James Ross Island, Antarctic Peninsula

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Numerous relatively complete fossil fishes have been recovered from the Paleogene of Antarctica, primarily from the lowest Paleocene and middle–upper Eocene. However, well-preserved, phylogenetically informative material of Antarctic Cretaceous fishes is far less common. In 2003, a National Science Foundation-funded expedition co-led by one of us (JAC) discovered a fossil locality on the Naze Peninsula of James Ross Island (James Ross Basin, Antarctic Peninsula), in deposits of the Upper Cretaceous (upper Campanian–lower Maastrichtian) Cape Lamb Member of the Snow Hill Island Formation. Among the fossils recovered — which also include the holotype of the non-avian theropod dinosaur ***Imperobator antarcticus*** — is an articulated skull of a medium-sized bony fish. External examination of the fossil-bearing block indicates the presence of the three-dimensionally preserved braincase plus elements of the jaw apparatus and branchial basket. A computed tomographic scan further reveals the preservation of much of the remainder of the skull, including, at minimum, the maxilla, orbital elements, postorbital, hyomandibular, preopercular, and opercular.

The only other associated osteichthyan cranial material from the Cretaceous of Antarctica is the holotypic partial skull of the beryciform ***Antarctiberyx seymouri*** from the Maastrichtian López de Bertodano Formation of Seymour Island. As such, the new Naze specimen represents only the second associated osteichthyan skull from the Antarctic Cretaceous, as well as the first from the Campanian–Maastrichtian Snow Hill Island Formation and James Ross Island. Ongoing analysis of the fossil promises to enhance understanding of the ichthyofaunas that inhabited Gondwanan polar latitudes leading up to the end-Mesozoic extinction event.

W
Antarctica
Cretaceous
Fish
James Ross Basin
Osteichthyes

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The Downton Bone Bed (upper Silurian, England): insights into a Lost World

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The Downton Bone Bed is a multitaxic fossil concentration-lagerstätte located within Weir Quarry, Herefordshire, England. It is found within the Platyschisma Shale Member of the Downton Castle Sandstone Formation, ca. 1.5 m above the Ludlow Bone Bed, it is dated to the Mid-Ludfordian (upper Silurian). The lack of an unconformity, and that both bone beds are in the same formation would infer a mid-Ludfordian date for the Downton Bone Bed. The aim of this study was to catalogue the fossil contents of the Downton Bone Bed in detail for the first time, as well as the sedimentology to define the depositional environment in which the bone bed formed, and gain an understanding of its wider global context. A total of ca.20 kg of Downton Bone Bed material was digested during this study, recovering hundreds of micro fossils. The bone bed is rich in fossils with a broad diversity of vertebrates (thelodonts and acanthodians), invertebrates (bivalves, gastropods, ostracodes and eurypterids), plants and allies. However within each group the diversity is low, suggesting that the Downton Bone Bed was formed in a restricted environment. The sedimentology reveals evidence of two energy conditions, alternating between quiet low energy settings where trace fossils occur, and periods of high energy events with rapid burial (e.g., storms) The Downton Bone Bed is therefore thought to have formed on a lower shoreface of a shallow sea (the Downton Sea), in close proximity to a quiet hyposaline inlet/lagoon, a terrestrial freshwater source and offshore barriers or barrier beaches.

Downton
Silurian
Bone Bed
Thelodonts
United Kingdom

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Strontium content and isotopes show ecological niches in North African Cretaceous dinosaurs

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The Cretaceous Kem Kem beds, Morocco, are well-known for their theropod (carnivorous dinosaur) taxa (***Spinosaurus***, ***Carcharodontosaurus***), but herbivores are rare, with a paucity of body fossils. Their teeth are more abundant, though not as numerous as for theropods. To study Kem Kem sauropod (long-necked herbivorous dinosaur) palaeoecology, sauropod and theropod teeth were used as proxies. As dental enamel incorporates trace elements via water and food uptake, the elemental composition may reflect trophic level, ecological niche or palaeoenvironment. In particular, the Sr/Ca vs Ba/Ca ratio works as a proxy for trophic level, as calcium is preferentially incorporated over strontium, so strontium levels are lower in carnivores than herbivores. Moreover, strontium isotope ratios ($^{87}Sr/^{86}Sr$) may reflect migratory behavior, as Sr levels reflect different habitat substrate conditions.

Sr/Ca vs Ba/Ca content was measured from 18 sauropod and 7 theropod teeth. Interestingly, only the semi-aquatic ***Spinosaurus*** showed distinct Sr/Ca levels. Titanosauriform sauropods show the highest Ba/Ca range with a relatively narrow Sr/Ca range, whereas nigersaurine sauropods show the reverse, possibly reflecting grazers vs browsers levels. It is unclear why theropods and sauropods should overlap in values, although it could be explained by the likely use of common water sources in arid regions. ***Spinosaurus*** and ***Carcharodontosaurus*** separate well, reflecting different hunting grounds; riverine and terrestrial, respectively. The $^{87}Sr/^{86}Sr$ shows the widest range for ***Carcharodontosaurus***, followed by the sauropods, indicating the terrestrial carnivore roamed over a large hunting ground. Sauropods might have been seasonal migrants, which matches the lack of sauropod body fossils in the region.

Spinosaurus
Titanosauriform
Cenomanian
Morocco
Kem Kem

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The Ins and Outs of coniform conodonts: Insights into feeding behavior using 2D and 3D analysis

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Predation is potentially one of the most impactful evolutionary traits to have ever developed. Conodonts, mostly regarded as an extinct group of early vertebrates, developed the first phosphatic dental tools, known as elements. Elements ranged from simple coniform types to more complex morphologies, predominantly in more derived species. Unlike the teeth of other vertebrates, these continuously grew throughout their lifetime by the periodic accretion of new lamellar tissues. This unique growth process continuously records chemical and physical characteristics throughout the animal´s lifespan which, when accessed, gives insight into the animal's ecology. Multiple lines of evidence, such as microwear studies and growth allometry, indicate that adult-derived conodonts fed as predators and/or scavengers. There is little indication how this feeding strategy developed in their evolution. This can be only elucidated by reaching to the earliest conodonts, which had coniform elements. Previous modelling of element position and mechanical properties indicates they were capable of processing or manipulation of food. A direct test would be to provide evidence of tissue damage and changes in its chemical composition.

This research focuses on samples of the coniform genus ***Proconodontus*** (Cambrian and Ordovician) and ***Panderodus*** (Silurian). Here we employ Backscatter electron (**BSE**) imaging, energy-dispersive X-Ray spectroscopy (**EDX**) and synchrotron radiation X-ray tomographic microscopy (**SRXTM**) data to identify growth dynamics, microwear and chemical sclerochronology recorded within their unique mode of growth. Our results have direct implications not just for understanding the feeding mode of early conodonts, but also the origination of predation in the earliest vertebrates in the fossil record.

Conodonts
Coniform conodonts
Earliest vertebrates
Predation

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“Its ears swing between land and sea”
Virtual osteological dissection of the middle ear of a protocetid whale (Cetacea, Artiodactyla) from the Middle Eocene of Togo

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Modern cetaceans mainly rely on an acute sense of hearing in their daily life. Due to the specific physico-acoustic conditions of the aquatic environment, the sound reception pathway in modern whales drastically differs from that of land mammals and implies strong modification of their auditory region. According to the fossil record, the adaptation of the cetaceans to the aquatic environment took less than 10 Ma and is a textbook case in macroevolution. The archaeocetes (i.e., fossil cetaceans that do not belong to the neocetes) include a large diversity of extinct taxa with different affinities for the aquatic environment, ranging from pakicetids with semi-aquatic trends to basilosaurids that are fully aquatic. Among this diversity of archaeocetes, the protocetids form a paraphyletic group at the heart of the transition from an amphibious to a strictly aquatic lifestyle. The auditory region of these four legged whales is only partially known and therefore often “misheard”.

Here, to discuss their ecoacoustic environment, we document and review elements of the tympanic bulla and the nearly complete ossicular chain of a protocetid whale from the middle Eocene phosphate deposits of Kpogamé, Togo. Through the light of a µCT-scan investigation followed by an integrative anatomical and functional study, this specimen brings strong evidence of the presence of a dual sound reception apparatus, via two distinct acoustic portals, allowing protocetids to hear efficiently in both air and underwater.

Malleus
Incus
Stapes
Auditory bulla
Archaeocetes

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Continental shell-bed taphonomy from the Upper Permian of Paraná Basin, Brazil

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Shell beds are recurring elements on the sedimentary record and a great source of paleoecological and paleoenvironmental data. Despite the taphonomy of marine shell beds are very well known, continental shell beds are still poorly studied. Hence, taphonomy features of a shell bed from Morro Pelado Member, Rio do Rasto Formation (Neopermian) were accessed. Sedimentological studies have previously attributed this section as a fluvial depositional environment marked by the alternation of flood events and dry periods. The samples came from an outcrop in Paraná State, Southern Brazil, geographic coordinate 23°50'S and 50°37'W. In all, 29 samples were described macroscopically, additionally a polished section and 4 thin sections were made. The taxonomic analysis of the bivalve mollusk shells found similarity with the species ***Palaeomutela platinensis*** and ***Relogiicola delicata***, already described for the same unit, however a more accurate comparison needs to be made. The shell concentration occurs in a horizontally bed, with the size of the shells varying from 2 to 12 mm and have a chaotic orientation. There is an internal complexity of the fossil assemblage with an upward change in the taphonomic features, levels with densely packed, disarticulated, whole and stacking valves graded to levels formed predominantly by fragmented and dispersed ones. The cycles are about 2 cm width. Signal of abrasion or dissolution are not observed. The taphonomic signature indicates an assemblage formed by high energy events, that promoted a fast burial and possibly reworked previously deposited shells resulting in significant temporal mixing

Taphonomy
Paraná Basin
Permian
Gondwana

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Cephalopods from the Cretaceous–Paleogene (K–Pg) boundary interval on the Brazos River, Texas (USA)

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Microvertebrate
concentration
Taphonomy
Photogrammetry 3D
Canary Islands

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We present the results of new field collections of cephalopods (ammonoids and nautiloid) from the Cretaceous–Paleogene (K–Pg) successions of the Corsicana and Kincaid formations exposed along the Brazos River in Falls County, Texas, USA. An abundant fauna of ten ammonoid species in six genera (***Discoscaphites***, ***Eubaculites***, ***Sphenodiscus***, ***Gaudryceras***, ***Pachydiscus***, ***Glyptoxoceras***) is present in the Corsicana Formation. Presence of ***Discoscaphites*** iris indicates the fauna belongs to the ***D. iris*** range zone, the highest ammonoid range zone in North America. Biostratigraphic correlation with calcareous nannofossils, dinoflagellates, and planktonic foraminifera confirm a latest Maastrichtian age. This is the most diverse ***D. iris*** zone fauna yet reported and includes one new species. Abundant aptychi (jaws) of ***Discoscaphites*** and ***Eubaculites***, as well as juveniles, indicate a living population which experienced little post-mortem drift. Stable isotope analysis ($\delta^{18}O$) of well-preserved ammonoid shell material indicate water temperatures of 18–23°C during the latest Maastrichtian. Three ammonoid genera (***Discoscaphites***, ***Eubaculites*** and ***Sphenodiscus***) occur in the K–Pg 'event deposit' at Brazos, likely representing deposition in the aftermath of the Chicxulub impact which occurred 1500 km to the south. A single specimen of the nautiloid ***Eutrephoceras*** was found in the early Palaeogene Kincaid Formation, within planktonic foraminiferal zone Pα and nannofossil zone NP1, <300 kyrs after the K–Pg boundary. These data provide new information on the differing fate of cephalopod groups during the K–Pg mass extinction and add to the picture of diverse and abundant global ammonoid faunas prior to the Chicxulub impact event.

Thematic Session:

Paleontology in Education and Society

This thematic sessionwill include all the topics concerning Paleontology and its impact in the education at all scholar levels, as well as the influence of this science in society.

Topics of Paleontology in Education can include strategies for a better understanding of paleontological processes in formal and informal education, experiences of students or instructors regarding class time, improvement of teaching/learning strategies, or designing of teaching material. Experiences of teaching Paleontology to minorities or persons with disabilities can be part of the session.

Topics of Paleontology and Society can include conservation of paleontological resources, perception of society of fossil sites or specimens, importance of fossils in certain cultures, or efforts of social groups or people to save fossiliferous sites or to create communal fossilcollections.

Organisers

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Please scroll down for Table of Contents

Table of Contents

Click on the title to go the Abstract

continues >

In the Abstract, click on the title to return to the Table of Contents

Paleontology in Education and Society

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

The paleontological area of Rincón Colorado, northern Mexico, an interactive space for heritage education

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In 1993, research began on the late Cretaceous fossils that crop out in Rincón Colorado, in Coahuila, Mexico. This investigation confirmed the existence of dinosaur bone remains in México, generating a series of expectations and appreciations from researchers, amateurs, and the community close to the area.

In 2010, the National Institute of Anthropology and History (**INAH** by the Spanish acronym) generated different lines of work for the protection and conservation of the area that was established as an educational trail, called "the quarry area". In November 21st of 2018, this area was open to the public and it became the first recognized paleontological area in the country.

The opening of Rincón Colorado aims for a new way of relating the cultural-paleontological heritage to the immediate community that surrounds it, including both researchers and the visitors. The implementation of the heritage education project will contribute significantly to the long-term conservation of the area. Moreover, one of the main objectives of the project is to involve local communities so they can feel their daily importance for the cultural life of their society.

Therefore, we are making a diagnosis of the current problems; we have identified the perception of fossils as an economic resource (sale and purchase), and to collect. We developed a strategy called "*tiempos comunitarios*" with the people who interact with the paleontological area (staff, researchers, visitors, authorities, etc.) to change these appreciations.

Rincón Colorado
Paleontological heritage
Heritage education
Community participation
Fossil landscape

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Palaeontology from lab to people, a Brazilian case study of science outreach

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In Brazil, Palaeontology is scarcely present in all levels of education, but mostly in the curriculum of elementary education. In this context, the project "Divulgando a Paleontologia na Educação Básica" (Promoting Palaeontology in Basic Education) aims to disseminate Palaeontology and scientific knowledge to students and teachers of the elementary education, as a way of giving back to the community the investments made in public universities and highlighting their importance for society. This process is carried out through visits to schools, where a presentation is made, in these lectures we present basic concepts of Palaeontology, such as fossilization processes, different types of fossils and dating methods. Besides, practical activities such as fossil identification are developed, also students are allowed to operate a microscope to observe microfossils. Since the beginning of 2017, 37 schools in Curitiba (Paraná state, Brazil) have been visited, integrating almost 2000 students and dozens of teachers. Through these activities, we have talked with a lot of students and teachers and realize that the paleontological knowledge is precarious, being, in most cases, coming only from TV and Internet. Thus, based on presentations and practical activities, the project proved to be effective as a science learning method and mostly of paleontological knowledge. Finally, we hope to encourage educators to use different methods in the educational process and expect to help teachers to use the methods covered by the project to facilitate the teaching of science to children and build a strong partnership between the university and the external community.

Science education
Palaeontology outreach
Open-ended activities
Brazilian education

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Big fossils in a small town: the origins of the Arroyo del Vizcaíno Collection

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In the summer of 1997, after an intense drought, residents of the rural area near the town of Sauce, Canelones (Uruguay), found in the bed of a stream one of the largest paleontological deposits of fossil megamammals in the country: Arroyo del Vizcaíno, a 30,000-year-old site amazing for its diversity of extinct wildlife and evidence of possible early human presence. Ground sloths, glyptodonts, a saber-tooth cat, a mastodon, a toxodon and a horse are some of the animals that constitute this still-growing collection. The fossils were first collected by students and teachers of the local high school and other members of the community, who also kept a detailed field diary, created the first catalog, identified and prepared the remains, and gave them their first repository. This initial work and dedication allowed the fossils to remain in the locality and laid the foundations of the current collection. Through photographs, home videos and other documents, we will aim to reconstruct part of the unusual history of this collection and the role that the community had in its birth.

With more than 1,500 fossils, the collection can still be visited in the town of Sauce and is currently part of a research, teaching, and outreach center managed by paleontologists of the *Universidad de la República*, who also excavate the site since 2011. Many of the activities that are carried out in the center aim to promote a sense of belonging and ownership of the paleontological heritage by the local community.

Paleontology
Collections
Museums
Pleistocene
Mammals
Science communication
Community Outreach

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Local museums and palaeontology in México: some challenges and perspectives

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In México local museums, meaning those managed by communities, are far to have common features, they are products of findings that are of interest to local people, some others were the product of government programs that tried to promote tourism and education, to be later abruptly abandoned. To date not exist a reliable record of these local museums, in some way, dedicated to palaeontology. Most of them arise as initiatives by local groups of residents with researchers, but rarely with the support of their academic institutions. Over time, the recurring experience fails or presents deviations from its original task, or a museum is an object of political disputes between political groups.

Despite this panorama, **INAH** has found cases of successful management of local museums. This presentation documents some of the central features of these experiences and discusses their importance to those communities where the fossil remains could acquire a biocultural value, since they collectively recognize as part of their past, and incorporate these findings as part of the local culture. Both of the main conditions to produce local museums are intensively planning and the community interest processed by participatory activities. The products should include proper conservation conditions for the paleontological resources, the collaboration with academic personnel and institutions, produce outreach and a heritage education process, but ever also include the tourism factor and economic impact to which communities aspire.

Palaeontology
Local museum
México
Heritage education
Scientific outreach

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Paleobotany for teachers of basic education schools in Curitiba, Paraná, Brazil

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The knowledge that schools must develop from the 1st to the 9th year of Basic Education in Brazil are defined in three thematic units. One of these units is “Life and Evolution”, which proposes a study related to living beings, including an understanding of the evolutionary processes that generate the diversity of life on Earth. The plants comprise a small portion of this unit. Paleobotany is especially suitable for developing the skills of the 2nd year of school, which includes the description of plants and their characteristics related to daily life. Teachers at these schools are rarely graduated in the areas of natural sciences. The greatest challenge is to understand the relationships and adaptations of plants in ecosystems, since this requires an integrated knowledge about the origin, evolution and analysis of changes in geological time. Based on this, a paleobotany activity was created, and learning materials were adapted for teachers to make guided observations, with an emphasis on understanding the plants, to later apply with students. In one of the activities, the objective was to understand the stages of plant evolution in the fossil record, making an analogy with the current plants found in a garden, square, or park. Teachers should also relate to ecological needs (for example, light, moisture, substrate) and morphological structures. At the end of the course, the teachers began to recognize the characteristics of living plants and observe the fossil plants that always appear in the reconstructions of paleovertebrates, but often do not attract attention.

School
Plant fossils
Education
Teachers
Brasil

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3D Digital Photogrametry: a cheap way to preserve and share palaeontological information

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Since the arrival of the new computer technologies, new ways and perspectives to perform palaeontological analyses have emerged. One of these new technologies is 3D digital modelling, a powerful set of techniques and tools that allow us to make a virtual copy of an object.

In the last years, several tests were made with a low-cost equipment to make some 3D models using a cell phone camera, a low-cost computer and a set of software's open-source such as Meshlab, CloudCompare, and VisualSFM. Results obtained had a very acceptable quality, once they are compared with the original object, proving the utility and viability of these techniques in palaeontology as an important tool to preserve and share palaeontological information. As result, a manual and a web page (www.museovirtualnacional.com) were created to teach anyone who is interested in making a 3D model and share models. At this moment, the website counts with a dozen 3D models of three groups, proboscideans, equids and a camel.

One of the main objectives of this project is to provide examples of models made through these techniques, but at the same time to serve as a repository where researchers can share their models with other colleagues and overall, with public in general, especially with those people and students that don't have access to palaeontological museums or fossil collections.

All the models uploaded are available to download for free with a creative common license; thereby, teachers are capable to downloading and printing their own copies to be used in classes as didactic material.

3D
Virtual
Model
Digital
photogrammetry

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Teaching plants evolution and adaptations to the environment through the comparative study of selected fossils morphologies

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One of the concepts that in the field of Natural Sciences has a great presence in the current Secondary Education curriculum in Spain is that of Evolution. Associated with this concept, appear others as speciation, adaptation, biodiversity, biogeography, etc. Despite the multiple references that appear in the Law for Improvement of Educational Quality to the interdisciplinarity and integration that should be in the official teachings, in the corresponding sections related to the assessable learning standards there are very few connections between biology and geology. It is important that students do not have compartmentalized and disjointed knowledge and, therefore, teachers should, whenever possible, provide links between these two sciences. In order to show some of these interconnections, an outreach activity was organized, related to the evolution and environmental adaptations of plants, for a group of students from 4th course of Secondary Education and 1st course of Baccalaureate. This workshop was proposed as a reinforcement of the theoretical classes and with a vision based mainly on paleontological evidence of evolution and adaptations. Students looked at changes in leaf, roots, fruit, pollen and seeds sizes and shapes, inferring evolutionary trends and adaptations to different environmental characteristics. In addition to the reinforcement of previous ideas, it has allowed the learning of new concepts through the use of multisensory materials (fossils, rocks, sheets of current plants...). Preliminary results indicate that in addition to having been motivating for students, it has meant more lasting knowledge over time as it was associated with visual and tactile stimuli.

High school
students
Evolution
Plants
Multisensory
materials

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Differences in perception of paleontology teaching in Mexican universities

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The objective of this research is to discuss the differences between teaching Paleontology to the students of Geology versus students of Biology at the bachelor's degree level. Differences between the student populations rely on the understanding of Paleontology in different fields.

In many Mexican universities, geologists learn Paleontology as a tool to understand the sedimentary environment and the relative age of the sediments. In particular, this field is of interest for future petroleum geologists. The main topics included in the courses are general paleontology, micropaleontology and stratigraphic paleontology. Because of this perspective, Paleontology is considered by many geologists to be a helpful technique, albeit with restricted uses.

On the other hand, Biology students consider Paleontology as a science that allows them to understand how the living world has evolved, and how the ancient organisms were functionally efficient to survive in a world different from the world of today. Biologists can understand the enormous time-lapses — and the evolution of the different lineages before their extinction — as well the possible causes of these extinctions. In many universities, the course "Paleontology" has been replaced by "Paleobiology", although the contents of the courses remain almost the same.

These differences in the perception of the students can be used by teachers to improve the courses as well as the effective transmission of the information in the classroom.

Paleobiology
University
Biologist
Geologist

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Social appropriation of paleontological heritage by children in the Mixteca of Oaxaca, south of Mexico

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The objective of this project was to know the appreciation of fossil heritage by kids from rural and semirural populations in Oaxaca, southern Mexico, through specifically designed workshops for their educative, social, and cultural characteristics.

Workshops were presented in three communities. Two of them (Cuauhtémoc Tayata and San Antonio Acutla) have multigrade rural schools, which means that there are one or two teachers for all the six levels of elemental education. The other community (Santiago Yolomécatl) has three schools, from elementary to high school level.

We visited a total of five schools. The workshop "Mis fósiles, mi patrimonio" was structured in five parts: **1)** an initial evaluation, **2)** an induction to basic concepts of Paleontology, **3)** sensibilization strategies to generate the valorization and appreciation of fossil resources in the municipal area, **4)** proposals of conservation strategies for the paleontological heritage, and **5)** cognitive closure and motivation dynamics for the long-term protection of fossil resources.

Didactic material used in the workshop included casts from different terrestrial and marine fossil organisms, posters with different themes related to Paleontology, and five leaflets.

Results indicated that children from rural communities are more receptive than semirural children. Rural children have a closer relationship with natural resources, which encourages feelings of care and proud of their environment. Semirural children have more academic background about Paleontology and their conservation proposals were more elaborated. However, rural children seemed more emotional, which could be used as an effective long-term strategy for the conservation of paleontological resources.

Fossil record
Informal education
Rural communities
Semirural communities
Workshops

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Protection of palaeontological heritage by means of local museums in two towns of the Mixteca Alta Oaxaqueña, southern México

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The Mixteca Alta region of northwestern Oaxaca has an exceptional paleontological record, spanning from the middle Jurassic to the late Pleistocene. Over the years, their inhabitants have been collecting fossils from their lands.

In Cuauhtémoc Tayata and Santiago Yolomécatl, people and schools organized and decided to donate fossil specimens and archaeological remains to open local museums to exhibit part of their fossils. In Cuauhtémoc Tayata, the exhibition consists of Pleistocene mammals, including mammoths (***Mammuthus***) of several ages, a giant deer (***Odocoileus***), gomphotheres (***Cuvieronius***), and a longhorn or long-horned bison (***Bison***). In Santiago Yolomécatl, Oligocene rodent burrows, bee and wasp ichnofossils are exhibited, along with rodent bones (***Gregorymys***), large mammal bones, Jurassic gastropods, and some archeological artifacts. In both museums, the infographics describe aspects of the history of life on Earth, the processes of fossilization, the Mexican palaeontological richness, glaciations and Pleistocene, and the importance of protecting the Mexican fossils complement the exhibitions.

The municipal authorities of Santiago Yolomécatl and Cuauhtémoc Tayata consider that their recently opened local museums will enhance the protection of their fossils and archeological remains in their lands during the near future, by sensitizing general public about the importance of their palaeontological heritage.

Palaeontological heritage
Oaxaca
Protection
Santiago Yolomécatl
Cuahutemoc Tayata

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Who's that Pokémon?
Teaching phylogenetic principles with pocket monsters

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Despite the fact that modern taxonomy has moved away from Linnean systematics since the adoption of cladistics analyses, that legacy framework is still taught to students in high school and college undergraduate courses. Although phylogenetic principles appear complex, the theories underpinning them are intuitive, especially if taught using familiar subjects. I have found that people of all ages and with a variety of educational backgrounds respond well to these ideas when Pokémon, the popular video game characters, are utilized. Here, I will give a brief overview of phylogenetic principles using both dinosaurs and Pokémon to illuminate underlying phylogenetic theories, terminology, assumptions, and references and then move into how to build a simple character list for 46 individual Pokémon from the original 1998 Game Boy games and produce a phylogenetic analysis using TNT for those taxa.

Phylogenetics
Education
Outreach
Pokémon

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Scientific activities in primary education: taphonomy explained in close contexts

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The emergence of active methodologies in education has revolutionized science teaching. The use of elements of scientific work such as the science notebook, databases or field trips, facilitate the development of critical thinking, the basis of scientific knowledge. The selection of Eirós Cave (Triacastela, Lugo) is due to its important lithic and faunal remains of the middle and upper Paleolithic periods.

