Fossoriality, a strong evolutionary force acting on appendage reduction among vertebrates

1st Palaeontological Virtual Congress

December 1st-15th, 2018

BOOK OF ABSTRACTS

Palaeontology in the virtual era

VNIVERSITAT DE VALÈNCIA

Museo Paleontológico de Alpuente

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Ist Palaeontological Virtual Congress.
Book of abstracts.
Palaeontology in a virtual era.

From an original idea of Vicente D. Crespo.

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PRESENTATION

The 1st Palaeontological Virtual Congress (1st PVC) is just the natural consequence of the evolution of our surrounding world, with the emergence of new technologies that allow a wide range of communication possibilities. Within this context, the 1st PVC represents the first attempt in palaeontology to take advantage of these new possibilites being the first international palaeontology congress developed in a virtual environment. This online congress is pioneer in palaeontology, offering an exclusively virtual-developed environment to researchers all around the globe. The simplicity of this new format, giving international projection to the palaeontological research carried out by groups with limited economic resources (expensive registration fees, travel, accomodation and maintenance expenses), is one of our main achievements. This new format combines 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 the online platforms, which allow to reach a high number of researchers along the world, promoting the participation of palaeontologists from developing countries. This abstract book is the best evidence of the succecc of the initiative.

At the moment of writing these words, more than 350 researchers on palaeontology from 35 different nationalities, and the five continents (Europe, Africa, America, Asia and Australia), have taken part in this initiative. It is important to highlight that numerous contributions from South America, Africa, Middle East and Eastern European Countries have been presented supporting our main goal of a palaeontological congress without barriers. Palaeontology is a wide discipline which encompasses a huge variety of topics, for that reason the 1st PVC has been organized 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, 14 specific workshops, ranging from the application of new analytical techniques in Palaeontology, Palaeobotany, Vertebrate Palaeontology, Taphonomy and Palaeoart,

have been proposed, providing a comprehensive forum for the exchange of ideas and discussing the issue with specialists in the target field. In total, 160 contributions are compiled in this Abstract Book, including three key-notes presented by Alexander M. Dunhill "A history of the world imperfectly kept: identifying, quantifying and dealing with sampling bias in the fossil record", Emilia Jarochowska and Niklas Hohmann "Turning biostratigraphy into big data" and Lars W. van den Hoek Ostende "The ABC of computer: just A Big Calculator". All those contributions presented in this volume, somehow, summarize the good health and multidisciplinary nature of our science, Palaeontology.

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, Museums, and Universities, that have supported this initiative, specially to the University of Valencia (the Department of Botany and Geology) for hosting the space to develop this project.

Thank you all,

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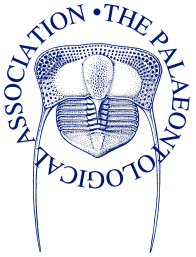
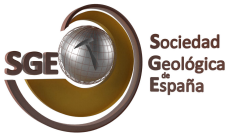
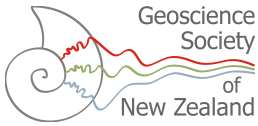
Supporting entities







Contributions

Guest Lectures - Keynotes

Workshops

General Paleontology

Mesozoic

Cenozoic

Big equipment, small structures: modernised, new and innovative techniques in fossil microanalysis 113

Fossil insect-names, publications, databases 123

The small mammals of the Neogene from Europe

Vertebrate ichnofossils

Guest lectures

Dr. LARS VAN DEN HOEK OSTENDE

Lars van den Hoek Ostende (1963) is a Dutch mammal palaeontologist, specialised in Neogene micromammals. In particular, he works on fossil insectivores from the Miocene of the Mediterranean, combining these with rodent data to reconstruct changes in the ecosystems of the region. As such, he developed a keen interest in pattern recognition and databasing, without necessarily having a strong background or even talent in computer analyses. Currently, he focuses on the Miocene of Anatolia and the comparison with the coeval European faunas. He is a strong advocate of international cooperation and is coordinator of the Working group Terrestrial Ecosystems of the Regional Committee of Mediterranean Neogene Stratigraphy (RCMNS) and assistant coordinator Micromammals of the New and Old Worlds Database (NOW).

THE ABC OF COMPUTER: JUST A BIG CALCULATOR

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Keywords: *multivariate analysis, phylogenetic reconstructions, databasing, methodology, Principal Component Analysis.*

Computers have made our life much easier, both in daily life and in science. For palaeontologists, they allow to deal with large amounts of data at once, detecting patterns that would be impossible to reconstruct with the naked eye. Undeniably, this has led to major advances, innovative thinking and some really good science.

Nevertheless, we should not overestimate the possibilities of computers. When used correctly, they are a scientist's best friends. But we cannot expect the computer to solve our scientific problems all by itself. There are sufficient examples in which the computer seems to have been used as a black box, which magically produced results that are counterintuitive.

In the end, the computer is just a big calculator. And as any calculator, the user is in control. So there are a number of basic principles:

1) The Nonsense in/Nonsense out principle apply. We need to think about our data. Also when databases are used, the data set needs to be evaluated critically.

2) The computer is not a black box. The user should know and understand the methods that are used, and particularly the limitations.

3) The use of a multivariate analysis is not per definition an improvement. Conventional methodologies as a scatter diagram can be more appropriate than a graphic output of a Principal Component Analysis.

The main tools of any scientist are knowledge and his good sense. These cannot be replaced by a calculator, but should instead be combined.

Dr. ALEXANDER M. DUNHILL

Alex is a lecturer in Palaeobiology in the School of Earth and Environment at the University of Leeds. His research focuses on large scale macroevolutionary and macroecological processes through deep time with a particular emphasis on late Palaeozoic and early Mesozoic mass extinction events and the accuracy of biodiversity data obtained from the fossil record.
Alex has a PhD from the University of Bristol and is a graduate of the University of Sheffield. Prior to his appointment as Lecturer, he was a Leverhulme Early Career Fellow at Leeds and was previously a Royal Commission for the Exhibition of 1851 Research Fellow in the Milner Centre for Evolution at the University of Bath.

A HISTORY OF THE WORLD IMPERFECTLY KEPT: IDENTIFYING, QUANTIFYING AND DEALING WITH SAMPLING BIAS IN THE FOSSIL RECORD

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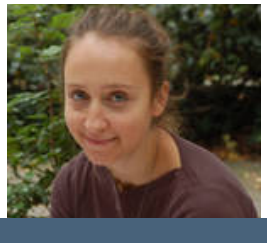
***Keywords**: sampling, bias, Phanerozoic, palaeodiversity, extinction*

The fossil record is the only direct line of evidence for deducing macroevolutionary and macroecologcal patterns through geological history. However, it is well documented that the fossil record is woefully incomplete and subject to a variety of biases, both across space and through time. Therefore, it is essential that palaeobiologists consider the incompleteness of the fossil record when drawing conclusions about long-term macorevolutionary trends and/or spatial macroecological patterns. For example, does a catastrophic drop in palaeodiversity indicate a mass extinction or just a reduction in sampling intensity? Methods for identifying and dealing with sampling biases in the fossil record are diverse, both mechanistically and with regard to what source of bias they combat. But, do any of these methods actually work and do they help us improve our understanding of the history of life on Earth? Alternatively, is it better to assume that the fossil record is a faithful representation of the history of life through the ages and is thus adequate for macroevolutionary analyses at face value, whilst simply being mindful of the caveat of variable preservation and sampling rates through time? In this talk, I will review the current understanding of the quality of the fossil record and give examples of how palaeobiologists can identify, quantify and deal with sampling biases in their fossil data. I will conclude by attempting to draw up a method of best practise for dealing with sampling biases in fossil data that can be applied to a wide range of palaeobiological studies.



Dr. EMILIA JAROSCHOWSKA

Dr. Emilia Jarochowska is an Assistant Professor in Palaeobiology at GeoZentrum Nordbayern, Friedrich-Alexander-Universität Erlangen-Nuremberg in Germany. She graduated in Biology and Geology at the University of Warsaw. In her PhD, awarded in 2015 in Erlangen, she demonstrated that a conodont extinction event which has been hypothesised during the Silurian was an artifact of the facies and unconformity controls over the conodont fossil record. She is interested in the feeding ecology of conodonts across several levels of complexity: from how their ecology translates into the assembly of conodont communities to how it is expressed in their ultrastructure and geochemical composition.

TURNING BIOSTRATIGRAPHY INTO BIG DATA

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***Keywords**: paleobiology database, biostratigraphy, diversity, ecology.*

Palaeontology took a sharp U-turn over the last two decades. In the last century, biostratigraphy and taxonomy formed the core of the field. Since then, progress in the theory of evolutionary biology and ecology has penetrated into palaeontology, demanding data compatible with standards used in this field. This progress is so rapid that palaeontologists, capable of fuelling it with data, are often left behind, as thorough and up-to-date training in these disciplines does not belong into traditional palaeontological curricula. As a result, there are currently excellent methods without suitable data as well as excellent data not amenable to known methods. On top of it, there is also, simply put, a substantial amount of terrible data which will be lost to any further analyses because it had not been reported properly.

Biostratigraphy remains the primary source of quantitative data on fossil occurrences. The impediment to unlocking this potential is the lack of consistent, standardized protocols on collecting and reporting this type of information. Producing this type of information is tedious and requires long, unrewarding training. Here we argue what are the benefits and necessities of archiving it in public, open access archives such as the Paleobiology Database and show how to profit from a standardized format for one's own research.

Workshops

1st Palaeontological Virtual Congress

General Palaeontology

Moderators: Organising Committee

INAH´S PALEONTOLOGICAL COUNCIL AND ITS ROLE IN PRESERVING THE MEXICAN HERITAGE

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***Keywords**: record fossil, legal protection, policy measures, paleontological research.*

The National Institute of Anthropology and History (INAH by its Spanish initials) is the federal institution dealing with the research, preservation, and protection of the historical, archaeological, and paleontological heritages from México. Although the historical and archaeological heritages have already been under care for more than 70 years, it was not until March 2017 when it was decided to undertake the functions of the Paleontological Council (ConPal by its Spanish initials). Currently the ConPal is constituted by members from 10 academic institutions from all over the country, bringing together high knowledge and capability within the distinct topics of the paleontological field. Among the several functions that the ConPal members are pursuing, there is the development of the regulations under which the forthcoming projects concerning the paleontological heritage will be reviewed. Furthermore, the necessity for writing guidelines and manuals for conservation and preservation of this heritage, coping with the present economic and social conditions of the country, is another goal for the members. Based on those considerations, we call for the paleontologist searching at deposits where fossil are to be found to comply with regulations set by ConPal and help to preserve the Mexican Paleontological Heritage.

PEER COMMUNITY IN PALEONTOLOGY (PCI PALEO): A COMMUNITY-DRIVEN, TRANSPARENT, FREE AND OPEN PLATFORM FOR PEER REVIEW IN PALEONTOLOGY

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Keywords: *preprints, peer review, Open Access, publishing.*

Academic publishing is becoming increasingly costly for institutions, users, and ultimately the taxpayer. This system is undergoing major changes, but the current transition from subscription journals towards an author-pays model (Gold Open Access or Hybrid) is unlikely to significantly reduce the overall cost of publishing.

A faster, more transparent, completely open access, and free publishing system is now possible thanks to modern technologies. This system can be based on preprints, which have successfully been in use for more than 25 years in physics, mathematics, astronomy and computer sciences. Preprints provide a way to freely and rapidly diffuse research results and to promote early feedback from a wider audience, but remain fundamentally non-peer-reviewed.

The Peer Community In (PCI) project calls for the creation of non-profit communities of researchers to peer-review articles available as preprints outside of conventional journals. The first community (PCI Evolutionary Biology) now counts more than 360 scientists. Launched in early 2018, Peer Community in Paleontology is backed up by an international Managing Board and a growing group of recommenders (= editors).

PCI Paleo is completely free and transparent. Submitted preprints are evaluated by an editor and at least two external referees. If the paper is accepted, a final version is uploaded on the preprint server and permanently linked to a recommendation text (written by the editor) and the peer-review reports published by PCI Paleo. Papers recommended by PCI Paleo are therefore transparently peer-reviewed, fully citable (DOI) and Open Access, obviating the need to publish them in conventional journals.

MEGAFAUNA 3D: FOSSIL DIGITALIZATION FOR EDUCATION, OUTREACH AND RESEARCH

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***Keywords**: paleontology, Pleistocene, mammals, science communication, 3D scanning.*

Megafauna 3D is a fossil digitization initiative and an educational project that aims to engage general audiences with paleontology by using 3D models and replicas of fossils of the giant mammals that inhabited South America until about 10,000 years and coexisted with humans. The project includes an online viewing platform of 3D models, interactive activities based in paleontology, a box with didactic material for teachers and students and a series of lectures in museums and schools across Uruguay. The fossils were scanned using structured light, photogrammetry and computer-scanned tomography. So far, eleven genera have been included, among them ground sloths, glyptodonts, mastodonts, saber-toothed cats, ungulates and notungulates, and this number will grow over time by adding new 3D models to the collection. Created in Montevideo, Uruguay, this project involves paleontologists, museologists, designers and programmers. All the scans were made by paleontologists from the Laboratorio de Paleobiología of the Facultad de Ciencias, Universidad de la República, who also built up the 3D reconstructions. The fossils have been collected in Uruguay and are housed in paleontological collections across the country.

PALEONTOLOGICAL HERITAGE AND MUSEUMS: SANTA POLA FOSSIL ATOLL IN THE PALEONTOLOGICAL MUSEUM OF ELCHE (SPAIN)

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***Keywords**: MUPE, Santa Pola Atoll, heritage, interactive, inclusive.*

The Santa Pola fossil atoll (Western Mediterranean) is one of the outstanding sites that constitute the paleontological heritage of the province of Alicante (Spain). Related to the Messinian Salinity Crisis, it has been classified as a Geosite. Based on the Spanish Geological and Mining Institute (IGME) and the Paleontological Museum of Elche (MUPE) methodologies on geoheritage assessment, it has obtain an extremely high value. Moreover, its scientific relevance is highlighted by numerous papers and scientific dissemination works dedicated to the atoll since the 70's.

The preservation of this paleontological heritage can be guaranteed and its value can be highly increased through museums. Those institutions play an important role in heritage research, conservation and education. In the current communication we present a proposal to incorporate an exhibit module regarding the Santa Pola atoll at the MUPE. This is the only paleontological museum recognised in the province and it has a whole floor dedicated to the palaeontology of Alicante. Those facts, and the proximity to the paleontological site, make this museum the ideal place for the project.

Accessibility, as well as other concerns regarding the inclusion of every social group, have been considered during the design of the exhibit module, therefore a vast array of exhibition techniques have been used. In an area such as Alicante, where the beach tourism thrives, the offer of alternatives as geotourism and geoeducational activities, is essential for changing the public understanding of Earth Sciences by focusing on the paleontological and geological heritage of this region.

QUATERNARY PALEONTOLOGICAL SITES DIGITALIZATION OF THE ISLAND OF TENERIFE (CANARY ISLANDS, SPAIN)

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***Keywords**: heritage, conservation, photogrammetry, Canary Island.*

The fossil record of the Canary Islands has great importance and outstanding nature due to its preservation in an active volcanic islands context. In the island of Tenerife there are marine and terrestrial environment sites which are fragile and make difficult their preservation. In this work we present the use of photogrammetry as a mean of digital preservation of the Canarian paleontological heritage. We have digitized different types of deposits to test the usefulness of conventional photogrammetry. In this way have been digitized 6 sites (marine and terrestrial), which 4 are seen in bedding plane and 2 are seen in cross section. As a result, in the cases where the site is a large horizontal platform (Igueste de San Andrés, Tachero) the ends are distorted when taking photographs at ground level. This problem is easily solvable with the use of a drone. Another problem that we have found is that some sites (La Punta del Hidalgo) are in the tide line, which means that the site is only accessible a few hours a day to be photographed. Besides, the presence of puddles of water produce errors during model generation. Lastly, the terrestrial sites (which are the ones to appear in cross section) have given the best results by far. This technique has proved itself useful and efficient. Furthermore, our proposal of creating a digital catalogue not only serves as a way of monitoring and preserving the natural heritage, but as a disseminating and educational tool of the Canarian paleontological heritage.

DISSEMINATING PALAEONTOLOGY IN SCHOOLS OF BRAZIL: EXPERIENCES AND DISCUSSIONS

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***Keywords**: science education, palaeontology outreach, open-ended activities, Brazilian education.*

In Brazil, educational outreach on Palaeontology has traditionally been very limited, but it is now in process of developing. In this context, we created a project entitled "Disseminando a Paleontologia na Educação Básica" (Disseminating Palaeontology in Basic Education), that brings palaeontological knowledge to primary and secondary schools. The main objective is to make palaeontology accessible to students and teachers of early childhood, elementary, and high school education, and to the broader community. The project aims to spread important Palaeontological concepts, such as the nature of fossils, fossilization processes, dating methods, differences between fossils and living organisms, and the scale of geological time. To date, we have worked with 15 schools of Curitiba, Paraná State, Brazil, and reached about 1000 students and teachers. We have made presentations, run activities such as board games and quizzes, offered fossil identification exercises, and produced replicas of fossils. The dialogues about dinosaurs and other big reptiles, and the activities with replicas of cropolites were the most excited topics to work with students. After the actions, the teachers were questioned about the success of our efforts, and all the interviewed educators approved the Palaeontological presence in the schools. Educational approaches developed during this project have for the first time used fundamental palaeontological concepts to achieve curricular goals in Brazilian science education. The integration of palaeontological materials (fossils, preparation tools, and replicas) with open-ended activities was an effective way to approach core scientific concepts, enhancing the participants' interest in the topic. Activities developed for this project will assist educators in creating new practices in science education, as well as strengthen partnerships between universities and schools.

THE APPLICATION OF PHOTOGRAMMETRIC ORTHOMOSAICS FOR DOCUMENTATION OF PALAEONTOLOGICAL SITES

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***Keywords**: fieldwork, digital photogrammetry, Structure from Motion (SfM), schematic maps, palaeontology.*

Fieldwork is crucial in palaeontological studies. Both when the fossils are being exposed from the site and when they are studied in situ. Therefore, an exhaustive documentation of these remains and their reciprocal position within the rocks are necessary for further study, including taphonomical, palaeoecological, and systematical analyses. For this purpose, a powerful, non-invasive methodology, based on Structure from Motion (SfM) algorithms was used to create orthomosaics and 3D reconstructions. Documentation of fossil features was performed through 2D photographs taken from multiple angles and with sufficient overlap and coverage. A series of individual photos matched up to constitute a new composite image or orthomosaic , in which the geometric distortion was corrected and orthorectified, such that the scale was uniform. The orthomosaic allowed a rapid and reliable documentation of the outcrops than conventional methods (i.e. drawings, total station). It reproduces a precise orthogonal X-Y scheme of the site and can be used to measure true distances and surfaces. During excavations, it is advisable to generate an orthomosaic before and after the extraction of each fossil to subsequently analyze the overlapping information. Thus, by adding the vertical (Z) information, three-dimensional positions of all the remains can be reconstructed during the excavation works, and quite precise 3D taphonomic maps can be obtained. The generation of photogrammetric orthomosaics turned out to be an effective, rapid and cost-effective tool for checking and correcting the relative and absolute position of fossils within a site, and complementing the traditional information obtained during palaeontological field trips.