The intervention is aimed at the fourth year of Primary Education. The proposal has been divided in five sessions following the scientific method: **1)** Observation, **2)** Formulation and prediction, **3)** Experimental development, **4)** Conclusions, and **5)** Dissemination.

In the experimental development, students' groups will choose a certain group of identified animals in the cave — carnivores, herbivores and omnivores. Subsequently, they will make a plasticine mold (safe material for students) of that group and place a methacrylate over the piece. Later, with their eyes closed, they will walk over the methacrylates — representing the passage of time — and describe the changes produced posteriorly. Some small bites and cuts will be applied in several animals to study the difference between human intervention and other predators.

The use of active methodologies allows students to develop procedural and attitudinal aspects through the research and the cooperative work. The fact that students face the definition of the concepts and write their science notebook allows them to organize their own research work in their group.

Primary education
Eirós Cave
Taphonomy
Scientific method
Active methodologies

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Unearthing my community's natural history: taking paleontology to rural schools of Mexico

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For over twenty years, El Madroño — a rudist-reef locality in the state of Querétaro, within the Sierra Gorda Biosphere Reserve in central Mexico — was extensively studied because it provided insights on the evolution of late Cretaceous reef life in North America. However, this knowledge never reached the local community, so the fossil's significance was lost, and the locality was ransacked by visitors. This conservation problem adds up to several marginalization problems in the region. It is therefore necessary that people become aware of the enormous natural wealth of their community, and they take part in its study and conservation.

In 2017, we set out to make knowledge of El Madroño accessible to students who live around the locality. We chose one kindergarten, four elementary schools, one middle school, and two high schools, reaching a total of 447 students. Through the development of modular workshops, using diverse techniques and materials, students were able to approach the world of paleontology and the natural history of their own land. By filming the activities and interviewing students and local adults, we were able to assess the impact of these activities and the social perception of fossils, as well as the background of the community.

This is an ongoing project that seeks to contribute to El Madroño's inhabitant's identity, focusing on the conservation of their community for greater social development. We believe that some of those students can grow up to be the next Mexican palaeontologists, unearthing the Cretaceous localities hidden in those mountains.

Science communication
Paleontological education
Rural schools
Mexico

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The spreading fossil heritage, how to valorize the lithographic limestone of la Pedrera de Meià Site in the Origens UNESCO Global Geopark

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The central Southern Pyrenees is characterized by a very rich continental Cretaceous fossil heritage. One of the most impressive sites is the Aptian (Lower Cretaceous) Lagerstätte of La Pedrera de Meià (Vilanova de Meià, NW Catalonia, Spain). Fossils are found in fine lithographic limestone slabs, which keeps fossilized remains of vertebrates, non-vertebrates (including insects), plants, and coprolites. The site has yielded so far more than 150 species and 109 types, such as the holotype of the earliest angiosperm ***Montsechia vidalii*** and the holotype of the enanthiornithine bird ***Noguerornis gonzalezi***, demonstrating its palaeocological significance. An early beginning of its commercial exploitation as a lithographic limestone quarry, in 1898, together with a weak palaeontological Spanish scientific network for much of the 20th century, resulted in the spread of more than 8,000 specimens across 12 European institutions. A new project led by the Museu de la Conca Dellà on the palaeontological dissemination of the Pyrenean Cretaceous fossils has started an exhaustive research on these institutions in order to achieve a complete database of the spread fossils, that will disseminate them on a virtual platform to visualize this site as a whole unit. On the other hand, the fossil collection of the Institut d'Estudis Ilerdencs will be exhibit at the dissemination center of the small village of Vilanova de Meià, the closest locality to the site, with the aim to return part of this heritage as a development tool for tourism and education.

Heritage
Fossil Lagerstätten
Lithographic limestone
Virtual museum

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A virtual lab to introduce undergraduate students to paleoenvironmental reconstructions using benthic foraminifera

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One of the most common challenges associated with teaching Earth Science classes online is the development of meaningful and engaging inquiry-based labs. One can come up with many interesting ideas, but implementing them online, in a rather inflexible setting where everything is set up ahead of time and direct interactions with the students are not possible, often appears as a daunting task. However, very good results can be achieved by shifting the focus from developing an activity that perfectly mimics what is done in the classroom, to designing an exercise that takes advantage of the online format and yet maintains the rigor of a scientific investigation.

Here I present an inquiry-based exercise developed for an upper-level, undergraduate online Oceanography class, which is a required course for the Earth Science majors, and an elective for the Geology majors. The lab accompanies a unit on Extreme Oceans, where students learn about the conditions that brought to the deposition of Banded Iron Formations, Cretaceous Black Shales, and Mediterranean sapropels. Before this unit students already learned the fundamentals of marine geology, ocean chemistry, and ocean circulation. In the lab, students are presented with the task of reconstructing paleoenvironmental changes in an ancient ocean using simplified (drawings) benthic foraminifera assemblages in 15 samples. Students follow the procedures commonly used in micropaleontological investigations to conclude on environmental conditions at the seafloor, time interval under consideration, and correlation to climate change. Students enjoy the lab, which offers a great opportunity to expose undergraduates to micropaleontology.

Virtual lab
Foraminifera
Benthic
paleoceanography

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Journal of Geek Studies: a platform for geek science communication

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Scientists are becoming increasingly aware that works of fiction can contribute to science communication and are amazing tools to begin conversations with the public. Such works comprise films, series, books, comics, and games in all their forms; together, they might be called geek culture. Being both scientists and immersed into that niche, we decided to join both realms to start the Journal of Geek Studies (https://jgeekstudies.org) in 2014. The **JGS** is an online magazine publishing articles that use a geeky background to discuss a scientific topic. This can go from Physics and Computer Science, to History and Archaeology, to Biology and Paleontology. Our experience has shown that there is a public out there interested in this and, more than that, we have also been attracting scientists to partake on science communication. They are keen on writing about things they love and do not usually have the opportunity to discuss, such as the biology of pocket monsters or the physics of superheroes. At the moment, the JGS has 66 articles, of which five are specifically about Paleontology (others include fossils but not as primary focus), covering a range of geeky themes, such as Pokémon, The Lord of the Rings and Super Mario Bros. Paleontology is always good at capturing the public's attention, so we are constantly on the lookout for more articles. All are welcome to contribute, of course, just remember our goal is the popularization of science, so everything must be explained with a broad audience in mind.

Fantasy
Paleontology
Pop culture
Science fiction
Video games

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Experimenting 3D models and virtual educational exhibits at the University Museum of Palaeontology and Prehistory “Piero Leonardi” (Ferrara, Italy)

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Since the decade of 1970’s, the “**Piero Leonardi**” University Museum of Palaeontology and Prehistory located in Ferrara (Italy) has had thousands of students walking its rooms yearly to engage in educational activities. These activities did not just involve students from the university, but also children from the neighboring schools. In addition, the museum organized experimental education workshops for teachers. Unfortunately, all these activities were put on hold on May 2012, when the province of Ferrara was hit by an earthquake: the structural damage to the museum’s halls forced the museum to temporarily close its doors. This project aims at creating a new way in which the museum can reconnect with the community, using virtual technology as a means to carry on its educational mission and have an impact on society. Since the role acquired by digital technology in the fields of communication and learning is indisputable today, the digitisation of the museum allowed the experimentation of new forms of communication that successfully engage an ever-changing audience, devising strategies that are tailor-made for the new generations.

The technologies we chose are low-budget and yet highly engaging: using online software and a 360° camera, we created a virtual tour of the Vertebrate Palaeontology hall. Also, a local fossil specimen that had not been previously exhibited was digitized using photogrammetry. The result is a captivating online exhibition that combines 3D models with scientific content, designed to be used as teaching material or lived as a personal educational experience.

Virtual tour
Palaeontology
Photogrammetry
Educational exhibit
3D models

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Amber education at University of Gdańsk

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Museum of Amber Inclusions was established in 1998, for scientific purposes. Since the beginnings of the Museum, the close cooperation with the amber-workers environment has been established. The small exhibition of the amber and its inclusions was presented since the establishment of the collection. In 2012, the new exhibition "Life in amber forest" was opened as a permanent educational exhibition devoted to amber and its inclusions. The Museum and its workers are involved in the scientific elaboration of the material, but rich activities to all age and interest groups were and still are offered. Museum of Amber Inclusions together with the Palaeoentomological Section of the Polish Entomological Society is present during the **AMBERIF** and **AMBERMART** fairs, various types of workshops are provided with the cooperation of the International Amber Association, for amateurs, tourist guides, amber sellers, and amber jewellery makers. Courses, workshops, and lectures are offered to the public during the events as Baltic Festival of Science, Night of the Biologists, Open Days at the University. The exhibition, collections, and facilities of the Museum of Amber inclusions were also used in popular science and documentary films. Museum of Amber Inclusions is a member of the University Museums Association, which enables new educational initiatives for secondary school pupils and students of various specialisations interest in amber knowledge and experience.

W Permanent exhibition
Workshops
Courses
Education events
Amber education

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A taphonomical approach to encourage local collaboration and social appreciation of the paleontological heritage

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The paleontological Upper Jurassic fossil record from the Los Serranos region (Valencia, Spain) provides a scenario that gives us an excellent opportunity to teach Paleontology as in a natural laboratory. Visits to the paleontological museum of the village of Alpuente, to the Paleontological Recovery Laboratory, to the footprint sites and the educational program of the museum are designed not only for the public to enjoy the fossils exhibited but also for them to value this natural heritage. In this way, the taphonomy has been a key tool to promote awareness and respect for the paleontological heritage of both, visitors and local inhabitants (whose role is crucial in identifying and protecting sites and fossils).

Following a large number of authors, taphonomy study the processes that act from the production of the taphonomic entities, i.e. fossils, until the present. Therefore, all processes and activities involved in the extraction, preparation, study or preservation of the remains also belong to their taphonomic history (i.e., sullegic and trephic processes).

When paleontologists are out in the field collecting fossils, we record a lot of information about what's around the specimens. When an anonymous person removes a fossil, it's like taking a body out of a crime scene, the specimen loses scientific value when is removed from their context. In this sense, the scientific community in Alpuente maintains close ties with the local community, and a positive result has been the call of the neighbors to communicate the finding of a fossil instead of extracting it.

Science education
Palaeontology
outreach
Heritage
Sullegic and
trephic factors

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The “Georg Gasser” Palaeontological Collection: a preliminary overview

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The Museum of Nature South Tyrol hosts the palaeontological collection of Georg Gasser, a self-taught naturalist, who assemblaged the most important historical collection of natural objects of the region. Born in Rentsch, Gasser began to collect natural history specimen in the 1890’s, creating the typical “Wunderkammer” setting inside his house.

His exhibition contained botanical, zoological, archaeological, mineralogical and palaeontological specimens. When Gasser died, part of his collection was purchased by the Mineralogical Institute of the University of Padua, while some specimens were sold privately. The remainder part of his legacy was donated by the heirs to form a natural history museum in Bolzano and became the foundation of the Museum of Nature South Tyrol. Thanks to a research project, the Gasser palaeontological collection will be digitized using modern techniques and a taxonomical revision is also in progress.

The purpose of the research project is to characterize the collection through the number of specimens and species present as well as to understand its stratigraphic and geographical distribution. Composed of palaeozoological and palaeobotanical objects, the historical collection has the potential to give insights in the scientific memory of the collecting areas during the XVIII and XIX centuries. Some of the areas that were sampled during those times may not be available anymore due to constructions and/or changes in the natural or human-based landscape.

Collection
Georg Gasser
Paleontology
Conservation
Museology

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Life stories behind the collections: the Loewenthal's Collection

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Museo di Storia Naturale di Verona, Italy

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The Natural History Museum of Verona hosts among its collections, also donations made by private, over time. Within these, there is the Loewenthal's collection, constituted by different specimens of minerals and fossils, with a varied geographical and chronostratigraphic distribution.

The Loewenthal's family was a German family of Jewish origin, that tried to escape the persecution of the Nazi regime, moving to Italy in the decade of 1930's.

The destiny of this family has a dramatic ending: only the two daughters survived.

The collection is the product of the passion for geology and paleontology of one of them, shared with her husband and her sister.

This collection has a great didactic meaning thanks to the good preservation of the samples and the scientific criteria used to make it. In addition, it has an educational role, helping us to keep memory alive.

In fact, through the surname associated with it, it recalls the personal history of the family and, in this way, it makes us remember, in a clear way, the violence of intolerance and the tragedy of its consequences.

Collection
Loewenthal
World War II
Memory
Museology

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Teaching palaeontology by distance learning; the experience from Birkbeck College, University of London

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Birkbeck College was established in 1823 with the aim of offering university education to people otherwise excluded from the university system. Birkbeck came to specialise in teaching part time degrees by evening teaching. To expand on widening participation, in 2000 the Department of Earth and Planetary Science started teaching by distance learning, initially offering modules and soon afterwards complete degrees. Initially CD-Roms were produced, later moving online as technology improved. Our student body now includes a mix of attending students (part time and full time), distance learning (**DL**) students who may be local (and prevented from attending by work or family commitments or disability) or remote, and students studying by "blended learning" — a mixture of the two mechanisms.

Whilst it was easy (if time consuming) to produce lecture material as "interactive text books", these lacks the hands-on experience essential in palaeontology. To improve the teaching experience for distance learning students, teaching labs were equipped with software allowing students to toggle between view through microscopes, a visualizer and the camera recording the lecture. Students in the labs have touch screen interfaces allowing them to likewise move between media.

Whilst we have experimented with virtual field trips, and have some available for students, the main field-classes for the Geoscience degrees are attended and offer an opportunity for all students to meet up and also for DL students to meet lecturing staff. Moving to pure DL output in March 2020 due to the coronavirus virus stress tested this system and proved its versatility.

Birkbeck
Distance learning
Geology
Teaching
Undergraduate

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The Paleontological Didactic Museum of Ocucaje, Perú

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The aim of this work is to communicate to general public, students, scientists, teachers, and professors the distribution of rooms and educational materials (illustrations, models, dioramas) of the Paleontological Didactic Museum of Ocucaje (**MDPO**). The MDPO was founded in 2015, under the management of the District Municipality. Nowadays, it has five exhibition halls, one library, 26 models representing peruvian species like ***Cinthyacetus***, ***Ocucajea***, ***Livyatan*** and ***Odobenoceptos***; extinct animals autochthonous of Ocucaje, three dioramas, 22 illustrations of the reconstruction of native fossils, and one school project. Ricardo Palma University, the National University of Arequipa and the National Agrarian University of La Molina visited the museum with undergraduate students. Ocucaje Paleontological Museum is being developed as a learning space where students can acquire scientific and paleontological knowledge.

Museology
Ica
Paleontological heritage
Education

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General Session:

General Palaeontology

Please scroll down for Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

General Session: General Palaeontology

Table of Contents

Peer Community in Paleontology: Let's rethink how research results are published

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More and more researchers are now mandated to publish their results in Open Access journals, the most prestigious ones charging Article Processing Charges (APCs) of $1,000–3,000 or more. The problem is not Open Access itself, but the actual structure and cost of academic publishing. This extremely profitable industry (worth $25 billions per year) is led by a few giants (Elsevier, Springer, Taylor & Francis, Wiley, etc.) boasting net profit margins of 30 to 40%, more than Google, Apple, Facebook, Amazon. This industry is sustained mainly by public money and profiting from the unpaid work of researchers who act as producers (authors), controllers (reviewers), and managers (editors), and whose salary is paid again by the public.

This is not a fatality. Open online archives (such as **bioRxiv** and **paleorXiv**) already permit the free, immediate dissemination of scientific results, questioning the need to maintain a costly journal-based system. The necessary peer review process of these online deposited articles can be organized quite easily outside of journals. The Peer Community In (**PCI**) project is a non-profit grassroots initiative with editorial communities in many disciplines, including Evolutionary Biology and Paleontology. PCI Paleo organizes the peer review evaluation of submitted manuscripts and publishes the complete editorial process of those papers that are ultimately accepted (transparent peer review). Accepted articles are clearly labelled as peer-reviewed and linked to their peer review process on PCI Paleo. This Open Access publishing workflow operates on very limited funds and is entirely free of charge for authors and readers.

Open Access
Publishing
Peer review

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Thin sections techniques in fossil remains of mammals impregnated with asphalt

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Paleohistological studies of vertebrates are based on the analysis and interpretation of bone microstructure of petrographic thin sections. These sections are mainly performed following standard techniques; however, the methodology can vary according to the particular characteristics of the sample (e.g. skeletal element, type of preservation) or the purpose of the work. As part of a paleohistological study on Equus occidentalis recovered from a Late Pleistocene asphalt seep ("tar pit"), Rancho La Brea (California, United States), in this contribution we describe the technique used to make thin sections of fossils impregnated with asphalt. The hydrocarbons act as a release agent, which causes the resins commonly used for glued or embedding not to adhere to the fossil remains. For chip preparation (= block) the sample were embedded in a large volume of low-viscosity epoxy resin, which generated a higher shrinkage and prevented the separation of the chip components (resin / fossil). The chip must be mounted on the glass slide using UV acrylic resin, which, unlike epoxy resins, does not require heat application, optimizes adhesion, and reduces the curing time, offering the possibility of cutting and polishing quickly after mounting. During polishing, it was necessary to reduce the cleaning time with ultrasound to avoid peeling and loss of portions of the sample. Based on the results obtained, we consider that this variant of the traditional methodology is optimal to work with fossils preserved in this particular context, as it allows making complete thin sections without altering the original osteohistological features.

Paleohistology
Vertebrates
Techniques
Thin sections
Asphalt

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Trilobozoa, crawling tri-radial Precambrian animals

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Trilobozoa Fedonkin, 1985 s.str. is well-distinguished group of Precambrian macroorganisms. The shield-like small (less than 4 cm) body of trilobozoans consisted of three straight or curved antimeres, bearing a branching network of grooves. The classic Ediacaran organism, ***Tribrachidium heraldicum***, is one of the trilobozoans. It had strongly curved antimeres and the appearance of a triskelion. According to our interpretation, a cluster of grooves located on the outer surface of the body and an elongated inner cavity associated with it belonged to each antimere of ***Tribrachidium***. We consider the grooves to represent a part of the ciliary organ serving for collecting food particles, and the internal cavity is considered to be digestive. Microparticles suspended in water could be a food source for trilobozoans. The fossil remains of trilobozoans are preserved *in situ* in the localities of the Flinders-Belomorian type. However, they were not sedentary organisms. A loose attachment to the substrate is indicated by specimens with one of the antimeres raised above the fossilization plane. Indirect indications of mobility are given by the specimens overlapping the structures of palaeopascichnids, supposed giant protozoans, spread along the surface of microbial mats. Only one specimen of a trace of trilobozoan movement is known. The imprint of the trace demonstrates a short, slightly curved depression laterally extending from the shield of ***Tribrachidium***. The depression is covered with numerous ridges, representing casts from the grooves covering the shield. The trace was presumably left by an animal that crawled in a thin layer of unconsolidated silty sediment, covering the microbial mat, just before its death. Thus, we believe that the trilobozoans were less mobile benthic seston-feeders that had gastric cavities closed at their ends and developed ciliary epithelium but did not have tentacles. According to this body plan, they can be considered Coelenterata. However, they belonged neither to the Ctenophores nor to the Cnidarians but represented a separate ancient branch of Coelenterata.

This study is supported by RSF grant No. 19-14-00346.

Paleohistology
Vertebrates
Techniques
Thin sections
Asphalt

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Escape Traces of *Dickinsonia*

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The classical Ediacaran macroorganism, ***Dickinsonia***, is considered by the authors to belong within the Eumetazoa. ***Dickinsonia*** was part of a community inhabiting hydrodynamically active shallow waters, which sporadically experienced being covered by siliciclastic material. Here we describe about two dozen specimens of structures preserved on the bottom of the sandstone layers of the north of European Russia, as the imprints of ***Dickinsonia***'s escape traces (fugichnia) from under the catastrophically deposited sediment. It seems that the traces were left on the surface of the microbial mat, and result from the stretching of individual parts of ***Dickinsonia***'s body in different directions along the fossilization surface. The described structures are mostly found in direct contact with the body imprint of ***Dickinsonia***, or a part of it, recognizable by the dark color of its own carbonized organic matter. Some of its parts can be raised into the strata of the overlying sandstone. Sometimes the body is completely absent on the bed sole but can be found within the layer as a pyrite pseudomorph after organic material. In this case, the fossilized body is located above the trace. The absence of lateral displacement and multidirectional movements preceding the liftoff of the body make it unlikely that the animal was separated from the substrate due to some external forces during or immediately after the burial. In some cases, only the trace is preserved and the body is not detected. The escape traces of ***Dickinsonia***, along with previously identified locomotion traces and feeding traces arranged in chains, provide additional evidence that these organisms were capable of active movement.

Eumetazoa
Dickinsonia
Trace fossils
Ediacaran
Precambrian

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Trace Fossils from the Permian and Triassic terrigenous succession of the South Verkhoyanie (Republic of Sakha – Yakutia, Russian Federation)

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The collection of ichnofossils is sampled from the Tiryakh-Kobyume section (N 63.374284, E 140.945873) located in South Verkhoyanie Mountain System.

The section consists of the Permian (Wordian–Changsingian; about 4000 m) and Triassic (Induan, about 500 m) sediments which represented by interbedding sandstones, siltstones, and mudstones. Rocks contain subordinate interbeds of bentonites, levels of siderite and carbonate concretions, diamictites, and glendonites. All strata, especially siltstones, contain numerous trace fossils, and usually are characterized by a high bioturbation index.

The most common traces found in siltstone beds of the whole section are flat, elongated blades, subhorizontal, or slightly inclined to the bedding planes, conventionally assigned to ***Phycosiphon*** Fischer-Ooster, 1858. In the Permian part of the section, these traces are characterized by relatively large size and are often found with ***Zoophycos*** Massalongo, 1855.

In the transitional Permian–Triassic interval, only ***Phycosiphon***-like forms occur. The size of these forms decreases to the first millimetres, but the bioturbation index of the rocks remains high.

In the Triassic sandstones, we identify vertical U-shaped spreite traces belonging to the ichnogenus ***Diplocraterion*** Torell, 1870. Interestingly, ***Diplocraterion*** is appeared as the first trace fossils after Permo-Triassic extinction in several sections worldwide.

The trace fossils ***Phycosiphon*** and ***Zoophycos***, which are abundant in the Permian interval of the section, can be attributed to the ***Zoophycos*** Ichnofacies, characterized by low wave energy, oxygen-poor settings, and located below the basis of storm waves. The early Triassic ***Diplocraterion*** icnocenosis indicate an oxygenation increasing and a highly dynamic coastal-marine environment with repeated erosion and deposition. The ***Diplocraterion*** icnocenosis can be attributed to the Skolithos Ichnofacies.

Ichnotaxonomy
Permo-Triassic Extinction
Palaeoenvironment
South Verkhoyanie

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Hydrodynamic transport potential of modelled turtle shell in a controlled fluvial setting: a case study in experimental taphonomy

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The Arlington Archosaur Site (**AAS**) is a fossil locality located between Fort Worth and Dallas, Texas, and contains an array of Woodbine Group (~96 Ma) fossils. Evidence suggests most AAS fossils were deposited in a low-energy freshwater or brackish environment. Among the most abundant remains scattered throughout the site are whole and fragmented pieces of turtle shell of varying sizes. Shell pieces exhibit a diversity of preservation states from complete pieces to small, eroded fragments. To test the hypothesized processes of shell deposition, a series of taphonomic experiments were conducted to explore **1)** potential entrainment velocities and settling orientations of shell pieces, and **2)** abrasion during transport and entrainment. To test potential entrainment velocities and settling orientations of shell pieces, models of generalized shell shapes were designed and cast in resin. Models were placed into a flume with manual velocity control, where velocity was increased to induce transport. To test the potential taphonomic modification to shell pieces during fluvial transport, modern turtle elements were placed in a rock tumbler with uniform sized sediment (silt, fine sand, coarse sand) to observe patterns of wear. Preliminary results suggest element length and degree of curvature affect transport potential. Curved elements require lower entrainment velocities while smaller, flatter elements require greater entrainment velocities but, once mobile, are transported further. Surface wear was observed on all shell pieces, though the nature and location differed. Turtle shell preservation patterns may be useful for understanding processes driving vertebrate accumulation at fossil sites such as the AAS.

Experimental taphonomy
Fluvial transport
Paleoecology
Turtle shell
Cretaceous

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Overview of the evolution of crurotarsal joint in Synapsida

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Archosauria and Mammalia are two lineages without close relationship but showing wide convergence in locomotion styles. We reviewed data about the crurotarsal joint in the Synapsida lineage, using the most recent phylogenetic hypothesis for the group, in order to a compare the evolution of bipedalism in both groups. We compiled available data referring to the crurotarsal joint in the mammalian clade: astragalar reduction in size, presence of astragalus sulcus, presence of astragalocalcaneal overlap, presence of calcaneal tuberosity, presence of sustentaculum tali and presence of joint between calcaneum and astragalus. These data were summarized in a cladogram with the taxa Ophiacodontidae, Venyukoviidae, Scylacosauridae, Ecteniniidae, Brasilodontidae, Megatheriidae, Palaeothentidae and Hominidae in a comparative analysis with the Archosauria postural evolution. The Ophiacodontidae, the basalmost synapsid group in the analysis, show plesiomorphic states in all characters, included a convergent Primitive Metatarsal joint. The derivate state of the joint between the calcaneum and astragalus appear in the Scylacosauridae and Ecteniniidae. This is a condition convergent with the Crocodile Normal joint in Archosauria. The calcaneum tuberosity and a astragalocalcaneal overlap, resulting in an convergent Advanced Metatarsal joint, appears in the Brasilodontidae. However, despite the Brasilodontidae family presents a quadrupedal posture, the Palaeothentidae and Megatheriidae are both facultative bipedal. These preliminary results show that in the Synapsida, morphological modifications precede the acquisition of postural changes, as it happened in Archosauria, with the acquisition of Advanced Metatarsal joint appear first and then the bipedal posture. A complete test of this hypothesis will however require a more extensive taxon sampling.

Crurotarsal joint
Obligate
Bipedalism
Mammals
Evolution

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Non-marine bivalves from the terminal Permian and Lower Triassic deposits of the Kuznetsk Coal Basin (West Siberia, Russia)

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Non-marine bivalves have been collected from the Tailugan Formation (Permian) and Maltsevo Formation (Permian–Triassic) of the Babii Kamen Section. Three distinct assemblages characterize the Tailugan Formation and the lower and upper parts of the Maltsevo Formation.