THE JACK PALLINI MUSEUM: AN EDUCATIONAL PROJECT IN MEMORY OF PROFESSOR GIOVANNI PALLINI, ITALIAN PALAEONTOLOGIST

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***Keywords**: museum, fossils, database, educational, project.*

The Jack Pallini Museum is an ongoing educational project that has involved Geology students from University "G. d'Annunzio" of Chieti (Italy), during the years since 2003, after the departure of beloved Professor Giovanni Pallini, known as Jack. The project started in 2003 and it's still ongoing. It followed different steps from collecting samples of invertebrate fossil during field trips in Northern, Central and Southern Italy, to the exhibition in a Museum, after cataloguing the finds in a database. Through the years, many private collectors donated important pieces to implement the collection, and many graduating students have worked on them for their final dissertations. The project was financed with university funds to promote socio-cultural activities for the students. Other funds arrived from InGeo Department covering the expenses of the showcases for the exhibition. The collection comprises invertebrate fossils from the most important stratigraphic sections in Italy, from North to South most important geological sites. From the North, the fossils collected at the Lesini Mountain around Verona are mostly ammonites and bivalves. The fossils from Central Italy come mainly from the Umbria – Marche basin, composed mostly by ammonites, and from the Lazio – Abruzzo Apennines that comprises bivalves, gastropods, rudists, echinoids, brachiopods. Other fossils in the collections come from Sardinia and Sicily, as echinoids, belemnites, ferns.

The Geology students also classified the fossils, and gave them a registration code through a progressive numeration preceded by an acronym, JMP, Jack Pallini Museum. The whole classified collection has been inserted in a database. The last step of the project is the setting up of a website for digital consultation.

CLOUD-BASED 3D RECONSTRUCTION OF SKELETAL REMAINS FROM SAN BENEDETTO NECROPOLIS (SARDINIA, ITALY)

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***Keywords**: photogrammetry, protocol, virtual, palaeoanthropology.*

Ultra close-range digital photogrammetry (UCR-DP) produces virtual representations from digital photographs of the specimen's external surface. New cloud-based software environments provide single-step automated workflow and do not require powerful workstations and trained operators.
The aim of the study was to apply UCR-DP to the virtual reconstruction of skulls retrieved from San Benedetto, an Upper Neolithic necropolis framed in the context of the Ozieri Culture, dated around 4900 BP.
To produce the 3D models, photographs were taken following a specifically designed protocol and then processed by means of the new cloud-based software environment Autodesk ReCap Photo, free for academic use.
30 3D models of crania were produced and exported in obj format so as to retain both mesh and texture for further analyses. Sharp, in-focus, high-resolution images proved to be the most convenient for UCR-DP. Moving or inconstant light sources both proved to be contraindicated.
The quality of the 3D models is convenient for didactic and scientific purposes, enabling effective specimen conservation, measurement, comparison and sharing. Autodesk ReCap Photo enabled the collection of 3D data in an easy and quick way, thus representing a promising low-cost solution for virtual palaeoanthropology. The 3D sample will be used for comparative virtual anthropology studies on skeletal remains, particularly those covering prehistory and history of Sardinia. A validation study comparing the accuracy and reliability of the procedure with the gold standard is currently being addressed.

THE CRYSTALLOGRAPHY OF THE ALLIGATORID EGGSHELL. INSIGHTS FROM THE EBSD

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***Keywords**: Crocodylomorph, biomineralization, egg formation, biological calcite.*

The crocodylomorph eggshell shows some of the fundamental characteristics of the archosaurian eggshell, as its calcite composition and shell units growing from amorphous or microcrystalline calcite aggregates, namely the basal knobs. Nevertheless, it remains to be proven that these structures are homologous to those of dinosaurs.

Electron backscatter diffraction (EBSD) is here used for the first time to study a non-dinosaur archosaurian eggshell, namely eggshell from *Caiman yacare* and *Alligator mississippiensis*. Inverse pole figure colouring and grain boundary maps show important differences in the general architecture of the alligatorid eggshell, when compared with avian and non-avian dinosaurs: shell units are formed by large orientation domains. In the inner part of the eggshell the orientation of these large domains is arbitrary, with crystals growing in every direction. The upper part of the eggshell presents, on the contrary, a strong alignment of crystals, with c axis subparallel to the shell unit vertical axis, although this alignment is much less marked than in dinosaur eggshells. The transition between both patterns occurs at the middle of the eggshell. Orientation domains are limited by high degree misorientation boundaries (over 20°).

EBSD data shows that the general eggshell architecture of the crocodylomorph and dinosaur eggshell is fundamentally different and suggest that any similarities between crocodylomorph and dinosaur eggshell are convergent. The general aspect of the crocodylomorph eggshell is that of a drusy cement, suggesting that the organic control of the eggshell growth is minimal, when compared with dinosaur eggshells.

FOSSORIALITY, A STRONG EVOLUTIONARY FORCE ACTING ON APPENDANGE REDUCTION AMONG VERTEBRATES

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***Keywords**: limb loss, eel-like fishes, elongated tetrapods, comparative phylogenetic analyses.*

Fin or limb reduction and the subsequent loss is a very common evolutionary trend among vertebrates. Fins or limbs are usually lost in groups of animals with elongated bodies and undulating locomotion. In fact, several groups of elongated fishes and tetrapods lost their fins or limbs independently. Recent studies have connected the limb loss of the earlier snakes with a fossorial lifestyle, and fossoriality has for long time been generally considered as a potential driver acting on appendicular skeleton reduction. But how much widespread among vertebrates this influence actually is? And how strong is the phylogenetical signal about the correlation between fin or limb loss and fossoriality? To answer these questions a database comprising 164 species of elongate and eel-like fishes and 140 species of elongate lizards has been compiled (the analysis of the amphibians is still in progress). After plotting these species on a phylogenetic tree, we analysed the correlation between fossoriality and fin or limb loss using the discrete comparative analysis available in the software BayesTraitsV3. We run three distinct analyses so far: i) extant fishes only, ii) extant and fossil fishes, and iii) extant lizards only. The results indicate a strong correlation (log(Bayes factor)>5) in all the analyses; the results were similar when fossil fishes were included or not. These preliminary results point to a widespread trend among vertebrates, in which fossoriality promotes the loss of the appendicular skeleton.

RECONSTRUCTING A NEANDERTHAL FIRST CERVICAL VERTEBRA THROUGH GEOMETRIC MORPHOMETRIC TECHNIQUES.

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***Keywords**: atlas, Neanderthal, geometric morphometrics, reconstruction.*

The atlas is the first cervical vertebra and it is an important part of the spine because it connects the skull with the postcranial skeleton. It is an atypical vertebra both anatomically and functionally. It consists of an anterior and posterior arch, two lateral masses and the neural canal. The atlas is informative about the morphology of both, the craniofacial and the postcranial system as well as the locomotor pattern. However, it is barely found in the fossil record and badly preserved when found, possibly due to its particular anatomy. Thus, reconstructing this vertebra may shed light on the evolutionary anatomy of the spine and head posture.

Our aim is to provide a quantitative virtual reconstruction of the atlas of La Chapelle-aux-Saints (LC) Neanderthal through geometric morphometric techniques.

A total of 28 3D atlas models of different individuals of the genus *Homo* make up the comparative sample: 6 *H. neanderthalensis*, 1 *H. antecessor* and 21 european modern humans. 119 3D (semi)landmarks form the template that quantify atlas shape. Previous studies showed that a Form Space PCA ordered atlas variation along an allometric gradient and an interspecific component. We use these variables, together with statistical methods and geometric morphometrics, to perform the reconstruction.

This reconstruction of LC atlas, based on atlas allometry and specificity, shows typical characteristics of the Neanderthal atlas and fits with the cranial base of the individual of La Chapelle-aux-Saints, evincing the usefulness of virtual morphology and geometric morphometrics. Even though, future studies will validate statistically this reconstruction.

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FOSSIL AMPHIBIANS FROM PORTUGAL

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Keywords: *amphibians, Anura, Caudata, Albanerpetontidae, Portugal.*

Since Devonian basal tetrapods emerge with amphibian way of life, but differently from modern lissamphibians. In Portugal, the fossil amphibians are scarce and poorly studied. There are few locations with several remains from Mesozoic and Cenozoic.

From the Portuguese Mesozoic there are temnospondyl amphibians from the Late Triassic of Algarve - *Metoposaurus algarvensis*, with 12 specimens described-, and some remains of Mastodonsauridae.

Fossil amphibians from Jurassic are the most representative Mesozoic material of Portugal.

There are some uninformative reports about the existence of anurans in the Kimmeridgian of Guimarota Mine identified as Alytidae.

Jurassic caudatans are known in Oxfordian of Pedrógão and *Marmorerpeton sp*. from the Kimmeridgian of Guimarota Mine.

Albanerpetontids are the most common amphibians of the Late Jurassic of Portugal, by one genus and species - *Celtedens guimarotae nomen nudum*, from Guimarota, Porto Dinheiro and Porto das Barcas, with 39 specimens described.

There are several localities with fossil Cenozoic amphibians: Anura (*Eopelobates* sp.) and Caudata (Salamandridae indet.) from the lowermost Eocene of Silveirinha (Coimbra). Miocene Urodeles were identified but not determined the genus or species from Langhian of Amor (Leiria).

Middle Pleistocene from Gruta da Aroeira (Torres Novas) is represented by Pelodytes sp. and *Bufo spinosus*. The upper Pleistocene from Guia (Algarve) provided the anurans *Pelobates cultripes*, *Bufo spinosus*, *Epidalea calamita*, *Pelophylax perezi*, the urodele *Pleurodeles waltl* and from Gruta da Figueira Brava *Salamandra salamandra Pelobates cultripes*, species that still exist in Portugal.

This work is the result of data collection included in a master thesis about Late Jurassic amphibians of Portugal, where is developed the state of art of amphibians studied in Portugal.

VIRTUAL FIELDWORK EXPERIENCES FOR CLASSIC EASTERN PACIFIC CENOZOIC FIELD SITES FOR THE EPICC PROJECT

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Keywords: *geoscience education, virtual fieldwork experiences, museum collections, educational technology, eLearning.*

Virtual fieldwork experiences (VFEs) are digital representations of field sites that allow exploration and inquiry in some of the same ways as actual fieldwork. In addition to incorporating typical photographs and maps, VFEs generally offer some combination of gigapixel-resolution images, panoramas, 3D imagery, and video taken at the site, and may also integrate research collections and microscope images, together with other data. VFEs are being created for four classic paleontological sites along the West Coast of the US as part of the educational outreach associated with the EPICC (Eastern Pacific Invertebrate Communities of the Cenozoic) project (https://epiccvfe.berkeley.edu).

The EPICC VFE sites include: 1) the Kettleman Hills near Coalinga in central California (completed); 2) outcrops of the Purisima Formation along the California coast (in late draft form); 3) Pleistocene terraces in southern California (under development); and 4) the Astoria Formation of Oregon (forthcoming). Each VFE is divided into modules, such as "Explore Landscapes", "Explore Sediments", "Explore Fossils", "Field to Museum", and "What is a Fossil?". Learners of any background could use the VFE imagery to explore the sites, but the text and supporting guides are designed particularly for secondary school teachers and students, and the modules have been linked to the U.S. Next Generation Science Standards (NGSS). The EPICC VFEs also are intended to highlight the importance of paleontology and research collections in contributing solutions to 21st century societal issues.

OPPORTUNITIES FOR OPEN SCIENCE: PALEORXIV

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***Keywords**: publishing, open science, paleorXiv, preprints.*

The academic publishing system can be really slow and costly, and has been slow to adapt to a Web-based communication style. We have the collective challenge to build the future for the dissemination of scholarly works. The use of preprints, as a form of rapid sharing, has been the norm in some research disciplines and is now widely gaining ground. A preprint is a manuscript version of a scholarly paper prior to peer-review and formal publication in a journal. Their use carries several advantages, such as helping to increase of the visibility of research by being freely available and at no cost to authors; the possibility of getting wider feedback, citations and more improvements; and last but not least important preprints get a permanent DOI. Encouraging palaeontologists to "stop hiding the bones", thanks to modern technologies, we have built paleorXiv which is a moderated, community-led, open source and non-profit platform that provides a space where palaeontologists can upload their working papers, preprints, peer reviewed and accepted manuscripts and published papers, providing options to link data and code, and for article versioning too. Our mission is to help researchers from around the world find ways of making their work freely accessible. At the time of writing this, 99 projects have been shared openly through paleorXiv, providing a great benefit in terms of cost and visibility to palaeontological research. Having in mind all these, the remaining question is what are we waiting for? Quoting Queen, I want to break free [from paywalls].

MODELING AND HYDRODYNAMIC RECONSTRUCTION OF TIDALLY INFLUENCED STROMATOLITES: YACORAITE FORMATION (MAASTRICHTIAN-DANIAN). JUJUY, ARGENTINA

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***Keywords**: stromatolites, intertidal, paleoenvironmental reconstruction, Cretaceous, 3D modeling.*

The external morphology and the architecture of in intertidal stromatolitic systems are mainly influenced by the hydrodynamic energy of the environment. In the outcrops of the Maimará locality (Jujuy, Northwestern Argentina), the Yacoraite Formation (Maastrichtian-Danian) exhibits a system of three-dimensional preserved intertidal stromatolites. In spite of the fact that modern analogues do occur, the rarity of three-dimensional outcrops in the fossil record limits our understanding of the hydrodynamic factors that influenced stromatolite morphology. That is why the Maimará site, from the Yacoraite Formation, represents a promising study case to characterize the relationship between these microbialite systems and the hydrodynamic factors.

Stromatolite surfaces were studied through in-situ logging, polished sections and thin sections analysis. In addition, digital photogrammetry was used to achieve an overall orthomosaic and a detailed three-dimensional model of the outcrop, to characterize the sedimentary setting.

The obtained data allowed us to infer how the hydrodynamic energy of the deposit has conditioned the stromatolitic growth at several scales. At macroscale, the morphology and architecture were influenced by the wave action, with the spaces among the domes representing first order recharge/discharge water channels for tidal flow. At mesoscale, the hydrodynamic energy influenced the microbial mat growth, causing the domal morphologies and giving rise to columnar structures. The space between the columns is interpreted as second and third order discharge channels according to their dimensions and position within the internal structure.

MACROEVOLUTIONARY PATTERNS ON THE EVOLUTION OF SHELL IN TURTLES REVEALED BY ANATOMICAL NETWORK ANALYSIS

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Keywords: *Testudinata, carapace, plastron, anatomical networks.*

I perform the first network analysis on the shell of turtles (Testudinata), using representatives from all major clades of extant and extinct turtles. Their shell is modeled into four networks (bony plates and horny scutes of carapace and plastron). The overall properties of the entire networks, as well as of the various nodes (= plates and scutes), are mapped into a simplified phylogeny to reconstruct their ancestral states. When the entire carapace is analyzed as a network, mapping reveals a conservative evolution of the turtle carapace. The main change is found on the node of crown turtles (Testudines), as a slight reduction in the number of plates and scutes and their connections. The remarkable differences between the carapace morphology of the various turtle clades are best interpreted under parsimony as autapomorphic changes. This slight simplification did not, however, lead to changes in the overall average path length and density compared to stem turtles. Crown turtles then followed different paths on their shell evolution, but in most cases without altering the density of their networks significantly. Two notable exceptions were discovered. Some turtles (e.g., testudinoids) slightly increased the density of their carapace network by increasing its complexity (reduction of plates and increase of connections between them); this could be linked to increased terrestriality. On the other hand, trionychids experienced a significant decrease in the number of bony plates. Although a shell with fewer plates should be "weaker", the analysis reveals that trionychids have the densest carapace network within Testudinata.

TOWARDS A COMPLETE DATABASE OF THE FOSSIL RECORD OF TURTLES (TESTUDINATA)

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Keywords: *testudines, turtles, tortoises, paleobiology database, fossilworks.*

Analyses of diversity and extinction are of key importance in many paleontological works. Usually assisted by the construction of diversity curves of taxa at different taxonomical levels (species, genera, families, or clades), diversity analyses require the aggregation, analysis, and presentation of a large amount of data. For this reason, the existence of open-access databases of fossil occurrences is paramount for performing diversity analyses in a fast and rigorous way, even if we take into account the various critiques and inherent flaws of this methodology (sampling bias; incompleteness; human errors). In this contribution, I would like to present the objectives, methodology and expected outputs of my primary research topic, which deals with changes in the diversity of turtles (Testudinata) through time. One of my primary aims is to reach a complete database of fossil turtle occurrences and species in the near future. Turtles have a rich and diverse fossil record with extensive geographical and temporal distribution, which is actually manageable compared to other reptile groups. For this reason I actively add information in the online PaleoBiology Database (PBDB), aiming to offer (together with numerous other contributors of this collective task) the complete fossil record of turtles at the tips of your fingers. The PBDB record of turtles has grown enormously during the last years and includes right now nearly 8,500 occurrences of Testudinata from more than 4,700 collections from all over the world—but there is still a lot to be added.

THE COLLECTIONS OF THE PALEONTOLOGICAL MUSEUM OF RONCÀ (VENETO REGION, NE ITALY)

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Keywords: *collections, molluscs, Eocene, Roncà, Italy.*

Roncà is a small village in Verona province (Veneto Region, north eastern Italy) and it is located in the southern area of Val d'Alpone. The territory of Roncà has been known for several centuries for its important paleontological heritage. The oldest historical information on the so-called "Orizzonte geologico di Roncà" is due to Alberto Fortis, Abbot of Arzignano, who in 1778 published a paleontological memory in Venice entitled "Della Valle vulcanico-marina di Roncà nel territorio veronese". In 1975 a small local museum was inaugurated that was renewed in 2002 and since 2009 was knowned as Museo Paleontologico di Roncà. The current paleontological collection of the Museo di Roncà was established in 1970, thanks to the collaboration of the "Val Nera" group from the Paleontological Association Val d'Alpone. Since 2010 the Museo Paleontologico di Roncà has planned research and excavations in the locality of "Valle della Chiesa" and "Monte Duello". Paleontological excavation campaigns are still under way. The initial collection consisting of 346 fossil remains, with the latest excavations of 2018 just concluded, exceeds now 2300 specimens.

The Paleontological Museum of Roncà, with its collections of latest Eocene bivalves and gastropods, aims to be a center of documentation, scientific research and educational dissemination of fundamental importance for the enhancement of the area and the Italian paleontological heritage.