The first assemblage (Tailugan Fm) is represented by the typical Permian genera of Angaraland: Anadontella and Degeniella. Geochemical data from fine-grained siliciclastic sediments (claystones) indicate humid precipitation conditions and oxidative redox conditions (high reduction-oxidation reaction (**Eh**)).

The second assemblage (lower part of the Maltsevo Fm) includes the Permian East European genus ***Palaeomutela*** and rare ***Anadontella***. Shells consist of primary aragonite (confirmed by **RAMAN** spectroscopy). Geochemical data from fine-grained siliciclastic and carbonatic sediments indicate a semi-humid climate and a decrease of oxygen in the sediment (Eh reduced).

The third assemblage is represented by Triassic taxa, partially new, partially belonging to ***Utchamiella*** Ragozin (known from Korvunchan Fm, Tunguska Basin, Siberia). Primary shell aragonite is preserved. The upper layer is simple prismatic, the lower layer–crossed lamellar. Ligament is opisthodetic. Geochemical data from fine-grained (claystone) siliciclastics indicate a semi-arid climate and anoxic conditions (low Eh).

Our findings support the radiometric dating of the lower part of the Maltsevo Formation as Late Permian (in contrast to previous biostratigraphic data, pointing to an Early Triassic (Induan) age). The Triassic bivalve assemblage needs detailed study and description. Shells with preserved aragonite suggest low partial pressure of carbon dioxide, relatively low Eh and buffer pH in the mud during sedimentation, and rapid burial of the bivalves.

Non-marine bivalves
Late Permian
Early Triassic
Kuznetsk Coal Basin
West Siberia

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Microstructure and mineralogy of dental plates of chimaeroid fishes (Chondrichthyes) and the relationship between modern chimaeroid tooth plates and teeth of Palaeozoic holocephalans

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Chimaeroid fishes possess a unique dentition of three pairs of continuously growing tooth plates, completely unlike the continuously replaced teeth of sharks and rays, the other extant Chondrichthyes. These tooth plates have a complex and unique structure, with hardened tritoral pads, rods and rows of ovoids which pass through the tooth plate from the wear surface to the growing edge. The morphology and distribution of these structures differs both between taxa and between juveniles and adults of the same species. Furthermore, this hardened tissue is not composed of apatite, the dominant material in vertebrate hard tissues, but magnesium whitlockite, a material otherwise found only as a minor component in bone.

Palaeozoic holocephalans have dentitions that are very varied in their form and growth. Many have a “shark-like” dentition, with individual teeth produced, and shed, in succession, whilst others have tooth plates that form spirals, with the oldest part of the plate in the centre of the spiral. The genus ***Helodus*** is uniquely positioned, with both tooth plates and separate teeth being present, sometimes in different parts of the jaw of the same individual. This genus thus offers a key to the understanding of holocephalan tooth evolution. Within these early holocephalans, tritoral tissue forms a surface layer to the dentition, not the complex 3D form of chimaeroids, and there is no evidence that Mg whitlockite was present. We propose that Mg in dental plates of modern holocephalans is related to the Mesozoic origins of the Chimaeriformes in Mg-rich, aragonitic seas.

Biomineralisation
Chimaeroid
Chondrichthyes
Microstructure
Teeth

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General Session:

Palaeozoic

Please scroll down for Table of Contents
Click on the title to go the Abstract
In the Abstract, click on the title to return to the Table of Contents

Table of Contents

Computed tomography of Devonian asterozoans from the Paraná Basin, Brazil

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The fossilized asterozoans from the Brazilian Devonian are fascinating records because most of the known specimens are articulated, well-preserved molds. However, the potential of samples is limited by the application of traditional investigation methods, such as silicone molding and mechanical preparation, which often damage the friable sedimentary matrix of siltstones and mudstones, where many fossils are preserved. Thus, we apply here X-ray computed tomography as a useful, non-destructive tool for the study of asterozoan molds partially or completely covered by sediments. For this, an i-CAT scanner was used to rapid three-dimensional recordings of four asterozoan samples, with single exposed fossils, from two outcrops of the Ponta Grossa Formation, in southern Brazil. As the multi-element skeleton of these asterozoans is preserved as a mold, space previously occupied by the ossicles was gradually filled with air due to post-diagenetic carbonate dissolution processes. This condition allows tomographic analysis to highlight any specimen obscured or largely hidden through the contrast between the air and the surrounding rock. As an important result, three-dimensional visualization revealed a well-preserved ophiuroid specimen buried in sand-siltstone, with the skeletal arrangement without marked ambital framework ossicles and, therefore, distinct from ***Encrinaster pontis*** and ***Marginix notatus*** recorded in the region. Furthermore, tomography also showed the disposition of pyrite nodules, obscured fragments of asterozoan arms, and changes in the orientation of associated tentaculitoid shells. Therefore, X-ray computed tomography provides a method of rapid, non-invasive analysis of echinoderm molds, mainly as a powerful resource for taphonomic research and overall taxonomic descriptions.

3D
CT scan
echinoderm
Ponta Grossa
Formation

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Endocast anatomy of the megalichthyid tetrapodomorph, *Cladarosymblema*, elucidated via micro-CT

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Scanning technologies such as micro-CT, synchrotron and neutron scanning have transformed palaeoneurology, the study of "fossil brains" in recent years. A mould of the internal space, a "virtual endocast" can elucidate details of neural anatomy in well-preserved 3-D specimens.

Much is understood about the changes to the postcranial skeleton that occurred over the fish-tetrapod transition but relatively little is known concerning changes to brain morphology during this "greatest step" in evolution, or indeed throughout much of the tetrapodomorph stem.

Two exceptionally preserved specimens of the megalichthyid, ***Cladarosymblema***, from Queensland, Australia, were scanned using micro-CT to uncover details of endocast anatomy. In overall form, the endocast is more elongate than that of the stem-tetrapodomorph ***Tungsenia***, and instead more closely resembles that of ***Spodichthys***. However in contrast to ***Spodichthys***, the hypophyseal region is more robust and does not extend so far ventrally in ***Cladarosymblema***, more alike the condition seen in ***Gogonasus***.

This provides one of the few tetrapodomorph braincases for which perfect, uncrushed 3-D reconstruction of the endocast is possible. Thus, it affords valuable insight into the brain morphology in stem tetrapodomorphs and can help shed light onto the changes that occurred as fish moved from water to land.

Sarcopterygii
Tetrapodomorph
Megalichthyid
Palaeoneurology
Endocast

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Olenellid trilobites from the Marianian (Cambrian Series 2) of Sierra de Aracena, SW Spain

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Olenellid trilobites in the Iberian Peninsula are very scarce and little studied. New specimens of olenellid trilobites have been found into Marianian (Cambrian Series 2) shales from the municipality of Cañaveral de León, northern Huelva province, within the Sierra de Aracena y Picos de Aroche Natural Park. These rocks are assigned to the lower part of the "Herrerías shale" (lower-middle Marianian) and included into a tectonosedimentary unit named as "Herrerías Cubeta". Initially, the trilobite specimens were described as ***Callavia***? ***lotzei*** Richter & Richter. Recent phylogenetic analysis of the suborder Olenellina, carried out by previous authors, suggests their assigment to the new genus ***Sdzuyomia*** Lieberman. The study of the olenellid specimens from Cañaveral de León section is intended to provide new information on this taxon in order to discuss its taxonomic position more precisely and to compare it in greater detail with closely-related genera.

Olenellina
Trilobita,
Cambrian Series 2
Cañaveral de León
Sierra de Aracena
y Picos de Aroche
Natural Park

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Late Permian fish assemblage from eastern part of Zechstein Basin

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A detailed description of the ichthyofaunal assemblage from Upper Permian (Lopingian Stage) strata of the eastern part of the Zechstein Basin presented here. The samples were collected from the Nowy Kościół quarry (south-western Poland); Kūmas quarry (south Latvia); and Karpėnai quarry (north Lithuania). The Lithuania-Latvia Region comprises late Permian limestone and limestone-dolomitic association while limestone-marl association such as spotted marls, copper-bearing marls and lead-bearing marls were obtained in the outer part of the North-Sudetic Basin. These stratigraphic units are related to the Zechstein Limestone deposits (Ca1).

In total, 2,507 well-preserved isolated chondrichthyan and osteichthyan microremains were collected in the studied area. Chondrichthyes are represented by Acrodontidae indet., Helodontidae indet., Lonchidiidae indet. and ***Omanoselache*** sp. teeth and six dermal denticles morphotypes. Eight morphotypes of actinopterygian teeth and six morphotypes of scales were identified. The morphotype division of the ichthyofauna was based on traits such as crown shape, neck, base, surface ornament.

This study details the Upper Permian ichthyofaunal taxonomic and palaeoecological records from the eastern part of Zechstein Basin. The new data will increase our understanding of the evolution and paleogeographic distribution of fishes during the Upper Permian and faunal migration into the Zechstein Sea.

Zechstein Sea
Chondrichthyans
Osteichthyans
Fresh water
Microremains

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Preservation of environmental signals within fossil body size distributions

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There is an increased interest in differences in size distributions across environments in space and time. However, most studies only focus on selected parameters of size distributions (e.g., central tendency or extremes) and rarely take into account the entire distributions and how they are affected by the collection style and facies. Here we introduce a new method to analyze the differences between size distributions in their entirety using Non-metric multidimensional scaling based on Kolmogorov distance. Furthermore, we evaluate the impact of facies, region, taxonomy and collection style on paleontological samples using Permutational analysis of variance. Linear mixed-effects modelling indicates that lithology has the largest impact on size distributions in closely related species of the Sporadoceratidae (***Erfoudites***, ***Maeneceras***, ***Sporadoceras***), while taxonomy, region and collection style have a lesser impact. Marls typically yield larger specimens within particular species than limestones, while black shales typically yield smaller specimens. This seems to be a true pattern rather than a taphonomic artefact as it also observed in other more distantly related taxa (***Manticoceras***) as well as both in anaptychi and conchs within the same species at the same locality. This highlights the importance of taking into account facies shifts and collection differences when evaluating size differences across space (Polar gigantism) and time (Lilliput effect).

Polar gigantism
Lilliput effect
LMM
NMDS
PERMANOVA

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High-resolution assessment of the Valgu event: conodont diversity and $\delta^{18}O_{phos}$ during the early Telychian (Silurian) in the Baltic Basin

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Major changes in biodiversity over Phanerozoic time are of particular interest in paleobiology, as the magnitude of these changes may be linked to global climate and oceanographic system dynamics. Previous studies of major Silurian bioevents, such as Ireviken, Mulde and Lau events, suggest that during these turnover episodes, different faunas were affected by disturbances in the carbon cycle, drops in temperature, and potential glaciations. However, the impact of the biological events has not been fully assessed, and the influence of climate change remains unclear.

Here, we examine the Valgu event, a minor episode of proposed environmental and faunal changes in the early Telychian (Silurian). The event has been recognized in Baltica and Laurentia paleocontinents by changes in conodont succession and a positive excursion in carbon isotopes ($\delta^{13}C_{carb}$) ratios.

Through the study of a limestone-marl alteration core section in Estonia, we assess carbon isotopes within the investigated interval, oxygen isotopes in monogeneric conodont samples, and conodont biodiversity based on sample-size and coverage. We estimate paleobiodiversity for rarefied and extrapolated samples up to a minimum size and up to fixed coverage determined with sample completeness. Contrary to our expectations, results indicate no substantial change in conodont biodiversity, a positive carbon shift of 1.4‰ during the interval, and constant values in oxygen isotopes ($\delta^{18}O_{phos}$) ratios during the interval. Our results argue against cooling or glacially driven sea-level fluctuations as drivers for the observed changes in other sections from the same time interval.

Silurian bioevents
Paleobiodiversity
analysis

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The ontogeny of Cambrian Series 2 Ellipsocephalidae trilobite *Strenuaeva incondita* Sdzuy 1961 from Purujosa (Iberian Chains, NE Spain)

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Ellipsocephalid trilobites are common and widespread in Cambrian Series 2 strata, yet their ontogeny is poorly known due to the scarce findings of juvenile specimens. Here we present a record of the partial ontogeny of the Marianian regional stage trilobite ***Strenuaeva incondita*** Sdzuy 1961 from the Purujosa section (Iberian Chains, NE Spain). Studied specimens collected from the same level of the Ribota Formation allow us to quantify individuals ranging from early meraspis to mature holaspis forms. Smallest specimens (cranidia measuring 2.6–2.8 mm in length) show a well-marked and wide (transversal) parafrontal band parallel to the anterior margin that is absent in the next meraspis phases (4.3–5.5 mm long and 6–8 mm long respectively). Pre-glabelar furrow becomes deeper and well-marked progressively and the anterior border transitions to more inflated, convex and wide (sagittal) in early holaspis forms (9.1–12 mm long). The anterior branch of the facial suture increases its length following the development of the anterior border. The shape of the glabella is more elongated in late holaspis forms (14.2–6.1 mm) than in meraspis phases and slightly tapered anteriorly. Occipital and posterior border furrows become slightly deeper and wider (sag.). There is also a progressive change in cranidia outline from sub-elliptical or sub-rectangular shape in early stages to a more sub-quadrate outline in mature specimens. Ontogenetic changes of ***S. incondita*** are consistent with other species of the genus (***S. spinosa*** and ***S. inflata***) and show the typical development of ellipsocephalid trilobites cranidia.

Ellipsocephalidae
Trilobites
Cambrian Stage 4
Ontogeny
Iberian Chains

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Review of the Lontras Shale microfauna (Late Paleozoic, Paraná Basin, Brazil) and future perspectives

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The Lontras Shale is a massive black shale deposit produced in a marine environment. This series belongs to the middle formation of the Itararé Group (Mafra Formation) and it is one of the most relevant fossil *Konservat-Lagerstätten* of Gondwana. The shale contains arthropods, fishes, plants, and ammonoids. The microfauna is composed of caddisfly case fragments, sponge elements, fish scales, conodonts and spare scolecodonts. The caddisflies cases indicate a proximal subtidal environment. The sponges belong to Desmospongiae and Hemidiscosa, and suggest an oxic context. The fish scales belong mostly to Palaeonisciformes. The mandibular conodont apparatus belongs to ***Mesogondolella*** and supports warm conditions. Scolecodonts could not support any environmental data based on the poorly preservation. The micro and macrofauna indicate that Lontras Shale was deposit in a subtidal to deep marine environmental setting, and suggest that other organisms could live in this condition. New microfossil studies are being developed and several new taxa are expected to be found in the Lontras Shale. Until now, we have found evidence of Foraminifera in the layers above and below the Lontras Shale, this package has similar environmental settings with the studied deposit and could lead to similar taxa. To obtain new data samples are being collected systematically from shale outcrops throughout the state of Santa Catarina (Southern Brazil) and processed through chemical and mechanical preparation. Besides, thin section and electron microscopy analyzes are also being carried out It is hoped that new data may be soon available in order to more deeply understand the biostratigraphy and the paleoenvironmental context of the Lontras Shale.

Foraminifera
Microfossil
Mafra Formation
Itararé Group

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General Session:

Mesozoic

Please scroll down for Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Table of Contents

continues >

The youngest mosasaur recorded from the Late Cretaceous, of South Western Desert, Egypt

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Mosasaurs had a world-wide distribution during the Late Cretaceous deposits. Sub-Saharan African mosasaurs are sparsely and some of them had been based mainly on fragmentary and isolated remains. Here, we report new mosasaur remains from the Late Cretaceous of Dakhla Oasis in Egypt. The fossils include a fragmentary mandible with two preserved alveoli, an isolated tooth and a small fragmentary dentary with a single in situ tooth. These specimens were collected from fossiliferous, calcareous sandstone with intercalated shale that forms the lower section of the Dakhla Formation, intertidal to subtidal deposit of Maastrichtian age. The specimens are associated with shark teeth remains. Mosasaur previously described from the Maastrichtian, Duwi Formation in the Eastern Desert of Egypt, include identifiable taxa such as ***Globidens phosphaticus***, ***Platecarpus*** sp., ***Liodon*** sp. and ***Igdamanosaurus aegyptiacus***. Preliminary results for studying the new materials may referred to ***Globidens***. The African mosasaurs Maastrichtian occurrences have been documented from Morocco, Nigeria, Angola, the Democratic Republic of the Congo and Niger. The stratigraphically oldest African mosasaurs are known from Santonian deposits in South Africa. The new collected remains from the South Western Desert of Egypt are currently the youngest recorded from the continent.

Mosasaur
Dakhla
Globidens
Maastrichtian
Egypt

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Adaptation of vision to depth in shrimps from the Late Cretaceous of Lebanon

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Exceptionally preserved fossil fishes from Lebanon have been reported from Lebanon since, at least, the 13th century. These fishes come from Cenomanian and Santonian outcrops (Fossil-Lagerstätten) with exquisitely preserved fossils (articulated, with soft parts), which also yield a very diverse fauna of crustaceans. Among crustaceans, Dendrobranchiata shrimps are among the most abundant, and those from the Santonian of Sahel Alma often possess unusually bilobed eyes. Systematic investigations show that shrimps with bilobed eyes often belong to distinct families, and their closest relatives from the Late Jurassic of Solnhofen and from extant faunas have subspheric eyes (the usual shape for most shrimps). The bilobed eyes seem therefore to be specific to the shrimps of Sahel Alma. Observations of the ommatidia of a particularly well-preserved specimen show the eyes were probably well-suited for low light conditions (reflective superposition optics). We also observe specialization of certain areas of the eye with larger ommatidia on the anterior lobe than the posterior lobe, suggesting that the anterior lobe, pointing downward, perhaps had an increased sensitivity and the posterior lobe a slightly higher resolution. These shrimps with bilobed eyes are a remarkable case of convergent evolution, probably linked to the regional tectonically controlled increase in depth during the Late Cretaceous.

Dendrobranchiata
Palaeoecology
Eyes
Ommatidia
Lagerstätten

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Niche partitioning among crocodyliforms in the Maastrichtian (Late Cretaceous) of the Iberian Peninsula

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The Tremp Formation records a coastal-to-continental succession of ecosystems related to a marine regression in the north-eastern Iberian Peninsula during the end of the Cretaceous. More than 10 crocodyliform species inhabited this region throughout the Maastrichtian, of which at least 7 have co-existed in the same site. This is an unusual amount of top predators cohabiting the same ecosystem, hence it can be expected that they reduced their interspecific competition in some way.

The taxonomic abundances differ significantly among sites with different depositional settings. In this regard, sebecosuchians, ***Acynodon*** and allodaposuchids such as ***Allodaposuchus hulki***, ***Allodaposuchus subjuniperus*** and ***Arenysuchus*** occurred abundantly in freshwater and terrestrial settings; whereas ***Allodaposuchus palustris***, a different cf. ***Allodaposuchus*** species, ***Thoracosaurus*** and other taxon resembling ***Acynodon*** are exclusively present in brackish coastal environments. Remains referred to cf. ***Theriosuchus*** show a continuous distribution regardless the habitats.

Likewise, feeding specialization separated crocodyliforms inhabiting the same palaeoenvironment in different trophic guilds. In this sense, ***Theriosuchus*** was a supposed insectivore; ***Acynodon*** and crocodyliforms with bulbous molariform teeth probably preyed on mollusks and/or crustaceans; sebecosuchians were cursorial predators; and ***Thoracosaurus*** fed on fish. Several ecomorphological traits in the skulls and jaws of allodaposuchids suggest that trophic specializations also occurred in this group.

Therefore, the Maastrichtian crocodyliform assemblage included generalist predators in freshwater (***Arenysuchus***, ***Allodaposuchus subjuniperus***), terrestrial (***Allodaposuchus hulki***, sebecosuchians) and coastal environments (cf. ***Allodaposuchus*** sp.); piscivorous taxa (***Thoracosaurus***, ***Allodaposuchus palustris***) in coastal habitats; durophages in freshwater (***Acynodon***) and brackish (aff. ***Acynodon***) environments; as well as insectivores (cf. ***Theriosuchus***) broadly distributed.

Sebecosuchia
Atoposauridae
Hylaeochampsidae
Crocodylia
Palaeoecology

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New plant fossil records and palaeocology of the Uspallata Group (Late Triassic) at Cacheuta Hill, Cuyo Basin, west-central Argentina

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The Triassic sedimentary rocks outcropping in the Cacheuta Hill (Precordillera, Mendoza province, Argentina) correspond to the upper part of the Uspallata Group (Late Triassic) comprising the younger levels of Potrerillos Formation, and the Cacheuta and Río Blanco formations. In this contribution, new fossil plant records in the Uspallata Group are described, the systematic palaeontology of previously described taxa is revised, and the plant-palaeocomunities are reconstructed. In addition, the studied unit is correlated with other Triassic formations of Gondwana. Our revision of the plant-fossil record from the Uspallata Group provides: the first record of the genus ***Androstrobus*** (Cycadales) and the genus ***Odyssianthus*** (Voltziales) in the Argentinean Triassic, the description of ***Rissikianthus*** as a new element of the Cacheuta palaeoflora, the transfer of ***Baiera rollerii*** to ***Rochipteris rollerii***, and the presence of ***Hamshawvia*** and ***Stachyopitys*** in the Argentinean Triassic, which confirm the record of these reproductive structures as related to the ginkgoalean lineage. The most diverse plant fossil group in the Triassic of Cacheuta Hill is the seed fern order Umkomasiales (= Corystospermales). Four types of plant palaeocommunities were inferred for Uspallata Group: conifer-dominated deciduous forests, corystosperm-dominated deciduous forests, corystosperm-dominated evergreen forests, and corystosperm-dominated shrubby-arboreal. These palaecommunities were developed in mixed load meandering fluvial, palustrine and meromictic lacustrine systems under seasonal or oceanic subtropical climates, varying from semiarid to humid environments. The plant fossil assemblages present in the Uspallata Group at Cacheuta Hill shows similarities with the Molteno Formation from South Africa, indicating a Late Triassic (Carnian–Norian) age for the unit.

Paleofloras
Paleocommunities
Carnian
Norian

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The leaf flora of the Iharkút Dinosaur Site (Bakony Mts. NW Hungary)

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During the 19 years of excavations Iharkút (Bakony Mts., Hungary) became one of the most diverse vertebrate localities among the Late Cretaceous sites of Europe. From a taphonomical point of view it is very interesting that bones, coalified seeds, fruits, and leaf imprints are preserved in the same locality. Based on the palynological assemblage the locality is Santonian in age. Published information on the Iharkút flora is very limited, and focused on the seeds and fruits. The recent study is focused on the co-occurring leaf flora.

In total, 253 leaf specimens were studied from the collection of the Hungarian Natural History Museum. Three preservation states were observed: coalified compressions (132 specimens), impressions (104 specimens), and compressions with preserved cuticle (7 specimens).

The flora is dominated by angiosperms. The most common forms of dicotyledonous plants are the platanoids (60 specimens). We used the name ***Ettingshausenia*** sensu Maslova for their sterile imprints. The other important dicot genus is ***Juglandophyllites***. The monocots are represented by ***Pandanites*** sp. Plant groups other than angiosperms are rare. Especially remarkable is the occurrence of the fern Sphenopteris gruenbachiana, a species previously known only from the Grünbach Flora. Despite the fragmentary preservation, the Iharkút specimens can clearly be assigned to this species based on the pronounced and cordate bases as well as the uniform marginal teeth. Gymnosperms are present in the flora with ***Brachyphyllum*** foliage remains and a cycadalean leaf fragment.

Based on the leaf flora from Iharkút two canopy habitats are distinguishable: a juglandaceous and ***Pandanites*** dominated wetland forest (bed-1) and an ***Ettingshausenia*** dominated riparian plant community (bed-6).

Project no. 130627,130190, 131557 and 120123 have been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the PD, FK and NKFI funding schemes.

W

Santonian Angiosperms, *Sphenopteris gruenbachiana* *Pandanites* sp. *Ettingshausenia* sp.

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Sedimentological, geochemical and paleontological investigations of Late Cretaceous (Maastrichtian) vertebrate fossils from Vălioara Valley (Densuş-Ciula Formation, Hateg Basin, Romania)

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In the early years of the 20th century, the Hungarian palaeontologist, Ottokár Kadić discovered a rich and diverse Late Cretaceous vertebrate assemblage around Vălioara in the Haţeg Basin, including fossils of several dinosaurs and the holotype remains of the iconic crocodyliform ***Allodaposuchus***. These fossils were collected from seven different main localities and are now housed in the collections of the **MBFSZ** of Hungary. However, the collection was mixed after the 2nd World War and thus this unprovenanced material currently can't be used for further paleoecological investigations. Nevertheless, as a result of archive research, the map of the Kadić excavation sites has been found. It shows the exact positions of the seven localities around Vălioara, and allows matching these localities with the historically collected specimens using geochemical methods. Using Kadić's map, we georeferenced, relocated and re-excavated these vertebrate-bearing outcrops, and documented their sedimentological context. In total, 117 vertebrate remains (bones and teeth) were collected during the new excavations around Vălioara, representing turtles (e.g., ***Kallokibotion***), crocodyliforms (***Allodaposuchus***, ***Doratodon***, ***Theriosuchus***, ***Acynodon***), dinosaurs (***Zalmoxes***, ***Telmatosaurus***, titanosaurs, theropods), pterosaurs, and mammals. In order to determine potential geochemical differences and variation among the sites, we selected bone fragments with stratigraphic position recorded during our fieldwork. Their TE compositions were then determined and used as independent proxies to assess the stratigraphic origin of the different vertebrate fossils from the historic collections. The detailed sedimentological, geochemical and paleontological investigations at Vălioara contributes to understanding the distribution and paleoecology of the Haţeg fauna during the latest Cretaceous.