Paleozoic

Moderators: Organising Committee

ASTEROZOAN DIVERSITY IN THE DEVONIAN OF SOUTH BRAZIL

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Keywords: *Echinodermata, Asteroidea, Ophiuroidea, Devonian, paleoecology.*

For a long time, ophiuroids and starfishes were considered sparse among the Devonian Brazilian Ponta Grossa Formation invertebrates. Consequently, the paleontological papers of these Brazilian asterozoans have always been rare. Thus, the present study focuses on the analysis of echinoderms, with emphasis on the classes Asteroidea and Ophiuroidea, from the scientific collection of the Laboratório de Paleontologia, Setor de Ciências da Terra, Universidade Federal do Paraná, Brazil. Fossils were collected over 22 years in different outcrops of the Jaguariaíva and São Domingos members of the Ponta Grossa Formation, Devonian of the Paraná Basin. Based on the specialized literature, the taxonomic description of 60 samples allowed the identification of two morphotypes of ophiuroids and two morphotypes of asteroids. In addition, the taphonomic study made it possible to characterize biostratinomic processes, emphasizing the high fragility of the ossicles of the calcitic skeleton of these echinoderms. Finally, the characterization of these asterozoans, sedimentary matrix and associated fossil fauna also contributed to the paleoecological and paleoenvironmental reconstruction of this Formation and increase the echinoderm diversity known in the area.

NEW ARTHROPOD JUMPING TRACKWAY FROM THE LATE PALEOZOIC GLACIALLY-RELATED DEPOSITS, PARANÁ BASIN, BRAZIL

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***Keywords**: ichnology, resting trace, arthropod, trackway, glacial.*

Ichnology is fundamental to understand the environmental energy, oxygenation, salinity and substrate consistence, which are rarely resolved by others fields like field-based sedimentology or body-fossil studies. The Itararé Group is a lithostratigraphic unit of the Pennsylvanian-Cisuralian of the Paraná Basin, the studied unit correspond to the topmost division of the Group, the Rio do Sul Formation. This Formation exhibits a diverse ichnoassemblage preserved in rhythmites of silt and clay. In these layers, ichnotaxa such as *Cruziana problematica*, *Diplichnites gouldi*, *Glaciichnium isp*., *Gluckstadtella elongata*, *Helminthoidichnites tenuis, Mermia carickensis, Protovirgularia dichotoma, Treptichnus pollardi* and *Umfolozia sinuosa* are observable. Until now, no body-fossils have been described at these rhythmites; however different kinds of crustaceans and insects are proposed as the most likely tracemakers of such ichnofossils. This contribution shows the first record of a well-preserved jumping trackway. The main specimen of this project (catalogued as UFPR 0042IC A) consists of a rhythmite sample with invertebrate trails and resting traces (probably produced by arthropods). Resting traces can provide much more accurate information about the morphology of the producer than trackways, and allow obtaining a better understanding of the diversity of ancient arthropod communities and their paleoenvironmental significance. This study systematically reviews the data obtained from the sample, aiming to propose the probable producers and to interpret the recorded behaviors.

EDS COMPOSITIONAL ANALYSIS OF LATE PERMIAN FISH FOSSILS FROM LITHUANIA AND LATVIA: PRELIMINARY RESULTS

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***Keywords**: Zechstein Sea, chondrichthyans, osteichthyans, fresh water, geochemical composition.*

The first preliminary results based on SEM-EDS analyses of fish microremain surfaces that were sampled from the most northeastern margin of Zechstein Sea (late Permian) is presented here. The samples were collected from carbonate rocks of the functional Karpėnai (northern Lithuania) and Kūmas (southern Latvia) quarries. They were chemically prepared using the optimal acetate 10% buffered acetic acid technique for extracting phosphatic fish microremains. The biostratigraphic correlation between these quarries points to the same pattern of the first and last occurrences of Upper Permian chondrichthyans and osteichthyans microfossils. However, the apparent difference between the quantity of microremains in the Lithuania-Latvia Region could possibly be explained by regional variations in fresh water input during episodic exposure events associated with regional or global sea-level fluctuations. Therefore, SEM-EDS analyses were made for testing the geochemical composition of microremain surfaces of both chondrichthyans and osteichthyans from the range of outcrop stratigraphic layers (Lower Member, Middle Member, Upper Member). Analysed euselachian type dermal denticles, actinopterygian scales and teeth from the Naujoji Akmenė Formation revealed a slightly more depleted chemical composition of Permian seawater concerning Mg^{2+}, Ca^{2+}, Na^{+}, K^{+}, Cl^{-} atomic norms in Kūmas quarry. Such results need additional EDS and XRD detailed geochemical analyses to investigate more carefully a significant difference in microfossil abundances between Latvian and Lithuanian localities from slightly differing parts of the depth gradient.

MORPHOLOGY OF THE COVERS OF PROARTICULATA (EDIACARAN METAZOA)

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Keywords: *Metazoa, Proarticulata, Dickinsonia, morphology, Ediacaran.*

Proarticulata, which include well-known genus *Dickinsonia*, were the largest mobile animals of the Ediacaran Period. Body fossil impressions, classified as Proarticulata, were formed by bilateral objects, divided in transverse direction into two rows of "half-segments". It has been previously thought that the body of the animal was isomeric, consisting of either a special organ located on its dorsal side or a solid shield forming a dorsal cover. The results of recent studies allow us to amend these views. Our observations show that objects that formed the majority of imprints did not represent the whole body of Proarticulata, but only a part, that was resistant to decomposition. This structure, divided into transverse elements, extended both to dorsal and ventral sides of the body. This structure was dense and probably served as an internal support. The study of some rare exceptionally preserved specimens suggests that a cover tissue was located over the segmented structure. On the dorsal side, it created a continuous shield that showed no signs of segmentation. The outer surface of the dorsal side of several genera of Proarticulata (*Dickinsonia*, *Yorgia*, *Archaeaspinus*, *Lossinia*, *Onega*) was covered with numerous evenly distributed tubercles. In *Onega*, the dorsal tissue at the posterior end formed a pair of long filamentous outgrowths.

Ichnofossils attributed to Proarticulata consist of shallow pits created by ingestion of the microbial mat. Based on these traces, the ventral side of the body was segmented externally similarly to the supporting structure. The cover tissue on the ventral side probably bore cilia; furrows from presumed ciliary movement are preserved on the traces. The newly obtained data are in accord with the concept of a relatively high level of organization of Proarticulata.

THE FIRST MILLERETTIDAE OF THE MIDDLE/UPPER PERMIAN FROM THE PARANÁ BASIN, BRAZIL

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***Keywords**: Millerettidae, vertebrate, Permian, rio do rasto formation, Parareptilia.*

This work concerns a new of Millerettidae of the Rio do Rasto Formation (Morro Pelado Member), Middle/Upper Permian of the Paraná Basin, Brazil. The material in study is a vertebrate fossil collected in São Jerônimo da Serra Site, southern Brazil. It is identified by the code UFPR 0252 PV (A, B) and corresponds to a mandible measuring 18 mm in length. The dentary presents twelve homodont and monocuspids teeth. In scanning electron microscope analysis, the teeth were identified as conical, subrounded and with longitudinal depressions. Furthermore, in computerized microtomography analysis, it was possible to view longitudinal linear ornamentation on the angular and surangular bones. To identify the possible related taxa, the mandible was compared with basal parareptilia groups. The group Millerettidae and the genus *Delorhynchus* were chosen due to similarities of theirs bone sutures with the sutures of the studied specimen. Compared with *Delorhynchus*, which has a mandible characterized by rounded ornamentations with tuberosities, the material in study has a different morphology. Instead, when compared with the millerettids, the ornamentation has the same parallel pattern. So, this represents the first record of Millerettidae for the Rio do Rasto Formation and supports a Permian age for that formation.

IDENTIFYING CHANGES IN BRACHIOPOD COMMUNITY STRUCTURES AND CORRELATING TYPE SECTIONS FROM THE UPPER ORDOVICIAN IN THE EASTERN BALTICS

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Keywords: *Silurian, Ordovician, Baltica, brachiopods, eastern Latvia.*

The position of Baltica during the Ordovician and Silurian period ranged from around 40-50° south, to a position close to the equator. The territory of modern day Latvia and Lithuania was located in the central part of the Baltic palaeobasin with sea levels ranging from deep sea, to littoral zones, due to several sea transgressions and regressions. The Baltoscandian territory has varying marine facies zones. There are significant lateral changes in facies belt deposits in the modern day territories of Latvia and Lithuania, with evident changes in brachiopod communities. The main deposits of this region are limestones, marlstones, and mudstones, but dolomites, argillite, and clays are also commonly found. To this day, three major issues remain in the eastern Baltic Upper Ordovician formations: i) incomplete type section correlations; ii) the lack of detailed brachiopod community structures, and; iii) a thorough understanding of brachiopod bioevents in Baltica. In a preliminary attempt to solve some of these issues, brachiopods from drill core samples from the Mežciems Formation (Upper Ordovician) in Latvia have been studied in detail in a 2014 thesis. Further research into analogous formations and palaeoenvironments, and significant brachiopod genera occurring in the Mežciems Fm, such as the orthids *Dalmanella, Howellites*, *Horderleyella,* and *Platystrophia*; the strophomenids *Sowerbyella, Longvillia,* and *Leptaena*; and the billingsellid, *Vellamo,* have led to a greater understanding of the palaeoenvironmental conditions that lead to changes in brachiopod community structures, which will also assist in further defining the stratigraphic borders of the Upper Ordovician in the Eastern Baltics.

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SOUTHERN POLAND MIDDLE TRIASSIC (MUSCHELKALK) MICRO- AND MACROVERTEBRATE REMAINS

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***Keywords**: vertebrate, fish, reptile, scale, tooth, taxonomy.*

Middle Triassic (Muschelkalk) limestones and dolostones of southern Poland are known to contain vertebrate remains. Here we present micro- and macrofossils from several sites and different sediment types, which allow recognition of geographic and lithologic trends in distribution of the collected material. Microfossils were picked under the binocular after dissolution of the crushed sediment samples in 10% acetic acid. Macrofossils were manually prepared by students of Jagiellonian University.

Macrospecimens comprise vertebrae, teeth and fragments of long bones, all belonging to aquatic or semi-aquatic reptiles, most probably nothosaurids. Microfindings are mostly fish remains, particularly actinopterygian teeth and scales and chondrichthyan teeth and fin spines, whereas reptilian remains are less common. The material and species diversity implies that faunas in the mid-Triassic sea was derived from many different biotopes. Geographical and stratigraphic differences in the fossil content probably reflect spatial and temporal changes in Middle Triassic vertebrate communities. Fossils can be found in all examined types of sediment, but the richest vertebrate remains are in crinoid limestone layers, interpreted as tempestites. This observation highlights storm activity as the main process of transport and accumulation of skeletal material.

MICROVERTEBRATES FROM THE LOURINHÃ FORMATION (LATE JURASSIC, PORTUGAL)

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Keywords: *Crocodylomorpha, Albanerpetontidae, Dinosauria, Lusitanian Basin, palaeoecology.*

The Upper Jurassic of Portugal is globally known for its vertebrate microfossil fauna thanks to the Konzentrat-Lagerstätte of the Guimarota mine, which provided thousands of bones, teeth, and even a complete mammal specimen: *Henkelotherium guimarotae*. However, no other Portuguese Jurassic vertebrate microfossil assemblage has been extensively studied. Hereby is presented a preliminary study on three localities from the Lourinhã Formation (Kimmeridgian-Tithonian). A total of 377 kg of sediment were collected from Porto das Barcas, Zimbral, and Valmitão have provided 2497 microvertebrate skeletal remains and teeth, from which 824 specimens have been identified, described and assessed to the conservative-most taxa. The remains have been attributed to chondrichthyans, actinopterygians, amphibians, squamates, crocodylomorphs, and dinosaurs. The sedimentology of the localities suggests that Porto das Barcas and Zimbral were floodplain mud deposits, whereas Valmitão was an oxbow lake mud deposit, all three deposited in transitional environments, with varying degrees of marine influence. Palaeoecological analyses suggest Zimbral and Valmitão were dominated by a terrestrial fauna, more diverse than Porto das Barcas, dominated by an amphibious fauna. The Lourinhã Formation deposited closer to the shoreline than similarly sampled localities in the contemporaneous Morrison Formation. All three described vertebrate microfossil assemblages present a high potential for further taxonomic, palaeoecological, and palaeobiogeographic studies, the localities of Zimbral and Valmitão being the most promising ones.

A LATE CRETACEOUS MASSIVE DEATH EVENT REGISTERED AT THE BURPEE NTQ SITE, HELL CREEK FM, MONTANA, US

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Keywords: *palynology, Cretaceous, bioevent, Hell Creek Fm.*

Palynological results are presented here from the analyses of samples taken at the Burpee NT Quarry, Hell Creek Formation near Ekalaka, Montana. Sample collected close to Bone #38, NT Quarry dinosaur/turtle bed show important changes in the palynological assemblage

The layer below the Ninja Turtle "Bone # 38" bed is characterized by a rich sporomorph association with many species of conifers, angiosperms pollen, fresh water floating fern spores, microscopic fresh water algae, and abundant fragments of woody and epidermal plants remains. All these points to a fresh water paleoenvironment in an area with abundant ponds and marshes.

At "Bone #38" bed itself there is a sudden change in the palynological assemblage that becomes relatively poor and clearly dominated by extinct angiosperm pollen species like *Aquilapollenites dentatus* and *Wodehouseia spinata*, mixed together with specimens of marine dinoflagellates from the *Aeroligera* complex and internal foraminiferal linings. The presence of the dinoflagellates and internal foraminiferal linings points towards a sudden marine influence.

The layer above "Bone #38" bed is characterized by few species with abundant specimens of pollen and spores, but scarce marine dinoflagellates still present with *Aeroligera* sp. and *Spiniferites* sp. pointing also to sea influence.

The abrupt change from fresh water terrestrial to marine palynofloras that occurs within a few centimetres of section at Bone #38 bed, that itself is characterized by a rich accumulation of dinosaur bones and anomalously abundant, well-preserved fresh water turtle remains, is most probably due to a "catastrophic" marine flooding followed by a short-lived marine incursion.

FIRST REPORT OF A TRIASSIC CHIMAEROID FROM WESTERN NORTH AMERICA

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***Keywords**: chimaeroids, holocephalans, Triassic, Nevada, Luning Formation*

Chimaeroid fishes range from the Late Triassic (Carnian-Norian) to Recent. Johnson-Ransom et al. (2018, Pal. Res. 22[4]:364) note that "fossil chimaeroids in the western North Pacific remain poorly understood," and until now the only Mesozoic examples from Western North America were from the Late Cretaceous. The new discovery extends the North American range of chimaeroids back to the Carnian-Norian, equivalent in age to oldest known chimaeroids of the Carnian/Norian of Yakutia and the North Ice Ocean archipelago. The Triassic Luning Formation of central Nevada has yielded a durophagous chimaeroid jaw plate fragment (12.5 mm x 12 mm). The fossil consists of part of the symphyseal tritor region on the anterior end of a right mandibular tooth plate. Estimated total length of the plate is 14 cm, for an estimated total length (TL) of the fish of over one meter. Wear on the symphyseal tritor (on both the labial and lingual surfaces) has exposed internal pleuromin tissue. Hypermineralization of the tooth plates with pleromin is a unique feature of chimaeroid fish. The morphology of this specimen strongly resembles that of the symphyseal tritorial series of *Edaphodon* and *Ischyodus*. Chimaeroids are usually (although not always) associated with deep marine habitats, thus the discovery of a chimaeroid specimen in the Luning Formation is in accord with a deep water interpretation for this limestone.

LIMBS INTO FINS: LIMB EVOLUTION IN LATE CRETACEOUS MARINE SQUAMATES (MOSASAUROIDEA)

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Keywords: *mosasauroids, squamates, Cretaceous, aquatic adaptation, flipper.*

Mosasaurs are traditionally considered to be a natural (monophyletic) group of Cretaceous marine lizards possessing aquatically adapted appendicular skeletons; specifically, paddle-like limbs (the hydropedal condition), and a loss of connection between the ilium and the sacral vertebrae (the hydropelvic condition). The semi-aquatic precursor to this derived condition is demonstrated by the 'aigialosaurs': small bodied, elongate lizards showing intermediate stage aquatic adaptations including laterally compressed tails and some reduction of the appendicular skeleton. The aigialosaurs are conventionally placed basally to a monophyletic group of derived mosasaurs, and consequently, are also referred to as 'mosasauroids'. Discoveries over the last decade and a half have challenged the conventional understanding of the concept of a 'mosasaur'. Certain aigialosaur-grade species show close affinities to clades within the derived mosasaurs, suggesting multiple independent origins of the mosasaur bauplan. The discovery of a new species of 'aigialosaur' with an exquisitely preserved forelimb provides new, solid evidence in support of the polyphyletic mosasaur hypothesis. It is the limb in particular that provides the robustness of this evidence, given that the definition of a 'mosasaur' is so closely tied to the evolution of the paddle-like limb. A thorough re-examination of all described species of semi-aquatic 'mosasauroid', and a wide variety of derived 'mosasaur' taxa has demonstrated two major limb morphotypes, each with hypothetical intermediate forms demonstrated by aigialosaur-grade species. These patterns provide strong evidence for the multiple, independent evolution and convergence of paddle-like limbs in mosasaurs.

STRATIGRAPHIC POSITION OF THE LATE JURASSIC TETRAPODS FROM PORTO DINHEIRO (LOURINHÃ, PORTUGAL)

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***Keywords**: Porto Dinheiro, Late Jurassic, Lourinhã Formation, tetrapods, Dinosauria, stratigraphy.*

Porto Dinheiro is a locality situated 4 km SSW of Lourinhã, in the central-western part of Portugal. It outcrops siliciclastic rocks of the Lourinhã Formation (Upper Kimmeridgian and Tithonian), within the Lusitanian Basin. In most Porto Dinheiro (N39°12'52"; W9°20'36") crops out the Amoreira – Porto Novo Mb. (Upper Kimmeridgian), but the Praia Azul Mb. (Upper Kimmeridgian to Lower Tithonian) starts above the first (of two) marine transgressive units in the top of the cliff. The outcrop area shows thick layers of brownish-grey mudstone that alternate with sandstone that tapers laterally. This outcrop evidences a continental environment rich in tetrapod fossils, aged as Late Kimmeridgian. The fauna succession is as follows:

Top of the cliff south of the port (lower beds): reptilian eggshell, teeth from rhamphorhynchoid pterosaurs, crocodylomorphs (namely the mesoeucrocodylian *Lusitanisuchus mitracostatus* and *Goniopholis brodiei*), choristoderan *Cteniogenys*, and teeth from the squamate *Saurillus obtusus* and the ornithischians *Trimucrodon cuneatus* and *Hypsilophodon*. About 800 mammalian teeth (Triconodonta, Symmetrodonta, Dryolestidae and Zatheria) but mostly Multituberculata (namely 250 of Pinheirodontidae: *Pinheirodon pygmaeus*, *P. vastus*, *Bernardodon atlanticus*, and *Iberodon quadrituberculatus*);

Base of the cliff north of the port: an anterior dorsal vertebra of the sauropod *Zby atlanticus*, a stegosaur spine, and postcranial elements of a relatively articulated small theropod;

Top of the cliff north of the port: teeth of the theropod *Torvosaurus gurneyi*, including a 17 cm long tooth, ribs and gastroliths of the holotype of the sauropod *Supersaurus* (=*Dinheirosaurus*) *lourinhanensis*; a diverse ichnofauna of dinosaur tracks; and the Zimbral microvertebrates bonebed.