W
Trace element analysis
Fossil bones
Dinosaur
Fluvial sediments
Archive research

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Agglutinated encrusting foraminifers from the Agua de la Mula member (Agrio Formation, Neuquén Basin - Argentina): paleoeocological and paleoenvironmental implications

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A new fauna consisting of agglutinated encrusting foraminifers has been collected from several nodular levels in the upper Hauterivian-lower Barremian Agua de la Mula Member of the Agrio Formation (Patagonia, Argentina). The study foraminifers come from two stratigraphic sections in the Neuquén Basin and show affinities with the genera ***Haddonia*** Chapman, 1898, ***Alpinophragmium*** Flügel, 1967, ***Bdelloidina*** Carter, 1877 and ***Coscinophragma*** Thalmann, 1951. Provisionally, the new specimens are considered to differ from the above-mentioned genera, but they remain in open nomenclature. One or more specimens are clustered around bioclastic nuclei of cerebroidal sub-spherical nodules, forming columnar and circum-granular 'microbuildups'. The nodules occur both separated from each other in a fine-grained siliciclastic matrix as well as forming larger mound-like accumulations of up to 2 meters in thickness. The encrusting foraminifers-bearing deposits consist of bioclastic sandstone, allochemic mudrock and micritic rudstone, and are embedded into an alternation of condensed bioclastic sandstone and grey/dark marly clay. The latter has been earlier interpreted as alternating couplets of sixth-order Milankovitch precession-driven cycles, named starvation/dilution sequences. These couplets are characterised by a switch from very low to high sedimentation rates, as recorded by deposition of condensed beds and siliciclastic intervals respectively. Semiquantitative analysis by Scanning Electron Microscope (**SEM**) was performed in order to characterise the morphology and test mineralogy of the specimens. A preliminary study on the type of growth of the 'microbuildups' allows us to corroborate previous interpretations of low oxygen conditions and of a lowered rate of terrigenous input for the analysed interval.

Agglutinated encrusting foraminifera
Agua de la Mula
Neuquén Basin

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New data on the theropod-ornithopod ichnoassemblage of the Late Jurassic Corcolilla Tracksite (Alpuente, Spain)

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The Corcolilla tracksite (Alpuente, Valencia, Spain) is one of the most interesting sites preserved in the Late Jurassic Villar del Arzobispo Formation of the Iberian Range. Previous studies described on a sandstone surface almost 50 dinosaur footprints, assigned to four different morphotypes. Excavations carried out during the last decade to prepare the site for exhibition allowed to unearth new footprints on the main surface (**MS**) plus a new exterior surface (**ES**) and an upper surface (**UPS**). A recent field campaign was carried out to digitize with photogrammetric techniques these three main surfaces. Preliminary data have allowed the identification of more than 35 undescribed footprints in the three surfaces. Interestingly, in ES and UPS the tracks displaying the higher morphological preservation quality are recorded. Two morphotypes are distinguished on both surfaces: **1)** A large sized and gracile theropod morphotype and **2)** a medium-sized ornithopod morphotype. These two morphotypes resemble the Late Jurassic ichnotaxa ***Megalosauripus transjuranicus*** (theropod) and ***Dinehichnus*** (ornithopod), identified in other European areas. In the UPS, a small sized and gracile ornithopod morphotype has been also identified. It shows similarities with ***Anomoepus***-like tracks described in other areas of the Iberian Peninsula (e.g., Asturias, Portugal). This theropod-ornithopod ichnoassemblage (***Megalosauripus transjuranicus***-like, ***Dinehichnus***-like, and ***Anomoepus***-like) is unique in the Villar del Arzobispo Formation and shows evidence of dinosaur groups poorly represented so far by the osteological remains in the formation. Further work is needed in order to understand how these three morphotypes fit with those previously identified in the MS.

W

Villar del Arzobispo Fm.
Anomoepus-like
Dinehichnus-like
Megalosauripus transjuranicus-like
Iberian Range

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Upper Jurassic caryophyllids from condensed pelagic deposits of the Umbria-Marche Apennine (Central Italy)

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Here we report newly collected corals from Kimmeridgian–Tithonian pelagites of Central and Northern Apennines. They grew on intrabasinal structural highs (Pelagic Carbonate Platforms or **PCP**s). The highs originated from dismembering and drowning of a vast peritidal carbonate platform during the Early Jurassic Western Tethys rifting stage. The drowning was followed by condensed pelagic sedimentation on the top of PCPs. Findings of both zooxanthellate and probably azooxanthellate corals in these facies shed new light on the Jurassic-Early Cretaceous paleogeography, paleoenvironment and paleoecology of PCPs. The occurrence of zooxanthellate corals in PCP-top condensed successions recently allowed to constrain the bathymetry of these depositional systems to the photic zone (40 – 150 m). The studied material is mostly represented by solitary, probably azooxanthellate corals, associated with light dependent organisms. These specimens usually display elliptical to circular calices and have ceratoid attached morphologies, finely granulated costosepta with a clear crown of palis. Pending a more detailed study of their microstructure, these features suggest an assignation to the scleractinian extant family Caryophyllidae. The collected azooxanthellate fauna is oligotypic but abundant, as a possible result of very slow sedimentation rates and extreme condensation. Most of the corals do not display in-life position, being detached from the substrate and randomly arranged within the pelagic deposits; others are attached on ammonites pseudoshells or on other corals. The new occurrence improves the Late Jurassic record of caryophyllids, providing additional constraints on their paleoecology and on the paleoenvironmental evolution of this sector of Western Tethys.

Caryophyllidae
Upper Jurassic
Tethys
Corals
Umbria-Marche Apennine

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The ornithopod dinosaurs from the Upper Cretaceous (Bajo de la Carpa Formation, Santonian) of Rincón de los Sauces (Neuquén Province, Argentina)

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The Ornithopoda clade remains poorly known in the Late Cretaceous fossil record from Argentina. In recent years, continental sediments outcropping near the Rincón de los Sauces (Neuquén Province, Argentina) have yielded abundant material, with numerous remains of indeterminate ornithopods, as well as a new taxon, ***Mahuidacursor lipanglef***. Recent fieldwork in the Bajo de la Carpa Formation (Santonian, Upper Cretaceous), in the area of "La Invernada-Cerro Overo", has led to the discovery of postcranial ornithopod material from two new sites. The remains correspond to at least two ontogenetic stages, including an adult and a subadult specimens. Adult individuals would have a medium-size (6 m), similar to other ornithopod remains found in the same area. Almost all collected postcranial bones are poorly diagnostic, except for the ilium MAU-Pv-CO-663. It is a right almost complete ilium (the preacetabular is broken), with a length similar to that of ***Macrogryphosaurus***. Also, MAU-Pv-CO-663 shows a profile more closely resembling ***Macrogryphosaurus*** than Talenkauen, with a rectangular and robust blade and a slender pubic peduncle. Unfortunately, the pelvic girdle of ***Mahuidacursor*** is not preserved, preventing further comparisons so far. However, the assignation to this species cannot be discarded. These new fossils increase the knowledge of the Santonian ornithopod fauna from Rincón de los Sauces.

The authors thank the Palaeontological Association for the support provided through the granting of the Stan Wood Prize (PA-SW201802).

Ornithopod
Santonian
Ilium

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The impact of the Pliensbachian-Toarcian crisis on belemnite diversity and evolution

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The Pliensbachian–Toarcian transition has been considered a major bottleneck in the early evolution of belemnites, probably related to major palaeoenvironmental and climatic changes during the Early Toarcian. Previous research has focused on the study of belemnites from higher, temperate latitudes, while high-resolution studies on diversity and size of subtropical belemnite assemblages in the northwest Tethys are comparatively rare. The lack of high-resolution (ammonoid subzone) abundance data on diversity and size distributions of belemnite assemblages does not allow separating changes during the Pliensbachian–Toarcian boundary event from those during the Toarcian anoxic event. Sample standardized diversity analyses on new data from Iberian sections suggest the Pliensbachian–Toarcian corresponds to a slight decrease in diversity and an adult size decrease within dominant species. Cluster and non-metric multidimensional scaling analyses, however, indicate that the largest changes in diversity and palaeogeographic distribution of belemnite assemblages occurred during the Toarcian oceanic anoxic event (**TOAE**) rather than the Pliensbachian–Toarcian boundary. In southern basins like the Lusitanian Basin and Riff Mountains, belemnites even disappear entirely during the TOAE. More generally, the TOAE corresponds with an increase in body size of belemnite assemblages driven by species turnover. The lack of widespread anoxia in southern basins of the northwest Tethys indicates that direct impact of warming or increased pCO_2 triggered by volcanism as well as indirect effects on nutrient availability and productivity might have played an important role during both crises.

Lilliput effect
Rarefaction
NMDS
Paleobiogeography
Extinction

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Updated description of the *Dicynodontipus*- and *Chirotherium*-bearing slab from the Solling Formation, Hildburghausen Town, Germany

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A track-bearing slab (MNHN.F.AC10007) from the Solling Formation of Hessberg (Hildburghausen, Thuringia, central Germany) is housed in the Muséum national d´Histoire naturelle of Paris, France, since 1835. The Solling Formation, Olenekian–Anisian in age, pertains to the lowermost part of the Germanic Triassic and records the evolution of a fluvial palaeoenvironment characterised by braided to sinuous meandering channels. Footprints are reported from floodplain facies. Originally, the slab was about 2.21 m long and 1.56 m maximum width, while nowadays the maximum wide is 1.36 m, seeing that a portion has been lost. On the slab, four vertebrate trackways are preserved as concave epirelief and interfered with polygonal cracks, likely testifying a desiccation event. One trackway, holotype of ***Dicynodontipus hildburghausensis*** Rühle von Lilienstern, 1944, is composed of six manus-pes sets, plus a further set in the lost portion. The rest of the footprints are assigned to the ichnogenus ***Chirotherium*** Kaup, 1835. ***Chirotherium barthii*** Kaup, 1835, is represented by a trackway composed of six manus-pes sets preserving skin impressions, while a trackway of two manus-pes sets and a footprint, with a fourth set in the lost area, is referred to as ***Chirotherium sickleri*** Kaup, 1835. Finally, a trackway composed of three manus-pes sets, not identified in previous studies, shares some features with ***Chirotherium***, although ichnotaxonomical assignment is to date prevented. Further up-to-date studies are currently underway, including 3D photogrammetric models, to provide a thorough re-discussion of the trackways, as well as their ichnotaxonomical and palaeobiological significance.

Dicynodontipus
Chirotherium
Ichnotaxonomy
Triassic

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The Anisian (Middle Triassic) palaeoflora of Monte Prà Della Vacca/Kühwiesenkopf – new investigations

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The Triassic fossil assemblage of Monte Prà della Vacca/Kühwiesenkopf (**MPdV**), in the Northern Dolomites, is one of the few that recorded the biotic recovery from the Permo-Triassic mass extinction. The MPdV fossil assemblage is also considered a *Fossillagerstätte* for its richness and amazingly good preservation of specimens. The assemblage includes marine and terrestrial fauna and flora, which permitted to reconstruct both marine and terrestrial middle-late Anisian (Pelsonian) environments dating back around 245 million years ago. The plant fossils were recovered from lens-shaped siltstone layers, which alternate with silty and marly limestone layers in the succession, in association with few marine fossils.

Terrestrial plants are well documented thanks to the rich macrofossil plant collection, stored at the Museum of Nature South Tyrol in Bozen/Bolzano, consisting of ca. 1200 specimens of leaves, branches, trunks, cones, and seeds of at least 36 different species and 29 genera of lycopods, horsetails, ferns, seed ferns, cycads, and conifers.

The correspondence of the fossil assemblage with a local shift to a more humid climate makes the flora of MPdV the ideal candidate for an integrated palaeobotanical, geochemical and palaeoclimatic study. Taxon-specific geochemical analyses on the organic carbon of plant fossils were performed, providing insights on the isotopic composition of different groups of plants, such as the wide isotopic variability observed in conifers, cycads and lycopods and the low variability observed in ferns. Moreover, the review of the paleobotanical collection led to the discovery of one of the oldest records of amber worldwide.

Triassic
Anisian
Pelsonian
plant fossils
$\delta^{13}C_{org}$
Amber

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Geometric morphometric data indicates high pelvic and cranial disparity in Triassic stem archosaurs and early bursts of evolution in the archosaur lineage

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Crown archosaurs are a major part of modern ecosystems and dominated the land fauna for ~150 Ma. Understanding their origins and spectacular radiation during the Triassic is of major interest, shedding light on adaptive radiations following extinction. Stem archosaurs were diverse in the Early/Middle Triassic, and their radiation can be considered the initial part of that of archosaurs. These taxa have often been considered as simply “forerunners” of archosaurs, with “sprawling” locomotion and other characteristics between early diapsids and archosaurs. However, recent work using 2D cranial geometric morphometrics indicates that these taxa were actually important and morphologically diverse parts of Triassic ecosystems, and only following archosauromorph extinctions in the Late Triassic crown archosaurs fully radiated. Here we extend this work updating the cranial dataset (new taxa and reconstructions, and more post-Triassic pseudosuchians to better estimate ancestral form — total 108 taxa), and assessing a new pubic dataset (10 landmarks, 110 semilandmarks, 73 taxa). We examine disparity through time, fully including branches and rates, using phylogenetic ridge regression. We find cranial and pubic disparity is high for Early–Middle Triassic stem archosaurs, confirming their ecological importance. We find no evidence for comparatively higher rates of evolution in crown taxa, indicating no “competitive advantage” and the “sprawling” posture of many stem taxa did not restrict pubic evolution. We find an “early burst” of evolution, with rates high at the start of the archosauromorph radiation and decreasing within clades; this is especially so for pelvic disparity, potentially indicating greater selective constraints than the skull.

Archosaur
Archosauromorph
Disparity
Triassic
geometric morphometrics

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Placodont remains (Sauropsida, Sauropterygia) from the Triassic of Hungary (Transdanubian Range and Villány Mountains)

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New placodont remains from the Triassic of Hungary are described which come from two different tectonic units and four stratigraphic levels at four localities. The Transdanubian Range Unit represents an Alpine type sedimentary basin and the Villány-Bihar Unit was the part of the southern passive margin of the European Plate during the Triassic.

The oldest specimen, a maxilla fragment, was found in the Late Anisian of Forrás Hill, near Felsőörs (Transdanubian Range). Based on dental morphology the specimen is referred to here as ***Paraplacodus broilii***. This site is similar in age to the Monte San Giorgio (Switzerland and Italy) locality and the occurrences of the species is thus comparable to its presence in the Besano Formation at Monte San Giorgio. Moreover, these sites had a similar paleogeographic position in the Anisian in the Tethyan realm. A Carnian occurrence of placodonts from this tectonic unit in Hungary is a dentary fragment and two isolated teeth referred to here as ***Placochelys placodonta***. The youngest specimen from this unit is a placochelyid tooth fragment from the Rhaetian of the Keszthely Mountains.

The richest assemblage is the Ladinian of the Villány Mountains, southern Hungary. Based on the teeth, this form is referred to as ***Cyamodus*** sp., which are similar to those of ***Cyamodus*** sp. described from Slovenia and both assemblages are among the last occurrences of the genus in the European Triassic. The Villány site is considered as a gap locality because of the rarity of Ladinian placodont occurrences in the German-Alpine sedimentary basins.

Paraplacodus
Cyamodus
Placochelys
Anisian
Ladinian
Carnian

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When bone palaeopathologies play hide and seek: a case study on sauropod dinosaurs

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Palaeopathology is the study of ancient pathologies preserved in the fossil record. While fossil pathologies have caught interests over the last decades, only those featuring externally-visible manifestations have been extensively studied. A study initially aimed at analysing growth dynamics of two basal sauropods (cf. ***Isanosaurus*** and ***Spinophorosaurus nigerensis***) lead us to consider that several palaeopathologies have gone unnoticed. Indeed, our histological survey unexpectedly unveiled palaeopathologies that were not expressed externally, but well internally under the microscope. Both samples featured abnormal radial fibrolamellar bone that we interpret as spiculated periosteal reactions ('hair-on-end' and sunburst pattern for cf. ***Isanosaurus*** and ***S. nigerensis*** respectively). A neoplasmic origin for this bone tissue is favoured for the former specimen, whereas another neoplasmic origin or a viral condition are favoured for the latter.

This indicates that several palaeopathologies have flown under the radar and that assessments of palaeopathological frequencies within fossilised populations likely underestimate the true value. We suggest that microscopic and/or CT scanning should become standard when assessing pathologies in the fossil record.

Palaeopathology
Bone histology
Radial fibrolamellar bone
Periosteal reactive bone
Basal sauropod

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A new record of a Late Triassic ichthyosaur with Jurassic-like dentition revealed by micro-CT scanning

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Ichthyosaurs were marine reptiles that were ecologically dominant during much of the Mesozoic. Ichthyosaur tooth and jaw morphology provides insights into taxonomic identity, lifestyle, and evolutionary history. Late Triassic specimens collected from Mexico in the early 20th Century housed within the University of California Museum of Paleontology (**UCMP**) shed light on an important window of ichthyosaur evolution. During this transitional interval, typical Triassic forms lived alongside individuals that more closely resembled Jurassic and later forms. During investigation of this material, an unusual partial ichthyosaur jawbone–one of several jaw pieces catalogued as UMCP 27141–was scanned using micro-CT and digitally segmented. The upper jaw exhibits well-preserved premaxillae, maxillae, and vomers, as well as taphonomically displaced nasals. The lower jaw exhibits well-preserved surangulars and relatively well-preserved dentaries, as well as highly splintered splenials. Forty-eight teeth are present in the specimen, including thirteen replacement teeth. A lack of visible connection to the jawbones and tight tooth packing within a dental groove suggests aulacodont tooth implantation, typical of Jurassic ichthyosaurs. Based on comparative evidence, this specific piece of UCMP 27141 represents a different individual than the other jaw pieces it is currently catalogued with and likely a different taxon. This previously overlooked specimen improves our understanding of ichthyosaur diversity and distribution in the Late Triassic and clarifies the sequence of acquisition of important characters prior to the major reorganization of marine reptile faunas across the Triassic-Jurassic transition.

Marine Reptiles
Ichthyosaurs
Dentition
Triassic
Micro-CT

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Late Cretaceous cold seeps in South Dakota: preliminary results from decapod crustaceans

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Decapod crustaceans are very abundant inhabitants of modern cold seep ecosystems and they likely play an important role in structuring these hotspots of biodiversity. They have also been found in fossil cold seep environments, but they remain severely understudied in deep time. We examined macrocrustaceans from cold seep limestones of the Late Cretaceous Pierre Shale (Campanian-Maastrichtian) in South Dakota, then located in the Western Interior Seaway. Specimens in the American Museum of Natural History (**AMNH**) collections were studied in addition to newly collected specimens. Thirty-three body fossils of decapods were found in the AMNH and many more were collected in the field, but no other crustaceans were discovered. Decapods are represented by **(1)** true crabs (Brachyura) that had a burying, epifaunal, and swimming lifestyle, and **(2)** burrowing ghost shrimps (Axiidea). All specimens belong to at least seven known species, implying that there is no endemism in these shallow-water seeps. Two synonymies were discovered. We found several lines of evidence for predation attributable to crustaceans: **(1)** repair scars in seven mollusks (six inoceramid bivalves and one gastropod), **(2)** two specimens of lucinid bivalves with pinch marks, and **(3)** one inoceramid shell with interconnected, arcuate holes in the shell. In sum, we show that decapods are more common at these seeps than was previously known. Moreover, decapods did impact the fauna of these seeps, but more research is needed to quantify their influence.

Cold seep
Decapoda
Paleoecology
Predation
Taxonomy

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Microremains of fossil fishes (Chondrichtyes and Osteichthyes) from the Late Triassic of Krasiejów, Southern Poland

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Analysis considering vertebrates from the Late Triassic (Norian) Krasiejów site (SW Poland) for years have been focused on tetrapods. Fresh water fish remains were known since the beginning of the discoveries, however rarely gained much attention. Recently interest in the Krasiejów ichthyofauna increased after the description of a new species of dipnoan fish — ***Ptychoceratodus roemeri*** Skrzycki, 2015.

Due to extensive prospection of fine-grained sediments, abundant fossil fish remains, including Chondrichthyes (cf. ***Lonchidion***) as well as Osteichthyes (including ***Gyrolepis***, ***Saurichthys***, ***Severnichthys***, cf. Semionotidae) were recovered. Most of the remains are microfossils such as teeth and scales. In the collection of Opole University, there are over a thousand of specimens ranging in size (from 200 µm to 2 mm) and shape.

Actinopterygian teeth are usually pointed, recurved, belonging most probably to predatory fishes. Slightly less numerous are rounded, massive or typical crushing teeth. Characteristic teeth of hybodontid sharks are also quite abundant.

Fish scales also display a variety of morphologies, including placoid, ganoid, cycloid and ctenoid scales. The largest ones belong to dipnoans (several millimeters of diameter), but due to their structure (external elements placed on the elasmodine layer), they are mostly fragmented. Ganoid scales differ in shape and outer surface ornament, revealing features of several families (Semionotidae/Lepisosteidae, cf. Polypteridae, Palaeoniscidae). Ctenoid scales are typical of Acanthopterygii, and are the oldest known remains of this group.

Aside from isolated teeth and scales, over a dozen complete specimens (with scale cover preserved) were found and will be described in the future, giving an opportunity to enlarge the material belonging to the taxa which have been so far only known from isolated elements.

Microvertebrates
Pisces
Keuper
Teeth
Scales

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Microremains of fossil amphibians and reptiles from the Late Triassic of Krasiejów, Southern Poland

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Late Triassic Krasiejów site is famous for an exceptionally rich bonebed bearing numerous remains of amphibians (temnospondyls) and archosauromorphs (phytosaurs, aetosaurs, rauisuchians, dinosauromorphs). Before the application of screen washing by the authors, remains of small animals were only found sporadically, and resulted in the description of only a few small vertebrate taxa (e.g., ***Ozimek volans*** Dzik and Sulej, 2016).

The examination of fine-grained deposits has revealed the occurrence of two microfossil bearing layers containing numerous remains of small tetrapods mostly including teeth and rather scarce postcranial elements. The use of screenwashing methods has obtained over 1000 teeth ranging in size from 200 µm up to 10 mm. These can be classified into several morphotypes representing at least four types of amphibian teeth, several morphotypes of lepidosaurian teeth and numerous types of archosauromorph remains.

Analysis of this highly taxonomically diverse assamblage has resulted in the recognition of new taxa at the Krasiejów site, including dinosaurs, crocodylomorphs, protorosaurians, pseudosuchians and cynodonts. These contribute to better understanding the Late Triassic ecosystems from western Laurasia.

Microvertebrates
Archosauromorphs
Temnospondyls
Keuper
Teeth

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Lissamphibia from the Villar del Arzobispo Formation (Upper Jurassic). The oldest Spanish albanerpetontid

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Cañada Paris site (Alpuente, Valencia, Spain) is an Upper Jurassic fossil site mainly known for the presence of two dinosaur trackways and other isolated footprints. A sample, collected from a grey marl level above the track site, has provided the remains of a diverse vertebrate fauna, consisting of osteichthyans and tetrapods, including crocodyliforms, dinosaurs and amphibians among others. In this work, we briefly report the scarce record of albanerpetontid lissamphibians found.

Albanerpetontid remains consist of three distal ends of humeri and a fragmentary unidentified bone bearing two teeth. These fossils show the typical morphology of the albanerpetontids, including two pleurodont, non-pedicellate, tall and narrow teeth, which are arranged close together; and a particular morphology of the humerus, with a large radial epicondyle and eminent capitata, this latter fully ossified. Unfortunately, the humerus shape in albanerpetontids is very conservative, preventing identification at generic level.

The family Albanerpetontidae is known from Middle Jurassic to early Pleistocene from Eurasia, North America and North Africa. In the Iberian Peninsula, the oldest records come from the Portuguese localities of Porto das Barcas, Puerto Dinheiro, Valmitão and Zimbral (Kimmeridgian, Upper Jurassic). On the other hand, all reported remains of the clade in Spain come from Lower and Upper Cretaceous localities. Thus, the remains described here extend the temporal record of albanerpetontids from spanish territory to the Upper Jurassic, hence constituting the oldest report of the group in Spain up to date.

Upper Jurassic
Iberian Peninsula
Amphibia
Cañada Paris

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Tzimol, a Konservat Lagerstätte in Chiapas, Mexico

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It is reported a new paleontological site Tzimol (Angostura Formation, Chiapas) of Campanian age The site is quarried for commercial purposes by Ochuxhob locals. The fossils collected are diverse, and contains a rich association with well-preserved specimens. These features identify the site as a Konservat-Lagerstätte new in the southeastern end of North America. The associations include microfossils, such as foraminifera and algae, as well as macrofossils of plants, vertebrates, and invertebrates. The plants are represented by probable fruits, leaves, and by other remains of conifers and palms. The invertebrates include molluscs (bivalves, gastropods and scaphopods) and echinoderms (echinoids). The vertebrates are composed by different groups of fish and by a single mosasaur. Up to now, the Tzimol biodiversity is composed by echinoids belonging to indeterminate hemiasterids, the rudist R***adiolites acutocostata*** that support the Campanian age of these strata, and the fish species ***Nursallia***, ***Saurodon***, and ***Enchodus***, as well as the first evidence of the fish ***Apuliadercetis*** in America. Fishes are by far the best-preserved fossils, they are mostly articulated, and under UV light, the large fish show phosphatized muscles preserved. The marly limestones interbedded with clays of Tzimol suggest that this biota was deposited into a marine environment of shallow and of low energy, like a lagoon.

Campanian
Angostura
Formation
Marine
depositional
environment

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A juvenile pachycephalosaurid (Ornithischia: Pachycephalosauridae) from the Frenchman Formation (Upper Maastrichtian), Saskatchewan, Canada

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In 1973, Dale Russell collected a small, partial ornithischian skeleton from the Frenchman Formation (Upper Maastrichtian) of what would become Grasslands National Park, Saskatchewan, Canada. The specimen primarily consists of the pelvic and hindlimb elements, and a series of 10 caudal vertebrae. It was eventually reported in the literature as belonging to a juvenile ***Thescelosaurus***. Our re-examination of the skeleton has instead revealed it to be a juvenile pachycephalosaurid. This identification is based on such characteristic features as a sigmoidal dorsal margin of the ilium, the near exclusion of the pubis from the acetabulum, and a prominent medial process of the iliac blade. The juvenile status of the specimen is attested by the lack of neurocentral fusion within the vertebral column. Histological analysis of the tibia demonstrates a fibrous bone texture and absence of annuli, further supporting the young age of the individual (probably less than a year). This new skeleton is therefore significant as Canada's second most complete pachycephalosaur skeleton, and as among the world's youngest known pachycephalosaurids. Because both juvenile and postcranial material is rare in this taxon, this specimen provides a unique opportunity to broaden the understanding of the evolutionary relationships, functional morphology, and ontogeny of these otherwise poorly understood animals.

Ornithischia
Pachycephalosauridae
Ontogeny
Phylogeny
Histology

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Preliminary report of hadrosaur remains near Presa San Antonio from the Cerro del Pueblo Formation, Coahuila, Mexico

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We report new indeterminate hadrosaurid post-cranial bones from the communal land Presa San Antonio, Parras de la Fuente municipality, Coahuila state, Mexico, in strata that belong to the upper Campanian of the Cerro del Pueblo Formation, in the Parras Basin. The remains includes partial elements from the pelvic girdle (left ilium, and right pubis, ischium, and incomplete sacrum), a distal end of a left femur, almost complete right and left tibiae, right metatarsals II and IV, dorsal and caudal vertebrae, and skin impressions. Also, partially complete unidentified forelimb elements are present, which still under preparation. The pubis shows characteristics of the Lambeosaurinae morphotypes, but the lack of cranial elements does not allow to directly differentiate this specimen from Velafrons. In association, angiosperm fruits and infructescences of the genus ***Tricostatocarpon*** and ***Operculifructus***, besides many specimens of the gastropod ***Tympanotonus***, bivalves and fragmentary remains of marine reptiles (Testudines and Squamata) were found in the same strata, indicating a transitional of brackish water to terrestrial depositional environment.

Hadrosauridae
Cerro del Pueblo Formation
Campanian
Mexico

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New material of ceratopsian dinosaurs from Mexico

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Current paleontological work in localities of the Upper Cretaceous Aguja (San Miguel), Cerro del Pueblo (Porvenir de Jalpa), San Carlos (Aldama) and Olmos (Sabinas) Formations of Coahuila and Chihuahua in Mexico, which were poorly documented in the past, has yielded ceratopsian dinosaur material from the Campanian-Maastrichtian of the southern province of the western landmass known as Laramidia (North America). The study of the recently collected cranial and post-cranial material has led to confirm the presence of at least one distinct very large chasmosaurine taxa from the Olmos Formation and it has also revealed the notable absence of centrosaurines in this formation.

The chasmosaurines ceratopsids record the presence of evolutionary centers of endemism within southern North America during the late Campanian. The preliminary result of this research contributes also to the knowledge of their ecology, evolution and biogeography, providing evidence for the ceratopsian provincialism hypothesis, based on the differences among ceratopsians in contemporary formations.

Ceratopsian
Mexico
Campanian
Laramidia

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Reassessment of *Enaliosuchus schroederi*, a metriorhynchid crocodylomorph from the Lower Cretaceous of northern Germany

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During the Jurassic, metriorhynchid crocodylomorphs radiated in marine ecosystems. However, their Cretaceous fossil record is sparse. This hampers our understanding of their marine specialisations, particularly as the first evidence mesopelagic adaptations are seen in Valanginian specimens. One of the best preserved Cretaceous metriorhynchids is the holotype of ***Enaliosuchus schroederi***, comprising a three-dimensionally preserved skull (lacking the anterior rostrum), atlas-axis, first postaxial cervical vertebra, and associated ribs. The specimen derives from the lower Valanginian Stadthagen Formation and was found in a now abandoned clay pit in Sachsenhagen, northern Germany. Initially referred to the genus ***Enaliosuchus*** in 1921 by Schroeder, Kuhn (1936) later named the specimen ***Enaliosuchus schroederi***. Later studies disagreed on the taxonomic status of ***Enaliosuchus***, its type species ***E. macrospondylus*** and whether ***E. schroederi*** is a valid species. Most recently both species have been referred to the Late Jurassic genus ***Cricosaurus***. Our reassessment of the type material of ***E. macrospondylus*** and ***E. schroederi*** found clear differences in their atlas-axis morphologies, validating ***E. schroederi*** as a distinct taxon. These differences include: the atlas intercentrum extending to the dorsal part of the atlas centrum in ***E. schroederi*** whereas it only extends to the midsection of the atlas centrum in ***E. macrospondylus***. The ***E. schroederi*** skull is also diagnostic, in lacrimal and sclerotic ring morphology, and orbit size. These craniofacial differences are significant when compared to the Late Jurassic ***Cricosaurus*** species. Our reassessment of the ***Enaliosuchus schroederi*** holotype begins to elucidate metriorhynchid morphological diversity at the zenith of their marine adaptations.

Thalattosuchia
Metriorhynchidae
Enaliosuchus
Cricosaurus
Lower Cretaceous
Germany

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Ontogenetic niche shifts in hadrosaurids of Late Cretaceous North America

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Research on hadrosaurid ontogeny has focused on the development of cranial ornamentation, with few studies considering the dietary implications of growth. In modern ecosystems, size differences facilitate resource partitioning both between and within species. Many extant reptiles that experience long growth trajectories undergo ontogenetic niche shifts (**ONS**s) wherein different ontogenetic stages occupy different ecological niches. Typically, size differences facilitate these shifts, and are accompanied by allometric growth within the skull. Given hadrosaurids experienced long growth trajectories, it is likely that they underwent ONSs.

We investigated skull allometry among immature (n= 32) and mature (n= 69) hadrosaurids using 12 linear measurements (e.g., tooth row length, snout length, occiput height) known to correlate with feeding ecology in living vertebrate taxa (e.g., reptiles, ungulates, macropods). We also applied a univariate measure of beak shape, and traditional methods for dental microwear analysis. Morphometric analyses show juvenile hadrosaurids differed from adults in their possession of shorter, less ventrally depressed rostra, and squatter occiputs. The shorter occiputs of juveniles suggest they did not require sharp head movements to sever vegetation. Juveniles may have subsisted on softer vegetation requiring little effort to pluck. The shorter, smaller rostra of juveniles would have made it relatively easier for them to selectively feed on this softer vegetation. Dental microwear analyses revealed greater variability in juvenile scratch orientations potentially indicating greater kinesis within the juvenile skull resulting from the presence of more cartilage/lack of sutural fusion. This study is one of few to assess the dietary implications of growth in dinosaurs and may have important implications for dinosaur community structure, with juvenile hadrosaurids potentially being key competitors for small ornithischian taxa.

Hadrosauridae
Microwear
Ontogenetic niche shifts
Late Cretaceous North America

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Early Triassic (Induan) conchostracans from the South Verkhoyanie Mountain System (Republic of Sakha – Yakutia)

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The collection of conchostracans is sampled from the Tiryakh-Kobyume section located in South Verkhoyanie Mountain System (N 63.374284, E 140.945873). The section is represented by Permian and Triassic sediments which overall thickness is about 4000 meters.

Conchostracans (about 150 specimens) are found in several carbonate-siliceous concretions. Ammonoids of the genus Tompophiceras are found at the same stratigraphic levels and indicate Early Triassic (Induan) age.

Assemblage include 7 species of conchostracans: ***Pseudestheria sibirica*** Novojilov, 1959, ***Ps. tumaryana*** Novojilov, 1959, ***Ps. kashirtzevi*** Novojilov, 1959, ***Sphaerestheria aldanensis*** Novojilov, 1959, ***Lioestheria ignatjevi*** Novojilov, 1959, ***Wetlugites pronus*** Novojilov, 1958, ***Euestheria gutta*** (Lutkevich, 1938). Some specimens are well preserved and have pitted type of microsculpture on the valve.

Holotypes of four species (***Pseudestheria sibirica***, ***Ps. tumaryana***, ***Ps.kashirtzevi***, ***Sphaerestheria aldanensis***) were collected from the same location in West Verkhoyanie. It is necessary to revise the validity of these species based on new methodology.

The species Euestheria gutta is an index species of the Lower Triassic and widespread in the Induan and Olenekian formations of Siberia, China, East European Platform, the Pechora Coal Basin. Euestheria gutta-like forms also occur in fine-grained siliciclastic sediments together with Rossolimnadiopsis in the Lower Triassic deposits (Ma'in Formation) in the eastern Dead Sea Region of Jordan. The wide distribution of this species will allow to correlate the sediments from different regions.

Species ***Pseudestheria kashirtzevi*** and ***Pseudestheria sibirica*** were previously found in Induan deposits in the Pechora Coal Basin. Thus, conchostracans confirm the Early Triassic age of sediments determined by ammonoids.

The work was supported by the Russian Science Foundation grant No. 19-17-00178.

W

Late Permian
Early Triassic
conchostracans
Biostratigraphy
South Verkhoyanie

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General Session:

Cenozoic

Please scroll down for Table of Contents

Click on the title to go the Abstract

In the Abstract, click on the title to return to the Table of Contents

Table of Contents

continues >

continues >

continues >

Ostracod and gastropod fauna of the Alagöz Section (Central Anatolia): new fossil data for the Neogene lacustrine deposits of Ankara region

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The study area is located 45 km southwest of Ankara (Central Anatolia, Turkey) where the Alagöz Formation crops out around Alagöz district. The Alagöz Formation consists mainly of coarse to fine clastics such as conglomerates, sandstones, and mudstones with thin fossiliferous limestone intercalations indicating fluvial to lacustrine conditions.

A 200 m long stratigraphic section was measured along the Alagöz Formation and twenty-nine samples were collected to determine the ostracod and gastropod fauna assemblages and to interpret the paleoenvironmental conditions prevailed during the deposition. Moreover, mineral analyses were realized to determine the source of the clastics along with the composition of the fossil steinkerns (internal casts). The Alagöz section is represented by clastics (sandstones, mudstones) in the lower and upper parts while fluvial to lacustrine carbonates (limestones, marls) are dominant in the middle part.

A low-diverse faunal assemblage is recorded, with a monospecific ostracod fauna being only represented by the genus ***Virgatocypris*** and three taxa of gastropods (***Melanopsis praemorsa*** Linnaeus, 1758, ***Falsipyrgula*** sp. and ***Planorbarius*** sp.).

The fossil genus ***Virgatocypris*** is known from Late Cretaceous and its species (esp. type species ***V. virgata***) have been frequently recorded from upper Oligocene (Germany and Switzerland)-lower Miocene (Germany, Czechia and Turkey) lacustrine successions. In Turkey, the genus was only reported from lower Miocene sequences of the Çankırı and Ilgın (Konya) basins and for the first time in this study, it has been obtained in Ankara (Central Anatolia). The genus ***Planorbarius*** is known from Oligocene-Quaternary deposits of the Palearctic ecozone, and it has been frequently reported from the Miocene. The fossil forms of the genus ***Melanopsis*** have been reported from Oligocene and Miocene deposits of Turkey. ***Falsipyrgula*** spp. are known from the Quaternary deposits of the Turkish Lakes Region in southwestern Anatolia. The ostracod and gastropod fauna point towards very shallow freshwater lacustrine conditions during the deposition of the carbonate-dominated part of the Alagöz Formation. Moreover, the discovery of the genus ***Virgatocypris*** suggests that the age of the Alagöz Formation is probably older (early-middle? Miocene) than the late Miocene–Pliocene suggested in previous studies.

The minerals identified by X-ray diffractograms are mainly clay minerals (smectite, illite), quartz, and feldspar and carbonate minerals. The SEM-EDX data along with the clay-size fraction analysis show that fossil steinkerns are made of smectite. Consequently, the presence of aluminosilicate minerals (e.g., feldspars, smectite, illite/mica) suggests clastic input from adjacent volcanic rocks (e.g. lower Miocene Ballıkuyumcu volcanic deposits).

Ostracoda
Gastropoda
Virgatocypris sp.
Paleoenvironment
Central Anatolia

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The Foieta La Sarra Palaeolake from the Early Miocene of the Campisano Ravine (Ribesalbes-Alcora Basin, E Spain)

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The Ribesalbes-Alcora Basin is located in the eastern Iberian Peninsula (Castelló, Spain) and corresponds to a complex graben of Neogene age that extends over an area of 150 km^2. Two depositional units in this basin are rich in fossils: unit B, which has provided a diverse fossil assemblage including plants, molluscs, insects and amphibians from a lacustrine/palustrine palaeoenvironment, and unit C, which has yielded fossil mammals from 48 palaeontological sites in the Campisano Ravine related to distal deltaic and shallow palustrine palaeoenvironments. The mammalian record makes it possible to correlate the sections to the local biozone C of the MN4 from the Calatayud-Montalbán Basin, early Aragonian in age (16.49–15.94 Ma). Here, we report a new locality within a laminated limestone level named **FSA** of the Foieta la Sarra section in unit C, which is the first known fish bonebed from the Ribesalbes-Alcora Basin. Apart from teleostean fish remains, the fossil record of FSA includes plants such as charophyte gyrogonites, isolated leaf remains and seeds, mollusc shells, and arthropods including ostracods, cladocerans and insects. The fish remains are currently being studied and correspond to elasmoid scales of cycloid type, ribs and fin rays. A taphonomic and palaeoecological study will address the diverse FSA assemblage to obtain an overview of the ancient lake. Moreover, the comparison between the inferred palaeoenvironments of the new locality and those from other palaeontological sites from units B and C holds the potential to provide new information for understanding the environmental dynamics and evolution of the Ribesalbes-Alcora Basin during the early Miocene.

Fish Biodiversity Early Aragonian Taphonomy, Palaeoecology

New paleontological records of the Cova del Tabac (Camarasa, Lleida). Preliminary data of the new Ursidae fossils

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The Cova del Tabac is situated in the Mont-Roig mountain range (660 m.a.s.l.), located to the north of the Noguera region (Lleida). During the intervention of 2018, a series of ursid remains were identified in an archeological survey at the entrance of the cavity. No other archaeopaleontological records have been registered in this section. This discovery allowed us to start the first paleontological excavations in the cave in order to know the extension of the paleontological level and to perform a morphometric analysis of the ursid fossils.

A total of 41 ursid remains were recovered but only 27 were analyzed due to their state of preservation and belong to the same individual: 3 carpal bones, 1 patella, 2 calcaneus, 2 talus, 7 tarsal bones, 4 metapodials and 8 phalanges. The metric analysis shows that the pieces have similar dimensions to those of the brown bear, with punctual overlap with the smallest specimens of ***U. deningeri***. Morphological characteristics such as the lower robusticity of metapods or phalanges, together with the morphology of the articular surfaces of calcaneus and talus, have allowed us to exclude the deningeri-spelaeus line. Based on both morphological and metric analysis, the fossil remains has been assigned to ***U. arctos***.

The discovery of bear fossils in the Cova del Tabac provides new insights about the distribution of the brown bears in the Pyrenees. Awaiting for new geological and chronological data of the site, the stratigraphic and chronological situation of the remains is uncertain.

Cova del Tabac
Ursus arctos
Pyrenees

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Oldest *Chasicotatus* (Cingulata, Xenarthra) remains give a new approach to this lineage biochron and taxonomic status

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Eutatini armadillos are a tribe within the subfamily Euphractinae (Chlamyphoridae), characterized by large piliferous foramina and the absence of a well-defined carapace scapular buckler. Though there are no living representatives, they are present in the fossil record from late Eocene to Holocene deposits of southern South America. Here we report new materials (CTESPZ-7852, isolated osteoderms) assigned to the genus ***Chasicotatus*** Scillato-Yané from Cañadón del Tordillo site (Colloncuran SALMA) of Neuquén Province (Argentina). This represents the southern record of the genus and extends its biochron by ~6 Ma (previously recorded in ~9–10 Ma). Though the genus ***Stenotatus*** Ameghino was the only Eutatini recorded for the Colloncuran SALMA so far, remains are assigned to ***Chasicotatus*** according to traditional diagnosis based on dorsal carapace features; including a flat transitional zone between articular and caudal portions of mobile osteoderms, a more dorsal orientation of the piliferous foramina of the osteoderms, and a more extended main figure of osteoderms ornamentation, that reaches the posterior margin of the osteoderm, unlike in ***Stenotatus***. These same characters have been used from the first descriptions of these taxa without being later discussed. However, it is to remark that the morphological variability that they present in current Euphractinae armadillos such as ***Chaetophractus villosus*** Desmarest, or even in other groups such as Dasypodinae or Tolypeutinae, suggests the future need of more detailed revisions in order to verify their validity and/or the identification of new more robust diagnostic characters that allow to keep supporting the validity of these two taxa.

South America
Xenarthra
Cingulata
Eutatini
Taxonomy

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New analysis of *Vetelia gandhii* (Xenarthra, Cingulata) gives a novel hypothesis: was this armadillo a carnivorous tolypeutine?

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Vetelia is a genus of armadillos traditionally included within the subfamily Euphractinae (Chlamyphoridae), restricted to the Miocene of Argentina. It includes the species ***V. puncta*** (early and middle Miocene, Santacrucian, Friasian s.s., and Colloncuran), ***V. perforata*** (middle and late Miocene; Mayoan, Chasicoan, and Huayquerian), and ***V. gandhii*** (late Miocene; Chasicoan, Huayquerian), mostly known by isolated osteoderms. In this contribution, we analyze and describe both cranial and postcranial remains assigned to ***V. gandhii*** (PVSJ-289; PVSJ-154) from the late Miocene of Loma de Las Tapias Formation (Chasicoan) of San Juan Province, Argentina. The morphology of the osteoderms of the dorsal carapace suggest a higher affinity with the extant representatives of Tolypeutinae, including ***Priodontes***, ***Cabassous***, and ***Tolypeutes***, rather than those of Euphractinae, based on: **i)** similar ornamentation pattern of both fixed and mobile osteoderms; **ii)** mobile and fixed osteoderms with external rugose surface; and **iii)** fixed osteoderms becoming subcircular towards the carapace lateral margins. Though molecular analyses already place the tolypeutines at ~26 Ma, and the most ancient record is represented by the Oligocene ***Kuntinaru***; remains of these armadillos are extremely scarce in the fossil record; a circumstance that could be enhanced by a historic misidentification of Tolypeutinae diagnostic characters. Additionally, we carry out for the first time an anatomical analysis on ***Vetelia*** cranio-mandibular features, which is characterized by a dorsoventrally expanded rostrum, very robust horizontal ramus, powerful anterior dentition, presence of premaxillary teeth, massive chisel-shaped molariforms, and absence of anterior dental diastema, suggesting a trend or specialization towards carnivory.

South America
Xenarthra
Cingulata
Tolypeutinae
Vetelia

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Disentangling the Early Pleistocene European record of the genus *Vulpes*

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The earliest record of the genus ***Vulpes*** comes from late Miocene deposits of North America. By the late Miocene early representatives of the genus had already reached the Old World. A characteristic of the ***Vulpes'*** fossil record is its utter scarcity and fragmentary nature. The relationship between the numerous different species are still poorly known.

Despite the relative abundance of the European Early Pleistocene fossil record of ***Vulpes***, three species were described and their diagnoses are based on partial, scanty or incomplete specimens: ***Vulpes alopecoides***, ***Vulpes praeglacialis*** and ***Vulpes praecorsac***.

The study of one the most complete Early Pleistocene European cranial specimen attributable to ***Vulpes*** (from Villany 3, Hungary, ca 2.0 Ma), lead us to reconsider the diagnostic features of the three species in order to contribute to the better understanding and clarification of their taxonomical validity. To do so we used the inter- and intraspecific variability displayed by extant species ***Vulpes corsac***, ***Vulpes lagopus*** and ***Vulpes vulpes***. Thanks to morphometric and morphological comparisons among the fossil remains from different European localities related to the Early Pleistocene, we were able to assess the degree of variability of the three fossil species. Our results suggest that the interspecific variability of ***V. alopecoides*** - ***V. praeglacialis*** - ***V. praecorsac*** is comparable to, or even lower than, the intraspecific variability observed in a sample of the living ***V. vulpes***. As a consequence, our results suggest accommodating all the analyzed European Early Pleistocene ***Vulpes*** specimens in a single species, i.e., ***V. alopecoides***, and thus regarding ***V. praeglacialis*** and ***V. praecorsac*** as junior synonyms.

Carnivora
Europe
Plio-Pleistocene
Taxonomy
Vulpes

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Strontium dating and the termophilic fauna of the lower Pisco Formation (Peru) suggest a Late Miocene strengthening of the Humboldt Current

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We seek to elucidate the Cenozoic history of the upwelling system off Peru-Chile, which currently forms the basis for one of the most productive fisheries in the world. To pursue this aim, we investigate the outstanding record of Eocene–Pliocene sedimentation and associated marine fossils in the East Pisco Basin of southern Peru, where the lower Miocene Chilcatay Formation is overlain by the Pisco Formation, the latter containing three allomembers, each reflecting a transgressive cycle: P0, P1 and P2, in ascending stratigraphic order.

The Chilcatay Formation and the overlying middle Miocene P0 allomember (based on our recent strontium isotope stratigraphy) are comprised of lithologies (sandstones and siltstones) that suggest a limited upwelling. Furthermore, a warm-water palaeoenvironment is indicated by the thermophilic fossil assemblage in these units, including mollusks (architectonicids, cypraeids, and the genus ***Ficus***), the only coral colony known from the basin (a rhizangiid scleractinian from P0), and the extinct snaggletooth shark ***Hemipristis serra***. The overlying P1 and P2 allomembers are late Miocene in age and are characterized by abundant diatomites that suggest high primary productivity conditions.

The present-day Peruvian coastal upwelling system results from a combination of the Peru Coastal Current and the offshore Humboldt Current. A precursor of this upwelling system emerged after the K/Pg boundary, and a proto-Humboldt Current originated only in the late Eocene. The Miocene transition in the East Pisco Basin from warm-water conditions to high-productivity and cooler conditions shows that there was a strengthening of the Humboldt Current during the late Miocene.

Upwelling
Miocene
East Pisco Basin
macro-invertebrates
$^{87}Sr/^{86}Sr$
stratigraphy

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Trace fossils in marine molluscan shells from the Holocene of Buenos Aires Province, Argentina

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The shells of bivalves and gastropods found in Holocene marine sediments of the south of Buenos Aires Province show bioerosion traces. Ten sites from three areas were analyzed: Colorado River delta (**CRD**) (39º15'S / 39º55'S) (6.9 – 2.1 ka); Bahia Anegada (BA) (39º55'S /40º31'S) (5.9 - 3.6 ka) and Bahia San Blas (**BSB**) (40º31'S /40º37'S) (7.5 – 2.1 ka). These sites are reported (N= 2.640 valves). Twelve ichnogenera were identified: ***Entobia***, ***Iramena***, ***Pinaceocladichnus***, ***Pennatichnus***, ***Maeandropolydora***, ***Caulostrepsis***, ***Gastrochaenolites*** (Domichnia); ***Finichnus*** and ***Centrichnus*** (Fixichnia); ***Gnathichnus*** and ***Radulichnus*** (Pascichnia) and ***Oichnus*** (Praedichnia), as well as eight ichnospecies: ***P. onubensis***, ***F. peristroma***, ***C. eccentricus***, ***G. pentax***, ***R. inopinatus***, ***O. simplex***, ***O. paraboloides***, and ***O. smiley***. The highest percentages of bioerosion traces were found in the deposits of BSB with 18.21%, followed by CRD with 4.30 and BA with 3.70%. The dominant ichnogenera in CRD are ***Pennatichnus***, ***Pinaceocladichnus***, and ***Iramena***, which reveal the existence of cteostomate bryozoans suggesting water currents and large availability of phyto- and zooplankton in the environment. The most represented ichnogenera in BA are ***Entobia*** and ***Iramena***, which indicate a high temperature range with a sublittoral environment of low sedimentation rate, water currents, high availability of suspension particles and high oxygenation of the water. While those of BSB are ***Entobia***, ***Maeandropolydora*** and ***Oichnus***, which suggest long periods of exposition, low energy enviroment, and sandy bottoms with polychaete annelids and carnivorous gastropods. Bioerosion is among the most relevant taphonomic features when interpreting specific environmental characteristics that suggest palaeoecological and palaeoenvironmental conditions during the Late Quaternary.

Bioerosion
Marine molluscs
Holocene
Buenos Aires

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Equus stenonis and *Equus stehlini* from the Early Pleistocene of Italy. Implications for the Old World *Equus* Evolution

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Equus stenonis and ***Equus stehlini*** are two of the most important equids in the Early Pleistocene of Europe; nevertheless, some issues about their taxonomy, occurrences and evolutionary history are still matter of debate, with different opinions among different authors.

Here new evidences from the Italian fossil record of Upper Valdarno and Olivola are presented, in comparison with the European Early Pleistocene localities, through morphological and statistical analysis.

E. stenonis from Olivola and Upper Valdarno Basin shares many morphological and morphometric features with the Pliocene North American ***Equus simplicidens*** and the first large Pleistocene European equid, ***Equus livenzovensis*** (among skull shape, snout lenght, upper and lower dentitions, metapodials and phalanges morphology). Furthermore, these two Italian ***E. stenonis*** samples evidence close affinities with the European ***E. stenonis*** subspecies, ***E. stenonis vireti***, ***E. stenonis guthi***, and ***E. stenonis pueblensis***. These data suggest an urgent need of a revision for all the mentioned subspecies in order to prove their taxonomical validity or consider these subspecies as an expression of ***E. stenonis*** variability among different populations.

E. stehlini represents the smallest Early Pleistocene horse in Italy, and its presence is also reported from Senèze, even if this sample need a deeply revision in order to understand which and how many species are in Senèze. Nevertheless, our study on the ***E. stehlini*** from Upper Valdarno basin, suggests a close relationship with the Early Pleistocene Equid samples from Senèze (France) and Coste San Giacomo (Italy). This evidence could provide new insights on the evolutionary history of the Villafranchian small-medium size horses.

Equus stenonis
Equus stehlini
Early Pleistocene
Evolution
Equids

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A palaeoecological analysis of the earliest killer whale, *Orcinus citoniensis* from the Pliocene of Italy

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Orcinus citoniensis (Capellini, 1883) is an extinct dolphin known by a single specimen discovered in 1882 from Pliocene (3.6–2.6 Ma) sandstones exposed near Cetona (Tuscany, Italy). With the present study, we aim at elucidating the palaeoecological significance of this fossil killer whale. The morphofunctional study of this specimen provides strong support for a mainly piscivorous diet based on small-medium sized fishes. The pattern and degree of apical tooth wear, the fine and shallow microwear features on the dentine exposed at the apices of the teeth, and the flat apical wear surfaces support the prominence of fish in the diet. On the other hand, a frequent consumption of marine mammals and/or of large bony fish seems unlikely given the absence of features that are typically associated with such a macrophagous behaviour (i.e., the presence of spalling, broken tooth apices, occlusal facets on the mesiodistal surfaces of the teeth, and microwear features on the dentine such as gouges or hypercoarse scratches). ***Orcinus citoniensis*** also lacks some peculiar features of the skull (e.g., a short rostrum and a very large temporal fossa) exhibited by extant species that feed on large prey and are susceptible to occasionally bite on bone material (i.e., ***Orcinus orca*** and ***Pseudorca crassidens***). Moreover, the body size reconstruction for ***O. citoniensis*** supports the hypothesis that smaller prey was targeted compared to extant macroraptorial species. Nonetheless, ***O. citoniensis*** might have occasionally relied on macroraptorial feeding upon medium- to large-sized fish, considering the conspicuous extent of dentine deposition in teeth (as revealed by the CT-scan analysis) and the large size of teeth themselves.