TOWARDS AN ASSESSMENT OF TRUE DIVERSITY IN FOSSIL ECOSYSTEMS

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Keywords: *diversity, Cassian Formation, lagerstätten, gastropods*.

Comparing diversity among different ecosystems is difficult even in modern environments, but the biases in the fossil record yield many more challenges. Variations in sampling intensity and preservation over time and space are the major problems. Variability of fossil preservation is usually countered with subsampling, which in essence degrades well-sampled intervals in a time series to the worst interval. We choose a different option and compare diversity in the nine best sampled and preserved fossil assemblages that are known to science: Early Cambrian Chengjiang biota (China), Middle Cambrian Burgess Shale (Canada), Late Carboniferous Mazon Creek fauna (USA), Late Carboniferous Finis Shale (USA), Early Devonian Hunsrück Slate (Germany), Late Triassic Cassian Formation (Italy), Late Jurassic Solnhofen Formation (Germany), Late Cretaceous White Chalk of Rügen (Germany), & Eocene London Clay (UK). We focus on the Upper Triassic Cassian Formation in the Dolomites, which is deemed the most diverse early Mesozoic ecosystem worldwide.

A total of 1591 species of animals (1687 species overall) have been described from the Cassian Formation, which exceeds the species richness of all other lagerstätten in our study. Other highly diverse faunas are reported from the Solnhofen Formation (861) and the White Chalk of Rügen (853). Among all formations containing over 200 species in the Paleobiology Database (PBDB), the Cassian Formation yields the highest Margalef diversity index (121.9). The high diversity of gastropods is the dominant constituent of the Cassian diversity peak. We argue that gastropods achieved their diversity-generating role already in the Triassic, much earlier than suggested in global diversity studies.

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EARLIEST PALEOCENE (DANIAN) CHONDRICHTYAN MICROREMAINS FROM NASIŁÓW (POLAND)

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***Keywords**: vertebrates, elasmobranchs, carcharhinids.*

In the earliest Paleocene (Danian) unconsolidated sandstone sediments of Nasiłów (Poland) yield abundant invertebrate fossils such as several kinds of echinoid spines, shells of a turret gastropods, Ostreidae bivalves, ostracords, and foraminifers. Less common and not yet described are elasmobranch remains comprising mostly shark teeth.

Preliminary research includes identification and description of the specimens from author's collection and manual sorting of sediment samples from Nasiłów under the microscope, resulting in additional findings.

Shark teeth from Nasiłów quarry can be ascribed to several morphotypes corresponding to different elasmobranch species, including the typical triangulare teeth of unidentified carharhinids and *Carharhinus*, high and narrow teeth of *Isurus* (Lamnidae) or durophagous flat teeth, representing most likely lateral teeth of *Heterodontus*. Among the teeth some poorly preserved, damaged vertebrae can be found.

Additional material, detailed taxonomic descriptions, and geochemical analyses of elasmobranchs from this locality might provide a better understanding about elasmobranchs surviving the end-Cretaceous extinction event possible diversification events in the aftermath of this crisis.

PRELIMINARY STUDY OF THE NEW PALEOLITHIC CAPRINI REMAINS OF THE NIAUX CAVE (ARIÈGE, FRANCE)

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***Keywords**: Niaux, Caprini, Paleolithic, Magdalenian, evolution.*

The Cave of Niaux (Ariège, France) is placed in the east part of the Pyrenean mountain range, 700 meters above sea level and 100 meters from the course of the Vicdessos river. Since the discovery of its famous Magdalenian paintings, and despite its more than 3 km of galleries, most of the studies have only concerned these paintings.

A recent exploration of one of the galleries near the entrance, the "Galerie des Empreintes Animales", has provided several fossil remains among which the tibia of a large goat (Tribe Caprini) that preserves part of the diaphysis and the complete distal epiphysis stands out. Morphometrically they present characteristics similar to several goat species (*Capra ibex* and *Capra pyrenaica*) and genus *Hemitragus*. For this reason, in the absence of more specific studies, we have decided to define it as Caprini indet. The date obtained through C14 indicates: between 16,496 and 16,105 intcal13 BP 95,4%, which is related to those obtained in several paintings of the Salon Noir.

The Department of Ariège is considered as a key region for the study of the evolution of caprini in general and particularly of genus *Capra* in south-western Europe due to the identification of three different goat species in different deposits. The analyzed remain can provide data of a key period in the evolution of this genus. Also, the location of these fossils within the cave can help us understand the evolution of the cavity and the use that the first inhabitants made of it.

THE WELL-KNOWN EARLY MIOCENE BIOTA FROM RIBESALBES/ALCORA BASIN (EASTERN SPAIN): TAXONOMIC AND PALEOECOLOGICAL ASPECTS

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Keywords: *compression fossils, lacustrine rhythmites, paleolake, Early Miocene, Spain.*

The endorheic, meromictic paleolake of Ribesalbes (Castellón Province, Eastern Spain) is an Early Miocene Konservat-Lagerstätte whose bituminous rhythmites contain abundant plant and animal compression fossils, some of later preserving soft tissues. A subtropical climate and the influence of the lake resulted in a diverse ecosystem.

The joint study of the fossils it provided allowed distinguish four different environments mostly characterized by some plant and arthropod taxa: (i) lake shores determined by the occurrence of aquatic gastropods, insects, amphibians and plants, for example linear leaf remains of reeds; (ii) azonal riparian zone with alders, willows, poplars and insects such as caddisflies, non-biting midges and March flies; (iii) mixed coniferous, evergreen and deciduous forests with tall trees (e.g., *Sequoia*) characterized by humid environments with diverse insects (ants, jewel beetles, thrips) and; (iv) zonal sclerophyllous pinewoods with leguminous trees where spittlebugs, katydids, net-winged beetles, sawflies and other insects inhabited.

Insects are the most abundant and diverse fossils including 47 families. They are represented by egg depositions, pupal exuviae, pupae and adults. To date, seven new species have been described from the fossil record of Ribesalbes.

LATE PLEISTOCENE PALEOENVIRONMENT BASED ON MICROMAMMALS FROM LA PRESITA CAVE (SAN LUIS POTOSÍ, MÉXICO).

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Keywords: *La Presita, micromammals, bioclimatic model, late Pleistocene, paleoenvironment.*

In Mexico several caves held late Pleistocene herbivores and carnivorous mammals. One of them is *La Presita* Cave located 21.4 km south from Matehuala in northeastern San Luis Potosí state, north-central Mexico, and there are known bone remains from 21 medium and small size mammal species pertaining the orders Cingulata, Pilosa, Perissodactyla, Cetartiodactyla, Chiroptera, Carnivora, Rodentia, and Lagomorpha, as well as amphibians, birds, reptiles and mollusk shells.

Due to the presence of the prairie dog, *Cynomys* sp., the horse, *Equus* sp., the camel, *Camelops traviswithei* and the white-tailed deer, *Odocoileus virginianus*, it has been proposed that in this locality during the late Pleistocene, there was a forest with a grassland. However, there is not a study for corroborating such inference yet. Because of that using a qualitative bioclimatic model based on micromammals, we infer the possible environmental conditions based on *La Presita* Cave.

The results obtained show that the mammal fauna from *La Presita* Cave lived in a savanna or grassland during the late Pleistocene. This agrees with what it was previously proposed in other studies conducted in northern Mexico that indicated that this region was more humid during the late Pleistocene, allowing the establishment of grassland during such time period.

UPPER DENTITION OF *PARACAMELUS AGUIRREI* (CAMELIDAE, MAMMALIA) FROM VENTA DEL MORO (VALENCIA, SPAIN)

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***Keywords**: Camelidae,* Paracamelus aguirrei*, Miocene, Upper dentition, Venta del Moro.*

Venta del Moro (Valencia, Spain) is a paleontological site from the late Turolian (or Ventian, late Miocene) magnetostratigraphically dated at c. 6.23 Ma. The fossil assemblage of this locality has more than one hundred faunal and floral taxa and it is also the type locality of nine species of mammals including *Paracamelus aguirrei*. This genus originated in North America, and later it dispersed through the Bering Strait during the last part of the Turolian and expanded all around Eurasia and the north of Africa where it is the only camelid found during the late Neogene.

In this study we describe the new material found of the upper dentition of *Paracamelus aguirrei* from Venta del Moro, consisting of 17 isolated premolar and molar teeth. The dental formula of this species is composed by one caniniform incisor, one canine, three premolars (caniniform P1, P3, P4) and three molars. When isolated, the caniniform teeth are impossible to distinguish because they have a similar morphology. The P3 is not molarized and it has a massive hypostyle. The P4 is very massive and it is molarized. The three molars are very similar, but the parastyle and mesostyle are more massive in the first molars than in M3, whereas the latter has a bigger metastyle. M1 is the smallest molar. In general, the dimensions of the studied dentition are similar to those of the Pliocene species *Paracamelus gigas* from China and *Paracamelus alexejevi* from Ukraine.

The study of these new dental remains of *P. aguirrei* from the type locality allows us to deepen our knowledge of the variability of this still poorly known species.