Autecology
Delphinidae
Dental wear analysis
Functional morphology
Macroraptorial feeding

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Stable isotopes in megamammals from the Arroyo del Vizcaíno Site (Canelones, Uruguay)

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The analysis of stable isotopes on fossil mammals has become a widely used tool for understanding the paleoecology and paleodiet of these organisms. In this work, we study the stable isotope composition of collagen ($\delta^{13}C$ and $\delta^{15}N$) and bioapatite ($\delta^{13}C$ and $\delta^{18}O$) of megamammal fossil bones from the Arroyo del Vizcaíno site (Sauce, Canelones, Uruguay), with an age of ~30 ka (29696–32009 cal BP). Seven species were analyzed: the ground sloths ***Lestodon armatus***, ***Glossotherium robustum***, and ***Mylodon darwinii***; the glyptodonts ***Glyptodon*** cf. ***reticulatus***, ***Panochthus tuberculatus***, and ***Doedicurus clavicaudatus***; and the saber-tooth felid ***Smilodon populator***. Although some results of collagen were not conclusive (***Glossotherium*** sample), in general the percentage of nitrogen in collagen and the C:N ratio were within the limits expected for collagen preservation in fossil bone. The collagen $\delta^{13}C$ and $\delta^{15}N$ results of the herbivores indicated that these organisms consumed C_3 plants in open, relatively dry, environments, with higher values of $\delta^{13}C$ being observed in sloths than in glyptodonts. Collagen samples obtained from different ***L. armatus*** individuals showed some intraspecific variation in the diet, possibly related to bulk-feeding behavior. Furthermore, relatively high values of $\delta^{18}O$ in bone bioapatite, which approximately tracks local drinking water, indicate low precipitation and/or high evaporation. This is congruent with temperate climatic conditions, slightly drier than present.

Collagen and bioapatite stable isotopes
Paleodiet
Arroyo del Vizcaíno
Pleistocene

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First record of the pond turtle *Mauremys* from the Upper Pliocene of Italy, with a new occurrence of the rarely reported ichnotaxon *Thatchtelithichnus holmani*

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Nowadays, the living species of the terrapin genus ***Mauremys*** (Testudinoidea: Geoemydidae) are mostly found in eastern Asia, but three of them inhabit the Western Palearctic. In Italy, finds of living individuals of ***Mauremys*** are interpreted as records of alien species; however, a growing fossil record demonstrates that this genus inhabited Italy as recently as the late Pleistocene. We report on a new fossil specimen of ***Mauremys*** from the upper Pliocene (Piacenzian) marginal-marine deposits of Tuscany (central Italy). This find, consisting of a partial plastron and an isolated neural, represents the second report of Mauremys from the Italian Pliocene, as well as the first one from the Piacenzian of Italy. Therefore, it represents a somewhat important fossil that fills a gap in the chronostratigraphic distribution of the Italian fossils of ***Mauremys***, contributing — together with the early Pliocene holotype of ***Mauremys portisi*** — to bridge the rich Miocene and Pleistocene segments of this record. Moreover, two unusual scars observed on the external surface of the studied plastron are here referred to the ichnospecies ***Thatchtelithichnus holmani***. These traces represent some of the few records worldwide of this rarely identified ichnospecies, as well as its geologically youngest published occurrence. The hypotheses regarding the origin of the ***Thatchtelithichnus*** traces are then re-evaluated in the light of our new report, and an origin as attachment scars of aquatic ectoparasites (possibly ticks, leeches, or flukes) is reaffirmed as probable in cases of traces occurring on the exterior of the plastral bones of turtles.

Geoemydidae
Freshwater turtle
Parasitism
Piacenzian
Ichnology

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Protochelonibia melleni, new combination for *Chelonibia melleni* zullo, 1982, and its impact on the stratigraphic and geographic distribution of the early coronuloids

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The fossil history of turtle and whale barnacles (Coronuloidea) is fragmentary and has only been investigated in part. In particular, fossils attributed to the currently monotypic family Chelonibiidae mostly consist of remains of the extant genus ***Chelonibia*** Leach, 1817 from Plio-Pleistocene strata worldwide. In geologically older deposits, the few published records of Chelonibiidae include some specimens of the Mio-Pliocene, Mediterranean/Paratethyan, archaic-looking genus ***Protochelonibia*** Harzhauser & Newman, 2011. A reappraisal of ***Chelonibia melleni*** Zullo, 1982 from the lower Oligocene of Mississippi (U.S. Gulf Coast) has revealed two characters that, among chelonibiids, are presently regarded as proper of Protochelonibia: **1**- the rostral complex consists of obviously unfused compartments; **2**- the parietes of both the rostrolaterals and rostrum exhibit acutely triangular outlines. Therefore, this species represents the oldest member of Chelonibiidae and a bona fide protochelonibiine, hence the new combination ***Protochelonibia melleni***. This action allows us to extend the fossil record of ***Protochelonibia*** back for some 10–12 myr, to ~32–34 Ma, as well as to recognise that, in late Palaeogene times, the range of protochelonibiines extended over the broad Western Tethyan realm, on both sides of the North Atlantic. Interestingly, the U.S. Gulf Coast is also home to the only known specimen of ***Emersonius cybosyrinx*** Ross, 1967, an enigmatic form from the upper Eocene of Florida, which represents the geologically oldest (albeit surprisingly derived) coronuloid fossil worldwide. Therefore, we hypothesise that the early coronuloids had their centre of distribution somewhere in what is currently considered westernmost Tethys. More discoveries of Palaeogene fossils of Coronuloidea are needed to improve our understanding of the earliest turtle and whale barnacles.

W

Cirripedia
Coronuloidea
Chelonibiidae
Palaeobiogeography
Turtle and whale barnacles

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Holocene aquatic ferns (Salviniaceae) from the eastern Chaco Region, Northeastern Argentina

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The Chaco region is a large subtropical plain and one of the major biogeographic and morphostructural areas of South-America. Eastern Chaco is the wettest sector of the Chaco region and has heterogeneous environments. Vegetation results of Quaternary alluvial plain dynamics including the intensive migration of the Chaco main rivers. Paleobotanical records do not attest significant floristic changes in the region during the last 10,000 years. Fern macrofossils (vegetative part impressions) and microfossils (spores) belonging to the group of heterosporous aquatic ferns (Salviniaceae) were collected from two sites (Formosa Province, Argentina) which include sediments of the Fidelidad Formation (Late Holocene - Bermejo River natural levees, Villa Escolar). Impressions correspond to ***Salvinia*** Ség. The floating leaves are orbicular to elliptical in shape, with smooth margin and both the apex as the base are rounded. The base bears a slightly developed keel. Venation pattern is dichotomous. These veins are anastomosed forming areolas. Generally, four tubercles (trichome bases) per areola are observed. The microfossils correspond to massulae and spores of ***Azolla*** Lam. The massulae are rounded, oval or kidney shaped and have septate glochidia. Spores are trilete and spheroidal. Aquatic ferns are significant paleoenvironmental indicators of open fresh water or wetlands, while ***Azolla*** and ***Salvinia*** represent floating plants. This evidence suggests that the basal sediments of the Fidelidad Formation formed under environments similar to those currently observed in the region.

Azolla
Salvinia
Massulae
Chaco region
Fossil ferns

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Shelf ecosystem response to the Eocene-Oligocene transition

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The Eocene-Oligocene transition (**EOT**) is one of the most dramatic climate shifts of the Cenozoic with severe consequences for reef ecosystems. Whilst numerous studies of the biotic response to the changes at the EOT have been carried out, most high-resolution studies consist of open ocean records of marine plankton and predominantly single groups of organisms. However, this is not representative of the ocean system as a whole and does not provide a holistic view of mechanism of restructuring of the marine ecosystems.

The Tanzanian Drilling Project EOT record is recognised globally for its completeness and exceptionally preserved calcareous microfossils. It is most importantly, a rare record of both shallow water organisms and open ocean plankton. Here we draw together a unique dataset of high-resolution mollusc, Dasycladaceae, bryozoan, larger benthic foraminifers, coral, smaller benthic foraminifera, trace element and isotope records from the EOT. Following rapid extinctions in the larger foraminifera at the Eocene-Oligocene boundary, molluscs, Dasycladaceae and bryozoans all show increases in abundance, indicating a major shift in shelf ecosystem composition. Comparison with the open ocean record of planktonic foraminiferal, pteropod, and nannofossils confirm fossil increases are a biological, rather than sedimentological response and additionally support a transition to more eutrophic conditions during the transition. The interaction of these groups, within an environmental framework of traditional and novel geochemistry indicate that increased nutrient fluxes, rather than the temperature change directly, played a pivotal role in restructuring shelf ecosystem dynamics, and offer new insights into our understanding of the EOT.

Foraminifera
Shelf
Eocene-Oligocene
Climate
Ecosystem

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Parasorex ibericus (Eulipothypla, Mammalia) from Venta del Moro (Valencia, Spain)

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The classical site of Venta del Moro is located in the Cabriel Basin (Province of Valencia, eastern Iberian Peninsula). Since 1970, fruitful palaeontological excavation of this site has yielded remains of about two hundred taxa, including vertebrates, molluscs, arthropods and plants. The mammal association of Venta del Moro suggests a late Miocene age (late Turolian, MN13), dated by means of palaeomagnetic techniques to 6.23 Ma. This site is therefore a key locality to understand the environmental and faunal changes that took place just before the Mediterranean **Messinian Salinity Crisis**.

A preliminary list of the insectivores from Venta del Moro was previously published and includes two talpids (***Desmanella*** aff. ***dubia*** and ***Archaeodesmana luteyni***), two soricids (***Paenelimnoecus repenningi*** and Soricidae indet.) and an erinaceid (***Parasorex ibericus***), which is the most common insectivore in this site with more than 400 remains. The Galericini ***P. ibericus*** has been identified in many other localities, but the collection from Venta del Moro represents the most abundant collection known until now and allows us to observe a high intraspecific variability. This variability is consistent on a mosaic mode of evolution, including a mixture of advanced and primitive features as the development stages of the metaconule posterior arm and the postprotocrista.

Erinaceidae
Galericinae
Iberian Peninsula
Mosaic evolution
Turolian

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Evolution and diversity of Old World telemetacarpal deer (Capreolinae, Cervidae, Mammalia)

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Modern Eurasian telemetacarpal deer represent a poor remnant of the rich evolutionary radiation of the subfamily Capreolinae from the past. The evolutionary radiation of capreolines took place during the Late Miocene in the middle latitudes of Eurasia, but their diversity was significantly depleted by the subsequent climate changes.

The multivariate cluster analysis of diagnostic craniodental characters (including antlers) of modern and fossil telemetacarpal deer and some cervid forms with uncertain systematic position demonstrates that such Late Miocene and Pliocene genera as ***Cervavitus***, ***Pliocervus***, and ***Lucentia*** should be regarded as capreolines, demonstrating a diversified evolutionary radiation of the subfamily Capreolinae in the past.

Lucentia represents the primitive two-pointed stage of antler evolution of Capreolinae and possibly belongs to the phylogenetic branch that includes ***Procapreolus*** and ***Pliocervus***. The ***Capreolus-Rangifer-Odocoileus*** phylogenetic branch has a more distant phylogenetic relationship with the ***Lucentia-Procapreolus-Pliocervus*** group. The cluster analysis shows that modern ***Capreolus*** may represent an early evolutionary off-shoot of the ***Rangifer-Odocoileus*** lineage. The obtained for ***Capreolus*** results do not fit the genetic data, suggesting that the set of recorded craniodental characters may be improved. The ***Cervavitus-Alces*** group is the most detached phylogenetic branch of Capreolinae. According to the present study, holometacarpal "***Cervocerus novorossiae***" from the Late Tertiary of China is nested within the subfamily Cervinae.

Among the most notable plesiomorphic craniodental characters of Capreolinae should be mentioned the parallel and sloped backwards long pedicles, the ***Palaeomeryx*** fold in lower molars, the protoconal fold in upper molars, and the high position of the first antler ramification.

Capreolinae
Eurasia
Evolutionary radiation
Phylogeny
Systematics

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Fossil-diagenesis of a fossil coral reef from the Pleistocene of Fauglia (Tuscany, Italy)

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A new palaeontological geosite has been discovered in the vicinities of Fauglia (Tuscany, Italy), in the Neogene Tora-Fine Basin. Here, an entire coral reef has remained "frozen in time" from Pleistocene times, exhibiting a peculiar fossil preservation. The studied outcrop extends over a 65 m-long artificial cliff where a 4-m-thick stratigraphic section is exposed. The section features an alternation of mudstones, clayey sandstones, and massive sandstones that host a reef of colonies of the Mediterranean scleractinian coral ***Cladocora caespitosa***. The entire reef is covered by a thick layer of sand.

The sedimentological features and the macrofossil assemblage suggest positioning of the outcrop in the Morrona Formation, which is locally referred to the early Pleistocene (Calabrian stage).

The faunal association of the reef includes several species of echinoids, bivalves, gastropods, scaphopods, crustaceans, and cnidarians. Complex interactions between animals have also been recognized (e.g., corals growing around bivalves and ***Oichnus*** traces). Body fossils display a peculiar preservation style. Corals, mollusks and echinoids are mainly comprised of composite molds, inner and outer molds, and pseudomorphs; pristine shells are rare . Bivalves exhibit a geopetal structure that testifies for three stages of mineral precipitation, namely: the cementation of the terrigenous infill; the precipitation of large crystals filling the voids; the re-precipitation of the shell carbonate to form pseudomorphs. Microscope analyses revealed a calcite composition of all these phases. Subsequent stages of dissolution and re-precipitation of calcite are here hypothesized, revealing a complex and unusual diagenetic history for this Pleistocene coral reef.

Cladocora caespitosa
Invertebrates
Calabrian
Calcite
Taphonomy

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Eocene-Oligocene turnovers of large benthic foraminifera in Florida

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The Eocene Oligocene transition (**EOT**) is one of the most dramatic climate shifts of the Cenozoic, associated with widespread cooling and biotic turnover. This includes the carbonate platform environment. Larger benthic foraminifera (**LBF**) are an important component of the platform ecosystem and have long been known to suffer global extinction of several long-ranging groups during the EOT interval.

Whilst detailed studies of the LBF have been carried out in Tanzania, Sarawak and the Tethyan region, there are very few studies in the Americas, with only one recent paper addressing the EOT directly. The LBF assemblages of the Americas are very different to those of Europe and the Indo-Pacific, and may have different responses to climatic events. It is therefore essential that the American LBF bio-province is included in studies of LBF evolution, migration and biodiversity, to understand these processes on a global scale.

Here we present data from sediment core sections through the EOT of North Florida. Thin sections have been used to examine ranges in morphological and lineage response patterns of the LBF, other shelf organisms and environmental changes. This is coupled with bulk stable isotopes ($\delta^{13}C$, $\delta^{18}O$) and nannofossil analysis to constrain LBF responses with respect to global bio- and chemostratigraphy. Allowing for comparison with global sites to gain a wider perspective of the timings, causes and effects across the EOT.

Eocene
Oligocene
Glaciation
Foraminifera
Florida

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Small vertebrates (Amphibians, Squamates and small mammals) from a Holocene gravelly deposit at El Salt (Alcoi, Alicante)

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There are few examples of small vertebrate' works centred in the Holocene in the south-eastern Iberian Peninsula. In this sense, Units I to IV from El Salt site (Alcoi, Spain) has been traditionally ascribed to the Holocene. The microvertebrate assemblage (350 remains) recovered from the water-sieving of almost 100 kg is composed by seven rodent species (***Arvicola sapidus***, ***Microtus*** sp., ***M. arvalis***, ***M. cabrerae***, ***M. duodecimcostatus***, ***Apodemus sylvaticus*** and E***liomys quercinus***), one lagomorph species (***Oryctolagus cuniculus***), two insectivore species (***Crocidura*** sp. and ***Sorex*** sp.), one toad (***Epidalea calamita***), three lizard species (Lacertilia indet, Lacertidae indet and ***Chalcides*** cf. ***bedriagai***) and three snake species (Serpentes indet, ***Coronella*** cf. ***girondica*** and cf. ***Coronella*** sp.). Moreover, 22 taxa of malacofauna have been described, being mainly terrestrial gastropods. All the vertebrates' species described in this work are present in the region nowadays, except in the case of ***M. cabrerae*** and ***M. arvalis***. The latter became extinct in the region at the end of the Late Pleistocene. However, the discovery of Neolithic pottery at the same levels implies an inconsistency from a biochronological point of view. The studied fossil remains show evidences related to transport. In this sensecontext, further taphonomical and geoarchaeological work is needed to clarify the provenience of the studied faunal assemblages, as they could have been reworked in more recent time periods.

Iberian Peninsula
Micromammals
Herpetofauna
Biochronology
Quaternary

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A great white shark (*Carcharodon carcharias* Linnaeus, 1758) paleopopulation from the Pleistocene of the Santa Elena Peninsula, Ecuador

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The white shark (***Carcharodon carcharias***) is a top predator in the present-day marine coastal ecosystems. Modern populations of this species have been studied in Africa, Australia and the Pacific coast of North America. However, the record of extant white shark populations in the coasts of South America is scarce. The fossil record of the white shark is relatively well known in Pliocene strata of the Pacific coast of Chile and Peru, while its fossil record in Pleistocene sediments from the region is scarce. Here, we describe the abundant isolated teeth of white shark that have been collected from the new fossiliferous locality "Quebrada Tiburón" (**QT**), where 157 teeth assigned to C. carcharias were identified. We used a regression formula to correlate tooth height and body length based on the fossil teeth of C. carcharias from QT. This allowed us to estimate the total body length range of this Late Pleistocene paleopopulation from the Ecuadorian waters. The mean body length in QT was 423 cm, distributed among three ontogenetic development groups. The geological context and body length estimation for the white shark paleopopulation from QT could support the presence of a tropical coastal paleoenvironment with prey-rich feeding conditions, where both subadults and adults converged. The study of both the intra-specific variability and ecological traits of the studied white shark paleopopulation is unique at this region, offering new light about the evolutionary history of this taxon, as well as supporting the presence of this top predator in Equatorial latitudes during the Pleistocene.

Elasmobranchs
Fossil teeth
Paleoecology
Total body length
South America
Eastern Pacific

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Diversity assessment of the family Rhinocerotidae (Mammalia, Perissodactyla) at the Late Miocene locality of Kerassia (Euboea Island, Greece)

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The locality of Kerassia was discovered in 1982, yielding a diverse Late Miocene mammalian fauna. Since 1992, the University of Athens has been conducting a series of recurring systematic excavations, unveiling seven fossiliferous sites belonging to two distinct stratigraphical horizons. The rhinocerotid diversity at Kerassia is notable, comprising two different horned rhinocerotid species, "***Diceros***" ***neumayri*** and ***Dihoplus pikermiensis*** (Subfamily Rhinocerotinae), along with the hornless rhinocerotid ***Acerorhinus neleus*** (Subfamily Aceratheriinae). The sympatric occurrence of all three species has been firmly confirmed in the lower stratigraphical horizon, within the site K4. However, in the upper horizon, only "***Diceros***" ***neumayri*** has been identified thus far.

The biogeographical and paleoecological implications are of particular interest, since Kerassia is located in-between the two classical Turolian localities of Greece, Pikermi and Samos. The Kerassia rhinocerotid association is the same as in Pikermi. In contrast, ***Acerorhinus*** is notably absent in Samos, where the hornless rhinocerotid ***Chilotherium*** is present. The relative higher abundance of "***Diceros***" ***neumayri*** in Kerassia, especially in the upper horizon, resembles though Samos, where it also emerges as the dominant rhinocerotid species.

The marked differences observed in the relative distribution and abundance of both horned and hornless rhinocerotid taxa among the Turolian localities of Greece and adjacent regions seem to have been primarily influenced by environmentally controlled provincial differences. The relatively slenderer and lower-crowned ***Dihoplus*** and ***Acerorhinus*** appear to have preferred more closed and temperate niches, whereas the more robust and higher-crowned "***Diceros***" ***neumayri*** and ***Chilotherium*** seem to have favoured more open and dry habitats.

Greece
Rhinocerotidae
Late Miocene
Diversity
Biogeography

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Larger foraminifera biostratigraphy and sedimentary evolution of a Paleogene succession of the Prebetic Domain (SE Spain)

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The External Prebetic of Alacant (eastern Spain) includes Paleogene carbonate platform deposits rich in benthic foraminifera, which have been previously determined only at group or generic level. A taxonomic analysis of larger foraminifera at species level was carried out in the stratigraphic sections of "Barranc dels Molins" in the surroundings of Ibi, and in the Natural Park of "El Carrascal de La Font Roja", nearby Alcoi. The biostratigraphic study was complemented with a sequence stratigraphic analysis and an interpretation of the depositional palaeoenvironment.

The Barranc dels Molins section includes larger foraminifera of Late Eocene (***Silvestriella tetraedra***, ***Borelis vonderschmitti***, ***Orbitolites*** aff. ***armoricensis***, ***Asterigerina rotula***, ***Discocyclina*** sp., ***Nummulites*** of the group ***fabianii*** and ***Fabiania*** sp.) and Oligocene age (***Penarchaias glynnjonesi***, ***Peneroplis thomasi***, ***P. flabelliformis***, ***Sorites*** sp., ***Sivasina egribucakensis***, ***Borelis pygmaeus***, ***B. inflata***, ***Risananeiza pustulosa***, ***Amphistegina bohdanowiczi***, ***A. mammilla*** and ***Cycloclypeus mediterraneus***), corresponding to SB zones 19-23 (Priabonian–Chattian). The presence of ***Risananeiza pustulosa*** throughout the whole La Font Roja section, together with ***Amphistegina mammilla***, ***Heterostegina assilinoides*** and ***Miogypsinoides formosensis*** indicates a SB 23 (Chattian) age for this section.

In both localities, the association of these larger foraminifera, together with other fossil groups, such as colonial corals indicates a shallow (<50 m) low-latitude marine environment. The vertical repetition of facies observed along the record studied is in agreement with aggrading inner carbonate platform settings. This high-rank aggradation system was punctuated by lower-rank regressive pulses, which ended with subaerial exposure of the inner platform, as indicated by the presence of several horizons with ***Microcodium***.

Biostratigraphy
Larger foraminifera
Carbonate platform
Chattian
Prebetic Domain

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Evolutionary ecology of fossil primates in southeast Asia. Results of two pilot studies

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Cenozoic Southeast Asia was a key area for primate evolution. Important episodes of diversification and evolution of anthropoids and hominoids took place there. Our project focuses on the evolutionary ecology of these fossil primates and the associated fauna. We performed isotopic paleoecological tracking on the fossil tooth material recovered from 1998 to 2020 by the Myanmar-French paleontological team from the middle Eocene Pondaung Formation (40 Ma) and the late Miocene Irrawaddy Formation (10–9 Ma), both located in the Central Basin of Myanmar. Our goal is to shed light on the ecological structure of the mammalian communities around the Eocene anthropoid and Miocene hominoid primates.

Carbon and oxygen isotopic analyses on the tooth enamel carbonates of the ungulates from the Pondaung Formation were collected in a pilot study. $\delta^{13}C$ values point towards an open forest habitat. Also, serial sampling on some of the teeth revealed a sinusoidal pattern of $\delta^{18}O$ values, confirming seasonality and monsoon-like events during the middle Eocene. Oxygen isotopic results suggest semi-aquatic habitats for the Amynodontidae, but not for the anthracotheres, in contrast with more recent members of this group.

All analyzed taxa from the Miocene Irrawaddy Formation lived in a pure C_3 open forested environment with no evidence of C_4 vegetation. Carbon and oxygen isotopic data of ***Khoratpithecus*** (MFI-K171) tooth enamel are consistent with a canopy habitat and a diet essentially frugivorous, in agreement with tooth wear analysis from Thailand.

The combination of isotopic analyses with dental microwear texture analysis will allow us to further understand niche partitioning and dynamics of these ecosystems.

Stable isotopes
Carbonates
Palaeoenvironmental reconstruction
Primate evolution
Southeast Asia

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Assessing climatic factors operating under *Microtus cabrerae* threatened conservation status in the Iberian Peninsula

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Inferring the future species distributions shaped by climatic shifts is a key part of conservation strategies. Climate niche models are commonly used for the description of past species distributions based on their climatic fitness. Among animals, mammals are highly sensitive to climatic shifts and some species possess a well-documented palaeontological record, like ***Microtus cabreae***, a Mediterranean climatic-explicit species endemic in the Iberian Peninsula. We aimed to address the influential factors that have driven ***M. cabrerae*** into a threatened conservation status assessed by the International Union for Conservative of Nature (**UICN**). We compared the evolution of **BIOCLIM** climate niche models for ***M. cabrerae*** and 6 climatic-neighbour species which shared historical distributions and non-threatened conservation status. Models were generated with **R** software (R, Inc) and based on **CCSM4** climatic variables availed in WorldClim (https://www.worldclim.org/) for Last Interglacial Period, Last Glacial Period, Mid Holocene and Present. According to our paleontological record database, ***Lepus granatensis*** was the climatic-neighbour species with better representation in the periods analysed. Results showed that climatic distributions of ***M. cabrerae*** and ***L. granatensis*** evolved along Pleistocene and Holocene following a similar trend. Nevertheless, ***M. cabrerae*** had lower tolerance to climatic shifts. We conclude that climate changes could be a key influence factor in the conservation status of ***M. cabrerae***, along with habitat fragmentation due to human activities. The understanding of the influence of climate factors and how they affected ***M. cabrerae*** and its climatic-neighbour species in the past are decisive for future conservation projects related to endemic Mediterranean species.

Climate niche model
Endemic
Mediterranean
Lepus granatensis
Climate change

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New material of *Ancylotherium pentelicum* (Mammalia, Chalicotheriidae) at the Late Miocene locality of Kerassia (Euboea Island, Greece)

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The family Chalicotheriidae formed a peculiar perissodactyl lineage with no extant representatives. The schizotheriine chalicotheriid ***Ancylotherium pentelicum*** was a rare, but typical faunal element of the sub-Paratethyan (Balkan-Iranian) biogeographical province during the late Miocene. In the present work, three new postcranial specimens of ***A. pentelicum*** from the Turolian locality of Kerassia are studied and compared to material from other late Miocene localities of the Eastern Mediterranean.

Kerassia features seven fossiliferous sites, belonging to two distinct stratigraphical horizons correlated to MN11–12. The sites relevant to this study are K4 from the lower horizon, and K1 from the upper one. Despite the small number of specimens recovered thus far, the material from Kerassia exhibits some notable size variability. A second metatarsal is larger than most known specimens of ***A. pentelicum*** from other localities, whereas a third metatarsal is close to the minimum values reported for this species. The limited material from Kerassia may be indicative of the metrical variability frequently observed within the species. This kind of variation has been documented in other species of the family Chalicotheriidae, and was attributed to the presence of a marked sexual dimorphism. This may also be the case for ***A. pentelicum*** to some extent.

The Turolian material from Kerassia represents a new occurrence of ***Ancylotherium pentelicum*** in the sub-Paratethyan biogeographical province, providing new insights into the stratigraphical and biogeographical distribution of this iconic but very rare taxon. ***Ancylotherium pentelicum*** is considered to have favored a relatively coarse diet, probably consisting of twigs and small branches.

Greece
Perissodactyla
Turolian
Postcranial

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Multiple ways to be a small carnivore in the Turolian

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The Turolian fossil beds of Greece include a high number of contemporary small carnivoran taxa, such as Mustelidae (***Promeles***, ***Parataxidea***, ***Martes***, ***Sinictis***, ***Enhydriodon***), Mephitidae (***Promephitis***) and Hyaenidae (***Protictitherium***, ***Plioviverrops***). Many of these species are found together in some localities, therefore they must have adapted some differentiating factors, in order to avoid competition. A wide comparison of these genera was made to a large sample of extant mustelids, skunks and civets based on a lot of ecomorphological parameters, such as bite force, canine strength, grinding vs shearing dental areas etc.

It seems that ***Promeles*** and ***Parataxidea*** occupied a niche similar to the extant badgers, although they are more basal, feeding mainly on plants and fruits and occasionally on insects and small vertebrates. Their dietary similarity probably acted as a competitive factor, not enabling them to thrive simultaneously in the same localities. Indeed, ***Promeles*** is dominant in Pikermi and ***Parataxidea*** in Samos.

Enhydriodon and ***Promephitis*** are the only representatives of their subfamilies (Lutrinae and Mephitinae respectively), probably occupying a similar niche with their extant relatives.

Finally, the rest of the genera seem to occupy a niche similar to extant martens, genets and civets. Probably their ecological similarity would be a disadvantage for their coexistence. This reason, as well as taphonomic bias, can explain their infrequency: ***Martes woodwardi*** is known only with two specimens and ***Sinictis pentelici*** only with one. It is possible that they could have been differentiated in their hunting terrain, in seasonality or in circadian rhythm.

Carnivora
Palaeoecology
Greece
Mustelidae
Promeles

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Being a scavenger in the Miocene: ecomorphological study on *Plesiogulo* and *Simocyon*

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The present study deals with two enigmatic carnivores of the Late Miocene of Greece, ***Plesiogulo crassa*** and ***Simocyon primigenius***, from an ecomorphological point of view. These species are compared to extant mustelids and canids respectively, in order to provide some suggestions on their diet.

Plesiogulo crassa was a large, wolverine-like mustelid. Most of its calculated characteristics seem to follow the general pattern of mustelids, such as endocranial volume, canine strength and bite force. Additionally, most of its size-independent features (relative m1 trigonid length and molars' size) indicate a similar ecology to extant wolverines, while some of them point out to a higher percentage of plant material in its diet.

Simocyon primigenius is an inimitable member of the family Ailuridae, similar to canids considering its dentition. Our results on many of its features (e.g., relative m1 trigonid length, bite force, overall upper teeth morphology) seem to fit into the group of small wolves. However, it differs from canids in having stronger canines, wider lower molars and shorter and wider rostrum. Many specimens preserve dental wear beginning from the main cusp of the premolars in a way similar to extant canids and hyenas that feed on bones. Additionally, it has developed frontal sinuses, which possibly act as air-pillows in bone-crushing.

Therefore, a similar role is proposed for both species: a solitary, robust opportunist similar to extant wolverines, but larger. Their dietary similarity could be a reason that these species have not yet been found in the same locality in Greece.

Carnivora
Palaeoecology
Greece
Ailuridae
Mustelidae

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Internal cranial structures of Late Miocene Bovidae

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Bovidae display a distinctive cranial architecture, characterised by multifarious frontal sinuses varying in size and shape. Frontal sinuses, as part of the paranasal sinuses, are believed to form pneumatic spaces that develop opportunistically where bone is not mechanically necessary, leading to reduction of the skull mass, and so, improvement of its performance. However, these features have not been widely or virtually studied and their function has not been yet clarified. It has been suggested that frontal sinuses might aid the absorption of shock and/or dissipation of stress during combat and feeding. These features are also considered of phylogenetic importance. In this study, we use high resolution computed tomography to identify these structures. The non-destructive nature of this method allows 3D digital representation of cranial internal features of fossilized material in high resolution, offering the unique opportunity to examine otherwise inaccessible parts of the skull. In order to investigate and clarify the differences and the extent of pneumatisation within the Bovidae the frontal sinuses were segmented from the CT data and digitally rendered into 3D models. Volumetric data were obtained from the 3D models and compared. Herein we present some bovid species from late Miocene Greek localities, such as ***Tragoportax amalthea***, ***Tragoportax rugosifrons*** and ***Palaeoreas lindermayeri***, which are part of a greater project. Our intention is to map these structures across selected material of Bovidae.

Bovidae
Frontal sinus
Computed tomography
3D

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First record of *Valgipes bucklandi* (Folivora, Xenarthra) outside Brazil

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The Pleistocene megafauna of South America comprises several large taxa, with xenarthrans standing out for their abundance. So far, the extinct ground sloth ***Valgipes bucklandi*** has been documented in the Brazilian states of Minas Gerais, Bahia, Piauí and Rio Grande do Norte, within the so-called Brazilian Intertropical Region (**BIR**). Here we report a fused tibia-fibula that we ascribe to this species. This extends the repartition of this scelidotheriine giant ground sloth to Uruguay. The remains of this species were extracted from the Arroyo del Vizcaíno (Sauce, departamento de Canelones) (34º37'3"S, 56º2'33"W), a fossiliferous site that harbors a large amount of megamammal remains at an approximate age of 30 ka (29696–32009 cal BP). The tibia-fibula (CAV 1573) presents a good state of preservation and, although it was fractured during the excavation, its restoration allows identifying key characteristics that allow attribution to this species, in particular the fusion of the proximal and distal epiphyses, a peculiar feature of ***V. bucklandi***. This finding, which constitutes the first record of this taxon outside the BIR, greatly expands the geographical range of ***V. bucklandi*** (about 2000 km further south), which could have implication on our understanding of the dietary and climate requirements of this species.

Ground sloth
Scelidotheriinae
Quaternary
Uruguay
Paleobiogeography

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First report of *Rhinoceros sondaicus* (Rhinocerotidae, Mammalia) from the Pleistocene Siwalik Deposits of Pabbi Hills (Pakistan)

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In this communication, we present the fossil remains of ***Rhinoceros sondaicus*** from the Pleistocene strata, exposed in the vicinity of Sardhok village, situated in Pabbi hills range of district Gujrat (Punjab, Pakistan) and having an age from 2.5 to 0.6 Ma. The sample comprises maxillary and mandibular fragments with well-preserved teeth along with isolated upper premolars and a broken horn boss. The morphological comparison of fossils with ***Rhinoceros sivalensis***, previously known from Pakistan reveals that dental characteristics like a distinct crochet on upper molars (more developed and rounded in ***R. sivalensis***); well-developed parastyle; no mesostyle in most of the molars and U-shaped anterior valley in the lower molars. However, ***R. sondaicus*** differs from the ***R. sivalensis*** in having a well-developed paracone fold on and crista in the premolars. The crochet arises from apex of metaloph in upper molars, the ecotolophs are markedly sinuous having prominent styles which favors the inclusion of the discovered fossils in ***R. sondaicus***. The ***Rhinoceros sivalensis*** is well documented from the Pliocene to Early Pleistocene of the Siwaliks of Pakistan while ***Rhinoceros sondaicus*** has been reported from Pleistocene for the first time which extends the species range from Pliocene to Late Pleistocene (~1.6 Ma).

Perissodactyla
Upper Siwaliks
Pabbi Hills
Pinjor Formation
Dental characters

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Paleoartistic depiction of the paleobiota from the Early Pliocene of Famara

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Paleoart is a valuable tool to communicate the importance of new paleontological knowledge and to test hypotheses during the restoration process. This work depicts a plausible reconstruction of the paleobiota from the Early Pliocene of Famara, the main volcanic massif in the north of the island of Lanzarote, Canary Islands, Macaronesia, which is a biogeographic region of four archipelagos in the African Plate, surrounded by the Atlantic Ocean. There are four gastropod species represented in the fossil record: ***Zootecus insularis***, ***Leptaxis orzolae***, ***Theba orzolae*** and ***Pupoides orzolae***, as well as at least two kinds of fossil eggs attributable to tortoises (Cryptodira, Testudinidae) and ratites (Aves, Palaeognathae) respectively. Based on current macaronesian floristic associations, the paleoflora includes endemic taxa of Amaranthaceae, Apiaceae, Chenopodiaceae, Crassulaceae, Euphorbiaceae, Geraniaceae, Juncaceae, Tamaricaceae, Zygophyllaceae. Due to the absence of skeletal remains, this work provides an unusual approach useful in paleoart. The representation of the vertebrate taxa within the reconstruction is based on the nearest continental paleofauna, considering adaptations that occur in current insular taxa, such as the lightening and modification of the shell and reduction of osteoderms for tortoises and shortening of the neck and legs for ratites. Compared to their extant relatives, Ratites are represented in a reduced number of individuals due to the likely limited resources that the emerged surface of the island of Lanzarote would have offered during Early Pliocene.

Palaeognathae
Testudinidae
Gastropoda
Paleoart
Island

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Elucidating the environmental Neanderthal context from El Salt Site (Alcoi, southeastern Spain) through taphonomic analysis

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Environmental conditions and formation of fossil deposits bearing Neanderthal remains and evidence of their activity may be a key factor for clearing up the regional context of their extinction. Taphonomic research appears to be an essential tool for shedding light on this controversial issue. In this line, here we propose a taphonomic study on micromammals recovered from different Stratigraphic Units from El Salt site (Alcoi, Alicante, Spain). This is one of the latest Neanderthal sites at the Southeastern Iberian Peninsula. Results regarding the identification of the predator responsible of the small mammal accumulation points to a generalist hunter (***Bubo bubo***) which enables entrusting palaeonvironmental reconstruction derived from this association. To determine any potential taphonomic processes affecting these remains, surface of long bones was examined to detect any possible modification to detect biostratinomic and/or fossildiagenetic processes, such as cut marks, tooth marks, rounding, trampling, burning or root marks among others. The small mammal taphonomic analysis point out different environments according the analysed units, as well as distinctive processes (type and frequencies) affecting microremains of each Unit. Palaeoclimatic and palaeoenvironmental results derived from taphonomic analysis match with the previous palaeoecological interpretations on a climatic trend increasing aridity conditions. In the context of a regional disappearance of Neanderthals, the question of whether or not this climatic trend affected its survival may be a key factor to be considered.

Small mammals
Site formation
Pleistocene
East Spain

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A new *Vaquerosella* (Echinodermata: Clypeasteroida) from the Miocene of Baja California Sur, Mexico

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The North American Pacific Coast represents an area with a rich fossil record of Neogene scutelliforms. Here, we present ***Vaquerosella perrillatae***, a recently described species of echinarachniid sand dollar, based on 21 well-preserved specimens from the Miocene marine deposits of the San Ignacio Formation, Baja California Sur, western Mexico. The skeleton of this species is characterized by the presence of deep postero-lateral notches and a straight posterior margin. Six nominal species had already been described in the genus ***Vaquerosella***, all distributed in California, USA. A phylogenetic analysis was performed in order to assess the inclusion of "***perrillatae***" in the genus. Our hypothesis is noticeable due the position taken by the new species described here, ***Vaquerosella perrillatae***, as the most basal member of this genus, a fact that allows us to propose the Mexican origin of ***Vaquerosella***, to the south and far from the Californian territory where most of its species have been identified. This, the first finding of ***Vaquerosella*** in Mexico, represents an important contribution to the knowledge of taxonomic and morphological diversity of this extinct genus. It also confirms that during the Miocene, this group was strongly represented in the southern region of the Pacific coasts of North America.

Echinoidea
New species
San Ignacio Formation
Baja California Sur
Miocene

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New considerations on the latest Miocene hippopotamid from Gravitelli, Sicily, Italy

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The history of the family Hippopotamidae is far to be completely understood. Hippopotamids abruptly appeared in the fossil record around 7.5 Ma at Lothagam and Toros-Menalla in Africa, and in the Baynunah Formation, in the Arabian Peninsula. This time span is known as hippopotamine event.

The first dispersal of Hippopotamidae outside Africa is recorded around 6 Ma and remains of this family were collected from the uppermost Miocene deposits of Spain and Italy.

In Italy, two different latest Miocene species were recognized, with uncertain taxonomic and phylogenetic position: ***Hexaprotodon*****?** ***pantanellii*** from the Casino basin (Tuscany), and ***He.*****?** ***siculus*** from Gravitelli (Sicily). Although particularly abundant, the material from Gravitelli went completely lost during the 1908 earthquake that destroyed the city of Messina. Luigi Seguenza reported some descriptions and pictures of the Gravitelli remains and assigned them to ***He. sivalensis***. On the basis of the Seguenza' pictures, Hoojier (1946) established the new species ***Hippopotamus siculus***; later this species was dubitatively included within "***Hexaprotodon*****?**". The remains of ***He.*****?** ***siculus*** were mainly represented by isolated teeth. Based on the works of Seguenza, it can be deduced that lower premolars of this taxon were relatively long whereas the molars were low-crowned with crenulated cingulum. Upper canines were characterized by a section with three well-defined grooves. The lower canine had a groove on the lateral side and the enamel was finely striated. These dental features point to closer affinities with ***Archaeopotamus*** than with ***Hexaprotodon***, thus suggesting a relationship with northern and eastern African hippopotamids.

Hippopotamidae
Dental morphology
Uppermost Miocene
Gravitelli
Italy

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Orientalosuchus naduongensis: A new species from the Late Eocene of Vietnam highlighting a monophyletic Eastern Asian alligatoroid lineage and its origin

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During systematic paleontological surveys in the Na Duong Basin in North Vietnam between 2009 and 2012, well-preserved fossilized cranial and postcranial remains belonging to at least 29 individuals of a middle to late Eocene (late Bartonian to Priabonian age; 39–35 MA) alligatoroid were collected. Comparative anatomical study of the material warrants the diagnosis of a new taxon, ***Orientalosuchus naduongensis*** Massonne, Vasilyan, Rabi and Böhme 2019. Unlike previous phylogenies, our parsimony analysis recovers a monophyletic Late Cretaceous to Paleogene East to Southeastern Asian alligatoroid group, here named Orientalosuchina. The group includes ***Orientalosuchus naduongensis***, ***Krabisuchus siamogallicus***, ***Eoalligator chunyii***, ***Jiangxisuchus nankangensis*** and ***Protoalligator huiningensis***. The recognition of this clade indicates at least two separate dispersal events from North America to Asia: one during the Late Cretaceous by Orientalosuchina and one by the ancestor of ***Alligator sinensis*** during the Paleogene or Neogene, the timing of which is poorly constrained.

Eocene
Crocodylia
Asia
Na Duong
Phylogeny

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A remarkable fish assemblage from the lower Pliocene of Arcille (Tuscany, Italy)

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For more than two centuries, the Pliocene marine successions of Tuscany (central Italy) have been the location of important fossil finds of vertebrates, mostly bony and cartilaginous fishes, marine mammals, and turtles. Within the present work, a stratigraphically informed study of a new fish assemblage collected from lower Zanclean (5.1–4.5 Ma) sands exposed at Arcille (Grosseto Province) was carried out. Among the Pliocene vertebrate-bearing localities of Tuscany, Arcille is particularly relevant for having provided many skeletons of the dugongid ***Metaxytherium subapenninum*** and the holotype and only known specimen of the monodontid cetacean ***Casatia thermophila***. The studied assemblage includes hundreds of teeth and spines referable to at least 24 species of elasmobranchs (sharks and rays) associated with a large number of teeth and skeletal remains of bony fishes. The presence, among the elasmobranchs, of the tiger shark (***Galeocerdo cuvier***), the bull shark (***Carcharhinus leucas***) and the bull ray (***Aetomylaeus bovinus***) suggests a shallow-marine, tropical palaeoenvironment, close to a river mouth, while the occurrence of the bluntnose sixgill shark (***Hexanchus griseus***) and of the bigeye thresher shark (***Alopias superciliosus***) indicates connections with open-sea and deep-water habitats. The bony fishes are mostly represented by a large number of teeth of sparids and sphyraenids, and by two partial skeletons referable to a large marlin species (***Makaira*** sp.), which bring further support to the connection with the open-sea. Further sampling and analyses of the Arcille assemblage will bring new information about the fish populations of the Mediterranean in the earliest part of the Pliocene.

Baccinello-Cinigiano Basin
Mediterranean Sea
Palaeoecology
Palaeoichthyology
Zanclean

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Bone histology and palaeobiology of the three-toed horse from Langebaanweg (South Africa, Early Pliocene)

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The early Pliocene (5.2 Ma) locality of Langebaanweg is a world-renowned palaeontological site located on the southwestern coast of South Africa. It contains a huge diversity of mammals, among which the tri-dactyl horse ***Eurygnathohippus hooijeri***. To date, only the anatomical morphology and the feeding ecology of this extinct hipparionine equid has been studied, and therefore there are many aspects of its palaeobiology that remain to be analysed. Bone histology has proved to be a valuable tool to infer palaeobiological information of extinct animals, such as important life history traits of the species including their age at maturity and their growth rate.

Here, we analysed the bone histology of ***E. hooijeri*** to reconstruct key features of its life history. Specifically, bone tissue types, bone vascularization and bone growth marks were studied in 4 metapodial bones (2 III-metacarpi and 2 III-metatarsi).

Fibrolamellar bone constitutes most of the cortex of ***E. hooijeri*** metapodia, although this tissue appears more vascularized as compared to Old World hipparionines. This finding indicates higher rates of growth for the three-toed horse of Langebaanweg, which might be related to the remarkable lengthening of its metapodia. The study of bone growth marks in these limb bones revealed the presence of a neonatal line plus two or three cyclical growth marks before the deposition of the external fundamental system or outer circumferential layer. This data generally concurs with previous findings for European hipparionines and suggests a similar age at maturity for the Pliocene three-toed horse ***E. hooijeri*** from Langebaanweg.

Bone histology
Life history
Palaeobiology
Langebaanweg
Hipparionine

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Chronologic distribution of the Glyptodontidae (Mammalia, Cingulata) recorded in the Villavil-Quillay Basin, Catamarca, Argentina

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The present work shows the precise age of some of the most complete fossil specimens belonging to Glyptodontidae exhumed in the Villavil-Quillay basin (Department of Belén, Catamarca Province, Argentina). Thisnspecimens were integrated into an ideal stratigraphic profile of the Santa María Group outcrops in this area, adding information of radiometric dating by K^{40}/Ar^{40} and Ar^{40}/Ar^{39} isotopes performed by other authors. Concerning Doedicurinae, the genus ***Eleuthherocercus*** shows a distribution of remains along the sequence, from 7.14±0.05 Ma to levels after 3.66±0.05 Ma; the geological record shows a higher concentration of fossils in the Zanclean, the lowest stage of the Pliocene, being also the taxon with the latest records together with the genera ***Stromaphorus*** and ***Phlyctaenopyga***. Oldest record of the genus ***Eosclerocalyptus*** is close to 7.14±0.05 Ma, but remaining fossils were concentrated in levels ranging from 5.64±0.16 Ma to 5.3±0.2 Ma, corresponding to the limit between the Messinian (the final stage of the Miocene) and the Zanclean (lowest Stage of the Pliocene). In turn, fossils of the genera ***Stromaphorus*** and ***Phlyctaenopyga*** are only recorded between ca. 6Ma. to 3.66±0.05 Ma, so far limited for the late Messinian to all Zanclean stage. Obtaining a precise time frame for these fossils will allow us the possibility of generating a much more reliable information in future in that concerning paleobiological, taxonomic and evolutionary issues still to be resolved for Glyptodontidae diversity of the Argentinian North Western region. Also, will allow a more accurate comparison with fossil remains of glyptodons of other areas of South America of equivalent age.

Xenarthra
Upper Miocene
Pliocene
North Western region

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Reassessment of the "Plohophorini" (Xenarthra, Cingulata, Glyptodontidae) from uppermost Miocene (Late Huayquerian) of Pampean Region of Argentina (Southern South America)

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The glyptodontids ***Plohophorops*** and ***Coscinocercus***, from the uppermost Miocene (late Huayquerian) of Argentine Pampean Region (Buenos Aires and La Pampa provinces), are compared in this contribution with several related forms from the Huayquerian of Uruguay (***Pseudoplohophorus*** and ***Stromaphoropsis***) and "Araucanian" of northwestern Argentina (***Stromaphorus*** and ***Phlyctaenopyga***), in order to analyze their taxonomic validity, potential synonymies and supra-generic relationships. Preliminary results allow to confirm the parafily of ***Coscinocercus***, while reinforce previous hypothesis about the authenticity of ***Plohophorops***, ***Pseudoplohophorus*** and ***Stromaphoropsis***. In first instance, it was proved the probable synonymy between ***Plohophorops araucanus*** and ***Coscinocercus marcalaini***, as well as the genera that they typify, being both indistinguishable at level of the caudal armor. These species differs from those assigned to ***Pseudoplohophorus***, with which are closely linked, by having an elongate-most terminal tube (around 30–70% longer), provided with a higher complexity on its external sculpture, due the presence of a greater amount of peripheral tubercles (12–18), tending to conform double transversal rows. On the other hand, it was found a strong resemblance among dorsal carapaces of ***Coscinocercus brachyurus*** and ***Stromaphoropsis scavinoi***, which possibly represent conspecific and/or congeneric taxa. These species differentiate from ***Stromaphorus*** and ***Phlyctaenopyga***, with similar ornamentations in their fixed osteoderms, by retaining a flat to softly convex (non-blistered) principal figures, that are surrounded by a lesser number of peripheral elements (10–18). Future comparative studies are necessary to redefine and diagnose the treated genera, besides to determine the validity of each cited species.

Cingulata
Glyptodontidae
"Plohophorini"
Plohophorops
Coscinocercus

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Preservation of fossil leaves from the Tijucas do Sul sedimentary basin, Paraná, Brazil

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The Tijucas do Sul Sedimentary Basin, located in the southeast of Paraná State, Brazil, was formed by three distinct sedimentary pulses, as a result of local tectonic events that occurred between the Upper Pleistocene and the Holocene. This basin was divided in five distinct sedimentary facies associations, two of which contain fossil plants. This initial study addresses the taphonomic and morphologic analysis of the fossil leaves found in a lateritic layer (25°49'25"S; 49°07'48"W), about 30 cm thick, in order to observe their characteristics and understand the processes that the material underwent during fossilization. Thirty-eight samples, containing more than five hundred angiosperm leaves, were analyzed by stereoscopic microscope. From these, some were selected to be examined under Scanning Electron Microscope (**SEM**) and by Energy Dispersive X-Ray Spectroscopy (**EDS**). This investigation shows that the material is characterized by leaves parallel to the layering, with no preferred orientation, varying from low to densely packed, with size variations (from leptophyll to microphyll) and entire to shattered leaves, and with fragmentation in the apex, margin and base. SEM analysis allowed us to recognize epidermal cells, stomata, mesophyll cells and veins. Some elements that compose the sample, such as iron, carbon, oxygen, silicon, barium, cerium and iron and manganese oxides, were detected by means of EDS. The preservation of fragile structures from the leaves indicates a relatively fast mineralization process. Future works will investigate the regional paleoclimatology, using the taxonomical and morphological characteristics of these leaves as a main source of data.

Quaternary
Taphonomy
Fossil leaf
Tijucas do Sul
Brazil

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A new early Pliocene murine rodent from the Iberian Peninsula and its biostratigraphic implications

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In the last years, a murid identified as ***Paraethomys*** aff. ***abaigari***, has been repeatedly recognized in several early Pliocene localities of the Iberian Peninsula. We have revised all these occurrences and suggest that these records correspond to a new species. The sample from Baza-1 (Guadix-Baza Basin, Andalusia, Spain) represents the largest and most complete sample of this novel species recorded thus far. Therefore, we characterize ***Paraethomys*** sp. nov. based on this sample. It is a medium-sized representative of the genus, with high t6–t9 and low t4–t8 connections in the M1; distal spur in t1 and t3 in the M1 and to a lesser extent in the M2; the t9 is absent in the M2; the m1 generally lacks a tma and shows a round islet of enamel between the anteroconid and the protoconid-metaconid, reduced longitudinal spur, and moderate labial cingulum with large c1. The new species differs from the other described European members of ***Paraethomys*** mainly in its size, which is intermediate between that of the small-sized ***Paraethomys meini*** and the large-sized ***Paraethomys abaigari***. In addition, the size and relative width are smaller than those of ***Paraethomys jaegeri***. The grade of development of the posterior spurs in the t1 and t3 in the M1 and M2 is higher than that of ***P. meini*** and lower than that of ***P. abaigari*** and ***P. jaegeri***. ***Paraethomys*** sp. nov. represents a significant biostratigraphic marker since it is restricted to levels of late early Ruscinian age (upper part of the MN14 unit). Thus, this species is useful for establishing divisions within the early Ruscinian, and becomes a characteristic taxon for the early Pliocene terrestrial record of the Iberian Peninsula.

Muridae
Paraethomys
Early Pliocene
Early Ruscinian
Iberian Peninsula

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Evolutionary pattern of the genus *Cercomys* and its biochronological implications

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Cercomys Pascual, 1967 is a late Miocene stem Octodontidae (Rodentia) whose systematic status and taxonomic diversity remains to be reviewed. We present the results of a systematic study of 75 specimens of this genus from 15 localities of central and western Argentina. Although the molar morphology is quite conservative, the comparison among samples shows variation in size. Results of quali-quantitative analyses (variance analysis, Kruskal-Wallis, discriminant analysis) suggest the recognition of four species. The smallest species (***Cercomys*** sp. **A**) is recorded in the lower late Miocene localities of Arroyo Chasicó (ca. 9.23 Ma) and Cerro La Bota (Cerro Azul Formation, central Argentina) and Ullúm (Loma de Las Tapias Formation, western Argentina). The largest species (***Cercomys*** sp. **D**) is recorded in the latest Miocene–earliest Pliocene of the Cantera Vialidad locality (ca. 5.33 Ma; Cerro Azul Formation) associated to ***Xenodontomys ellipticus*** (Ctenomyidae, Rodentia). ***Cercomys*** sp. **B** and ***Cercomys*** sp. **C** are intermediate in size between the two latter, which is consistent with biochronological evidence of the sites where they are found. We interpret the ***Cercomys*** species as members of a single, undivided lineage with directional evolution marked by size increase from the late Miocene to the Mio-Pliocene transition (ca. four million years of recorded evolution). The polarity of this directional change in ***Cercomys*** is congruent with that detected for other octodontoid lineages from the same deposits, such as ***Chasichimys*-*Xenodontomys***, ***Neophanomys*** (Octodontidae) and ***Reigechimys*** (Echimyidae). This pattern allows refining biochronological and biostratigraphic interpretations for the late Neogene of southern South America. In particular, ***Cercomys*** sp. **D** and ***X. ellipticus*** are key species for identifying the Mio-Pliocene boundary in the continental record of central and western Argentina.

This research was supported by ANPCyT PICT 2016-2881 and (FCEyN) UNLPam 06G.

Octodontidae
Late Miocene
Mio-Pliocene boundary
South America
Anagenesis
Biostratigraphy

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Preliminary report on fossil amphibians and squamates from Late Pleistocene from the area of Perez de Galeana, Apaxco, State of Mexico, Mexico

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In this study, we provide preliminary information on approximately 180 continental fossil remains from the Pleistocene, specifically small vertebrates collected from northeast of the State of Mexico, Mexico. The amphibian and squamate fossils are here reported as new records for the study area located 18 kilometers east of Pérez de Galeana within "Las Palmas" locality, belonging to Apaxco municipality, located in central Mexico. During the late Pleistocene this area experienced an expansion of predominantly Pinus humid forests, while today the vegetation is xerophilous scrub, with a dry climate. The fossil material was obtained by sieving the collected sediments and it is housed in the collection of the Museum of Palaeontology, of the Autonomous University of Hidalgo state, Hidalgo, Mexico. Fossils of amphibians and squamates represent 20% of the whole fauna. At least nine taxa are represented at the site; four families of Amphibians (Ambystomatidae, Plethodontidae, Bufonidae and Ranidae), three families of lizards (Phrynosomatidae, Anguidae and Teiidae), and two families of snakes (Viperidae and Colubridae).The remains represent different osteological parts of the axial and the appendicular skeleton. Approximately 60% of the osteological elements are snake vertebrae. In the sample there are extant taxa still living in the area but also extinct taxa, possibly because the ecological requirements of the fossil fauna do not match the current ecological conditions of the area. With these preliminary results, we are working on a faunistic succession to compare fossil and current biodiversity.

Pleistocene
Small vertebrates
Fossil
Amphibians
Squamates

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The first evidence of autopodium palaeopathology in extinct Giraffidae (Artiodactyla, Mammalia)

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Late Miocene large Giraffidae (e.g., Samotheriinae, Sivatheriinae) are characterized by long and robust metapodials with a significantly stout diaphysis. As a consequence, they constitute one of the most common postcranial elements of giraffids found in the fossil record. Autopodium pathologies in modern captive giraffes have been thoroughly studied, but there is a clear lack of knowledge on orthopaedic pathology of extinct Giraffidae. Here we describe two distinct cases of hyperostosis found in the metatarsals of two large late Miocene giraffids: ***Alcicephalus neumayri*** from Maragha (Iran) and ***Helladotherium duvernoyi*** from Samos (Greece), stored in the Naturhistorisches Museum Wien (**NHMW**). The first specimen (NHMW MAR-4019) shows two main osseous anomalies on the diaphysis: a dorsal cortical oval protrusion, and a massive growth located below the lateral epicondyle dorsal head. The second specimen (NHMW 1911/0005/0308) shows three different nuclei of nodular isolated hyperostosis, a large one towards the proximal epiphysis and two smaller ones positioned towards the distal epiphysis. The evidence of extensive secondary bone production in these specimens may be the result of several causes. We suggest that the malformations of NHMW MAR-4019 possibly represent a type of neoplastic sclerotic process that specifically affects the diaphysis as some kinds of bone tumor (e.g., enchondroma). Subsequently, the hyperostotic nodules of NHMW 1911/0005/0308 were probably caused by a bone-healing response to fracture trauma involving bone or adjacent ligaments (e.g., subperiosteal hematoma). These lesions are extensive, possibly having serious survival implications, and represent the first record of skeletal pathology in extinct giraffids.

Ruminantia
Pathology
Hyperostosis
Metatarsal
Late Miocene

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An arrowhead fruit from the late Miocene of Argentina

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A fossil achene (fruit) related to ***Sagittaria*** sp. was found in late Miocene sediments (Palo Pintado Formation) from the northwestern of Argentina. The sedimentary succession, 1200 m thick, crops out on both borders of the Calchaquí River (southern of Salta Province), between 25°41'01"S – 66°07'55"W and 25°40'59"S – 66°05'49"W. The Palo Pintado Fm. consists of sandstones alternating with siltstones and subordinately with conglomerates; it belongs to the Payogastilla Group, which is included between the Angastaco and the San Felipe Formations.

The achene originates from the basal portion of the Formation, at the Quebrada El Estanque locality. The fossil was preserved as an impression that shows 1 wing on each face and the beak of the achene ascending. It was also possible to observe the attachment scar to the bottom and the curved seed inside of the fruit. The whole achene is 2.3 mm in length x 1.1 mm in width, while the seed is 0.6 mm in length x 0.3 mm in width.

The arrowheads grow in freshwater and slow current wetlands (i.e., swamps and marshes). During the late Miocene, these plants would coexist with other aquatic plants (i.e., ***Cabomba***, ***Salvinia*** and ***Mayaca***), previously recorded from the sediments of the Palo Pintado Formation attesting the great fossil diversity of aquatic plants preserved in its sediments. This report represents the first record of an Alismataceae fossil in South America.

Sagittaria
Palo Pintado Formation
Salta Province
Neogene
Aquatic plants

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First recording of *Succinea* Draparnaud, 1801 for the Holocene of the Lerma Valley, NW Argentina

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Here we present the first record of land snails of the genus ***Succinea*** (Eupulmonata: Succineidae) for the Holocene of the Lerma Valley in Salta province, NW Argentina. In this intermontane basin, three units have been described for the Quaternary: the Calvimonte, Tajamar, and La Viña formations. In the south of the valley, the La Viña Formation outcrops expose a slightly coarsening-up sequence that corresponds to an alluvial-fluvial succession. At the Tajamar creek, the La Viña profile starts with a paleochannel filled with white-greyish volcanic ashes (0.1–0.04 Ma), continues with a few meters of very fine and fine reddish sandstones with intercalations of fine gravel lenses with a sandy matrix. The sequence ends with a lenticular level of white volcanic ashes (5130 ± 250 and 3920 ± 190 years) and around one meter of medium sandstone. Immediately above the younger level of ashes, in a bank of fine reddish sandstone, one very small shell (maximum length 6 mm), fusiform, imperforated, with slightly inclined and deep sutures, with 3 visible slightly convex turns, whose last whorl comprises 70% of the total length, ornamented on surface only by growth lines was found and assigned to the genus ***Succinea***. Living representatives of this genus inhabit non-marine water or water-related environments, and the paleoenvironment interpreted for La Viña Formation matches with these requirements. This is the first record from Salta, and the northernmost of the Holocene distribution in Argentina for this genus.

Succinea
Gastropoda
La Viña
Holocene
Argentina

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A new locality with fossil turtles and tortoises from the Neogene of Thermaikos Gulf (Thessaloniki, N. Greece)

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During the last decade, numerous fossils of turtles and tortoises have been unearthed in the coastal outcrops of Thermaikos Gulf (near Thessaloniki, Northern Greece), starting in the Miocene/Pliocene limit and covering the entire Pliocene. At that time, the sea was located further to the south, and a vast plain existed in the present-day gulf, with rivers and lakes in a warmer and more humid climate. This environment was ideal for turtles and tortoises, including some giant ones that exceeded one meter in length. As most of these fossils have been unearthed on the eastern side of the Gulf, we now turn our attention to the western one, the coastal area of Katerini plains. We study fossil tortoises from the Makrygialos area (latest Miocene–Pliocene age), based on newly excavated material and some previously collected specimens. The recovered assemblage is quite diverse, containing a freshwater ***Mauremys*** turtle, two species of small-sized tortoises (the hinged ***Testudo*** and the hingeless ***Chersine***), as well as several specimens of the giant tortoise ***Titanochelon***. This is the most diverse area with fossil turtles in Greece. Although non-chelonian specimens are rare in the Thermaikos Gulf, the sediment that was cleaned from inside some of the giant tortoise shells contained a carnivoran tooth and a caudal vertebra of a varanid. Additionally, scattered remains of various large mammals were found associated with the turtle fossils.

This work has been supported by a National Geographic/Waitt Grant 435-16 to EV.

Makrygialos
Titanochelon
Testudo
Mauremys
Gigantism

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The phylogeny of the genus *Equus* (Perissodactyla, Equidae, Equini): insights from a preliminary cladistic analysis

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The phylogeny and taxonomy of the horse (genus ***Equus***) remains contentious. Several recent studies (i.e., Barron-Ortiz et al. 2019; Sun & Deng, 2019) introduced new topologies for the genus ***Equus***, but these are largely based on dental characters long known to be homoplastic and polymorphic. Additionally, existing cladistic analyses concerning ***Equus*** have not incorporated the large body of linear and geometric morphometric data from the taxonomic literature. Here I constructed a new matrix based on 246 linear measurements (96 craniodental, 150 postcranial) from Eisenmann (2018 and references therein), encompassing 11 extant ***Equus*** species and 35 proposed extinct taxa. This matrix was analysed via maximum parsimony with extended implied weighting in **TNT** 1.5. Preliminary results are in agreement with phylogenies of extant ***Equus*** based on mitochondrial and nuclear DNA, with caballines sister to a large ass/zebra clade. The placement of most extinct taxa is less certain, but the late Pliocene-early Pleistocene "***simplicidens***" and "***stenonis***" species groups are robustly resolved as a derived clade within the ass/zebra group, contrasting with all other recent studies which recover them basal to extant ***Equus*** taxa. Therefore, separate generic status is not supported for ***E. (Plesippus) simplicidens*** and ***E. (Allohippus) stenonis***, nor for ***E. (Harringtonhippus) francisci***. However, a diagnosis of a crown-clade "genus ***Equus***" with respect to Miocene-early Pliocene monodactyl equids will require further research, especially through increased sampling of non-appendicular postcranial characters and of genetic and proteomic sequences.

Cladistics
Equidae
Equus
Morphometrics
Plio-Pleistocene
Taxonomy

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The biogeography and biostratigraphy of earliest Paleocene eutherian mammals in North America: wither the faunal provinces and intervals?

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The Puercan North American Land Mammal Age (~66–65 Ma) was the first mammalian biochronological unit of the Paleocene epoch, and encompassed the early diversification of eutherians (including placentals) following the Cretaceous/Paleogene mass extinction. This **NALMA** is traditionally partitioned into three interval-zones (Pu1, Pu2, Pu3), with faunas sorted into "northern" and "southern" provinces (and occasionally more) along the Rocky Mountain Cordillera. The most recent study of Puercan eutherian biogeography and biostratigraphy (Smith et al., 2018), suggested increased geographic provinciality in the Pu2–Pu3 compared to the Pu1, based on a correspondence analysis, but it had limited geographic and taxonomic scope. Here I evaluate these hypotheses using a more complete occurrence dataset for 109 taxa from 53 local faunas, compiled from all available literature on Puercan eutherians as well as museum collection catalogs. Ordination was examined using **NMDS** and **AGNES** clustering. Potential sampling biases due to spatiotemporal provenance, lithology, and collecting methods were evaluated using chi-square and **ANOSIM** tests. In my results, Puercan faunas are sorted into 3–4 groups similar, though not identical, to those recovered by Smith et al. (2018). Geography and chronology are the most important factors, while lithology and collecting methods have little or no statistically significant effect on ordination. However, the spatiotemporal signal is biased, as most of the local faunas come from the Williston (Pu1 and Pu3), Denver (Pu1–Pu3) and San Juan basins (Pu2–Pu3); faunas from the other basins (Crazy Mountain, Bighorn, Great Divide, Hanna, Power River) have not been as intensely studied.

Biogeography
Biostratigraphy
Eutheria
Paleocene
Puercan

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Stable isotope analysis of Middle Miocene faunal communities from the Siwaliks (Pakistan)

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Stable isotope analysis has become a leading tool to investigate palaeodiet and palaeoecology of past mammalian communities over the last three decades. In this paper we have utilized thirty fossil dental samples belonging to three families (viz. Deinotheridae, Rhinocerotidae and Suidae) for $\delta^{13}C$ and $\delta^{18}O$ analyses to investigate palaeodiet and palaeoecology of the middle Miocene (15 Ma to 12 Ma) Siwalik mammals of Pakistan. The stable isotope analysis of carbon reveals that suids (***Hyotherium pilgrimi***) mostly browsed (-11.23‰) on woody plants and inhabited the woodland and forest land habitat where C_3 vegetation was in excess. The results are found to be coherent with their tooth morphology, which shows brachydonty (low crowned tooth) implying that suids in middle Miocene were exclusively browsed (on leaves or fruits). Rhinocerotids and deinotheres were coherent in their feeding exclusively as browsers on C_3 vegetation (-12.27‰ and -12.45‰ respectively) in a closed canopy forest system. The average $\delta^{13}C$ value (-11.96‰) indicate that faunal elements of the middle Miocene Siwaliks browsed on C_3 diet exclusively in a forest/woodland preferring closed canopies forests (rhinocerotids and deinotheres) while $\delta^{18}O$ (-9.94‰) indicate that the environment was humid and animals mostly drank from water sources with low $\delta^{18}O$ values, which were present largely as ponds. We did not find any evidence for C_4 vegetation thus we exclude the possibility that in middle Miocene any C_4 diet existed.

Palaeoclimate
Palaeodiet
Mammals
Chinji Formation

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The Early Pleistocene amphibians from Copăceni — The first of their kind in the Dacian Basin (Southern Romania)

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An isolated remnant of the Paratethys, the Dacian Basin shifted to a freshwater lacustrine depositional setting at the beginning of the late Pliocene, and functioned as a mostly fluvial basin during the latest Pliocene and most of the Early Pleistocene. Numerous large mammal remains were found in the lower Pleistocene deposits of the Dacian Basin, but, since high energy deposits (gravels and sands) dominate, small vertebrate finds are rare. Mudstones and fine sands crop out along the Argeș River at Copăceni, south of Bucharest, and yielded elephantid, rhinocerotid, bovid, and cervid remains. Bulk screen-washing of the silty sediment also yielded small vertebrates, including fishes, amphibians, squamates, and rodents. The fossil sample allows for the identification of a moderately diverse amphibian assemblage, the first of its kind for the entire Pleistocene of the Dacian Basin, which includes representatives of eight genera belonging to six families: Salamandridae (***Lissotriton vulgaris***, ***Triturus*** sp.), Bombinatoridae (***Bombina*** sp.), Pelobatidae (***Pelobates syriacus***), Bufonidae (***Bufo bufo***), Hylidae (***Hyla*** ex gr. ***Hyla arborea***), and Ranidae (Ranidae indet., ***Pelophylax*** sp., ***Rana*** ?***temporaria***, ***Rana*** sp.). The taxonomic composition of the Early Pleistocene amphibian and assemblage from Copăceni is similar to those reported from other sites of the same age from western Romania, and also to that of extant Romanian herpetofaunas. The amphibian assemblage from Copăceni supports the existence of a permanent freshwater body, of neighbouring forests or shrubberies, and thick soil, in an Early Pleistocene climate that was warmer than the present one.

Amphibians
Early Pleistocene
Palaeobiodiversity
Herpetofauna

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New fossils of giant tortoises (Testudinidae) from the Late Pleistocene of “Toca Dos Ossos” Cave (Bahia State, Brazil)

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The sediments of the “Toca dos Ossos” Cave (hereafter, “**TOCA**”; Ourolandia Municipality, Bahia State, Brazil) contain fossils of at least 27 mammalian species. This rich faunal assemblage is dated to the Late Pleistocene. Nearly two-thirds of them are now extinct, demonstrating the faunal changes that took place in South America during the last few thousand years. Our study focuses on another animal from the cave that went extinct at the same time: the giant tortoise. The studied material, housed at **PUC** Minas (Brazil), comprises nearly 190 disarticulated specimens from the carapace, plastron, and appendicular skeleton of a giant tortoises. At least 14 different individuals are represented in the material, including animals of different sizes and ontogenetic stages of a single species. The identified neural plates show the characteristic “gibbosities” — a condition also called “pyramiding” — similar to the morphology observed in other South American giant tortoises. Therefore, we identify this species as a large-sized member of ***Chelonoidis***. Comparable elements with other giant ***Chelonoidis*** spp. (e.g., ***Ch. gallardoi***, ***Ch. australis***, ***Ch. lutzae***), show that the TOCA tortoise had neurals that were different from other giant ***Chelonoidis***, with an hexagonal first neural with short posterolateral sides and quadrangular neurals that were much longer than wide. These characters will be evaluated within the known variability in members of this clade. Although disarticulated, this material is arguably the most anatomically diverse and abundant in South America to date, and provides a better understanding of the anatomy of this clade and early evolution of ***Chelonoidis***.

Chelonoidis
Gigantism
Pyramiding
Extinction

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Brief description of materials of *Panochthus* Burmeister (Xenarthra; Cingulata; Glyptodontidae) recorded at higher altitudes

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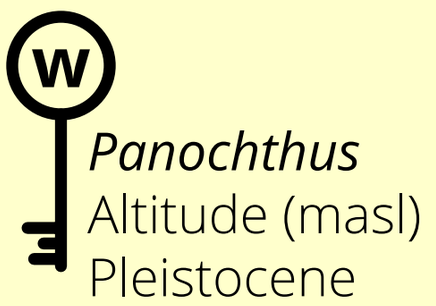
Panochthus Burmeister constitutes one of the most abundant, diversified and widely distributed xenarthrans of the South American Pleistocene, as well as one of the glyptodontids with higher latitudinal and altitudinal distributions. In this contribution are analyzed those records assigned to the genus, recovered at higher altitudes. In decreasing order of height / elevation: **(1)** ***Panochthus hipsilis***: fragmentary skull, two vertebrae, almost complete dorsal armor (MURB 1906A/B, holotype) and caudal tube (MHNS 8, paratype); surroundings of Potosí (Bolivia); ~4000 meters. **(2)** ***Panochthus*** sp.: isolated osteoderm (MUSM-s/n); Desaguadero (Perú); ~3800 meters. **(3)** ***Panochthus intermedius***: almost complete specimen (MHNC-13491); vicinity of Cochabamba (Bolivia); ~2600 meters. **(4)** ***Panochthus*** sp.: dorsal osteoderm and caudal tube portions (MNPA/V 006598); Tarija Valley (Bolivia); ~1870 meters. **(5)** ***Panochthus*** sp.: caudal tube (MUFyCA 383); Traslasierra Valley (Argentina); ~920 meters. ***P. hipsilis*** would represent an endemic species of the Bolivian Altiplano, possibly adapted to high altitudes. There is a probable relationship between geographical altitude and body mass in ***P. intermedius***, since the holotipe from the Pampean Region is larger than the paratipe from the Bolivian Altiplano. This correlation was cited in other Xenarthra, e.g., Megatheriinae and others Glyptodontidae (***Glyptodon*** Owen).



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A peculiar specimen of *Panochthus* Burmeister (Xenarthra: Glyptodontidae) from the Late Pleistocene of Quequen Salado River, Buenos Aires Province, Argentina

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Panochthus Burmeister is one of the glyptodontids with greater latitudinal distribution in the Pleistocene of South America. Seven species are traditionally recognized for the genus: ***P. intermedius*** Lydekker, ***P. subintermedius*** Castellanos, ***P. tuberculatus*** (Owen), ***P. frenzelianus*** Ameghino, ***P. greslebini*** Castellanos, ***P. jaguaribensis*** Moreira and ***P. hipsilis*** Zurita, Zamorano, Scillato-Yané, Fidel, Iriondo & Gillette. In this contribution, we describe an almost complete specimen assigned to the genus ***Panochthus*** (MCP s/n), from the late Pleistocene of Quequén Salado river (Buenos Aires province, Argentina), that comprises the skull, mandible, most part of postcranial skeleton, cephalic shield, carapace, fragmentary caudal rings and caudal tube. Although anatomically similar to ***P. tuberculatus***, the new material exhibits remarkable endoskeletal differences from the type of the species, especially in the presacral series (two distal most lumbar vertebrae well differentiated from the remaining elements). Likewise, the caudal sheath does not resemble any of the known species, characterized by the presence of three apical figures. Future comparative studies are necessary to determine if the observed features represent intraspecific variations and/or are indicatives of a new taxon.

Panochthus
Late Pleistocene
Quequen Salado River
Argentina

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The fossils of the Pesciara Lagerstätte (Bolca, northeastern Italy): a statistical analysis

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Bolca is a small town in the municipality of Vestenanova (province of Verona, northeasth Italy) located in the Alpone valley, at 852 meters a.s.l. Bolca is well known since the 16th century for its Eocene limestone successions, which contain well preserved and articulated specimens of bony and cartilaginous fishes, crocodiles, turtles, bird feathers, insects, cephalopods, crustaceans, jellyfish, worms, aquatic and terrestrial plants. The two main geosites in Bolca are the Pesciara and the Monte Postale, both of Ypresian age (early Eocene), and dating back to about 50 million years ago. Since 1999, the Verona Natural History Museum in collaboration with the Universities of Milano, Padova, Modena and Reggio Emilia has resumed the excavations in Bolca using a modern approach. The new stratigraphic data, acquired with coring and geoelectric prospecting, extend the knowledge of the Pesciara and Monte Postale stratigraphic successions. This is very important for the palaeogeographic reconstruction of the Tethys Sea.

With regard to the paleontological excavations, here we present the data collected in 2010 at the Pesciara site, where 145 specimens were retrieved. These mainly include fishes, crustaceans, insects, coprolites, terrestrial plants, amber and algae. The study focuses on the relative distribution of the various specimens in their respective layer. Our statistical analysis, in particular, identifies the most abundant fossiliferous strata along with those with the broadest diversity, laying the groundwork for further research.

Bolca
Lagerstätte
Fossils
Pesciara
Veneto
Italy

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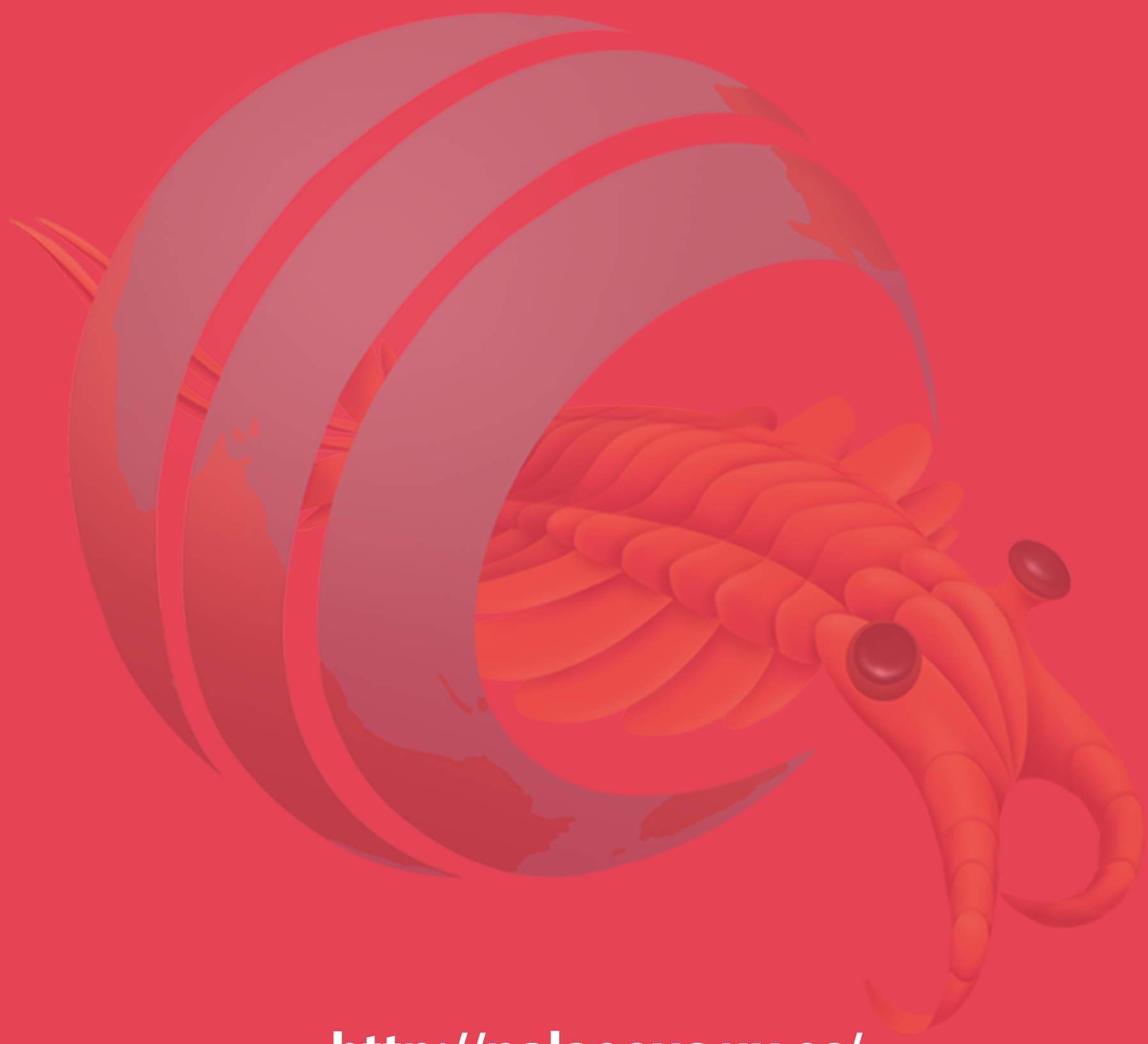

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