THE PLIOCENE ELASMOBRANCH COLLECTION AT THE PALAEONTOLOGICAL EXHIBITION OF G.A.M.P.S. (BADIA A SETTIMO, TUSCANY, ITALY)

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Keywords: *G.A.M.P.S., Palaeontological exhibition, Elasmobranchii, Pliocene, Tuscany.*

In the little village of Badia a Settimo (Scandicci), close to Florence (Italy), in an old school facility, a collection of fossils of prime importance is managed by an association of volunteer, amateur palaeontologists: the G.A.M.P.S. (Gruppo AVIS Mineralogia e Paleontologia Scandicci - Mineralogical & Palaeontological AVIS Group of Scandicci). In this collection, several unique or simply very well preserved specimens have been stored and prepared, and some of them were eventually put on public exhibition. Most of the exposed specimens are fossils of vertebrates and invertebrates from the Pliocene marine deposits of Tuscany. Most of the G.A.M.P.S. invertebrate collection is comprised of gastropods, bivalves, brachiopods, echinoids and crabs. These benthic invertebrate fossils, which include some exquisitely preserved specimens, shed light on the diversity of the Pliocene biota of the central Mediterranean Sea. Furthermore, the G.A.M.P.S. exhibition is enriched by a spectacular section devoted to of the marine vertebrates that lived along the coasts of Tuscany during the Pliocene: an almost complete specimen of a balaenopteroid baleen-bearing whale, together which some specimens of *Metaxytherium* (an extinct species of sea cow), *Etruridelphis* (an extinct species of dolphins), and a plethora of fishes are admirable at Badia a Settimo. In particular, the G.A.M.P.S. collection of elasmobranch teeth and spines is remarkable: over 30 species of sharks, rays and skates have been found in the Pliocene sediments of Tuscany and are now present at the G.A.M.P.S. palaeontological exhibition. Each of these species tells the visitors a different story about the biological and environmental evolution of the Mediterranean Basin during the last five million years. The G.A.M.P.S. experience highlights how the continuous collaboration between amateur and professional palaeontologists, in compliance with the laws in force and modern scientific and museological standards, has the potential to adequately highlight and give value to new palaeontological finds. The aim of the present work is to present the elasmobranch collection of the G.A.M.P.S. and to discuss the communicative strategies used to present the Pliocene world at the G.A.M.P.S. exhibition at Badia a Settimo.

THE CONTRIBUTION OF MOLLUSKS IN THE DETERMINATION OF HOLOCENE PALEOBIOZONES IN NORTH-EASTERN ALGERIA

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Keywords *: Morsott region, Paleobiozonation, Pedogenesis, Holocene.*

The Holocene sequences of north-eastern Algeria are composed of alternating dark and light layers (alternating fine sandy-clayey levels with coarse sandy-silty levels), which could correspond to synchronous environmental phases. The different facies deposited in the Morsott region were systematically sampled as part of a molluscan study in order to establish a palaeobiozonation of the Holocene. The alternation of sandy clayey silts levels, which contain a significant amount of molluscan hygrophilous organisms; which match to biostasis (pedogenesis) cycles, alterned by rhexistasis (weathering) cycle at the top, dated Holocene by U / Th, with an absolute age, less than 10, 350ky BP; they comes above the basic isostasis (stability) cycle, which contains only breccias and calcareous crusts. The molluscan record shows a dominant succession of xerophilous organisms *Sphincterochila candidissima, Rumina decollate* and *Helix aperta* in relation to *Helicella stiparum* and *Zonitoides nitidus* the hygrophilous organisms. The high species richness in the fine levels more than 240 species in level H, 190 species in level F and 125 species in C level. Moreover, is linked to sub-humid periods. The reduction in the number of species in the coarse levels is likely due to desiccation when the climate was semi-arid.

ANATOMY OF THE FOOT OF *LESTODON ARMATUS* (XENARTHRA, FOLIVORA) AND ITS RELATIONSHIPS WITH OTHER SLOTHS

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***Keywords**: Pleistocene, megafauna,* Lestodon*, foot, anatomy.*

The anatomy, osteology and biomechanics of the extremities of the terrestrial sloths (Xenarthra, Folivora) have been studied as examples of their particular characteristics not found in other mammals. In this work, we describe the bones of the hind foot of *Lestodon armatus* Gervais, 1855, the most represented sloth genus in the fossil record of Uruguay, comparing it with those of other sloth species (*Thinobadistes segnis* 0. P. Hay 1919, *Glossotherium robustum* Owen, 1842 and *Paramylodon harlani* Allen, 1913). It was observed that the talus and calcanei of this giant mylodontid are more similar to that of megatheriids, which is interpreted as a consequence of their very large body size and the possibility of adopting a bipedal posture rather than reflecting closer phylogenetic relationships.

A NEW SPECIMEN OF THE EXTINCT GHOST CRAB SPECIES *OCYPODE ITALICA* (DECAPODA: BRACHYURA: OCYPODIDAE) FROM THE PLIOCENE OF TUSCANY (ITALY)

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Keywords: *Crustacea, ghost crabs, Mediterranean Basin, Piacenzian, Tuscany.*

Well-preserved fossils of benthic marine invertebrates, including decapod crustaceans, are often found in the Pliocene sediments that constitute the substratum of the hills of Tuscany. Year after year, new or "exotic" taxa are thus found and documented, mostly thanks to isolated finds. In systematic paleontology, the ideal condition for instituting a new species is by working on many specimens: in this way, a newly instituted taxon may be described on the basis of the holotype and other specimens that would depict its intraspecific variability. That said, given the fragmentary nature of the fossil record, this happens rarely, and several extinct species are instituted and described based on very few specimens. It is the case for the ghost crab species *Ocypode italica* Garassino *et al*., 2010, which was known so far by the holotype and one paratype. Such a limited fossil record is typical of the *Ocypode* spp. and might reflect the habitat preferences of this group of ghost crab species, inhabiting high-energy sandy shores at tropical and subtropical latitudes worldwide. Among the Neogene record of decapod crustaceans from Italy, the two known specimens of *O. italica* are nonetheless of prime importance, as they represent the northernmost finds of the genus *Ocypode* in the Mediterranean Basin, as well as the geologically oldest species of *Ocypode* in Europe. Recently, thanks to the cooperation between some local amateurs and academically educated paleontologists, a well-preserved new specimen of *O. italica* has been collected from the same upper Pliocene deposits of Tuscany (central Italy) from which the type specimens originate. Our new find represents the third known specimen of this species, and as such, it allows to better characterize the anatomy of the carapace, chelipeds and walking legs of this rarely reported extinct form of ghost crabs. In particular, anatomical resemblances between *O. italica* and the extant form *Ocypode cursor* (Linnaeus, 1758) may suggest similar ecological and trophic habits for these two Mediterranean species. In the present work we figure and describe this new specimen, and briefly discuss its significance in the broader picture of the Pliocene fossil record of Tuscany.

PALEOBIODIVERSITY OF QUATERNARY FOSSIL TETRAPODS IN CONTINENTAL PORTUGAL

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***Keywords**: census, representativeness, fossil record, Pleistocene, inventory.*

Paleobiodiversity studies have been used to study the representativeness of the fossil record or to detect extinction events. The fossil fauna of the Quaternary is the most comparable to nowadays, thus can be used to test the representativeness of paleobiodiversity studies. However, studies of this type with Quaternary vertebrates are not widespread and usually focus into certain groups.

On this work, an inventory of all tetrapod taxa scientifically published as fossils in the Quaternary of continental Portugal will be provided, thanks to an extensive bibliographical research. Then they will be compared with the current biodiversity for the same groups (Taking into account the introduced species); inferring rates of extinction and representativeness of the fossil record.

There are 176 tetrapod species recognized in the fossil record of the Quaternary of Portugal (7 amphibians, 13 non-avian reptiles, 80 birds and 74 mammals). 125 species (71%) still live in the country today, while 49 (29%) are only known as fossils; 29 (17%) are locally extinct and 20 (11%) globally extinct. The 125 species detected as fossil that still live in the country represent 38% of the total 332 species. Most findings come from cave deposits, without them, the representativeness falls to 35 species (10%). Amphibians and non-avian reptiles do not suffer any kind of extinction besides turtles. Bird modern biodiversity is much higher than its paleobiodiversity, only 30% of the modern species were detected as fossils. Mammals suffered a high level of extinction with almost half of them being locally or totally extinct.

OCCURRENCE OF *CROCODYLUS* IN THE EARLY MIOCENE MOGHRA FORMATION, NORTHWESTERN DESERT, EGYPT

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Keywords: *Moghra,* Crocodylus, Rimasuchus, Tomistoma, Euthecodon.

Neogene African crocodylians, particularly from North Africa, are of critical to understand the origin and historical biogeography of African and European crocodylians. The Moghra Formation (Qattara Depression of the North Western Desert, Egypt) is characterized by sandstone and shale intercalations, which are related to a tide-dominated estuary environment within a tropical, warm climate. It is the best exposure formation along the Northern scarp of the Qattara Depression. The Moghra locality has an unusually high abundance and diversity of vertebrate fossils, due to the warm environment and proper conditions needed for fossilization, with records of mammals, reptiles, birds and even fishes. The vertebrate fossil remains are concentrated within four stratigraphic horizons, mainly of lag deposits. The crocodylian remains are concentrated just in the lowest horizon. The systematic study of the crocodylian remains has allowed us to reidentify and describe *Crocodylus* sp. alongside with other three crocodylians (*Rimasuchus lloydi, Tomistoma dowsoni and Euthecodon* sp.). In addition, geological and paleontological significance indicate that the Moghra Formation is known to be older than Gabal Zelten, in Libya, and of similar age to the deposits at Rusinga, in Kenya and Napak, in Uganda. Therefore, the fossil record of *Crocodylus* from the Moghra Formation might be the oldest form of *Crocodylus* in Africa.

A PRELIMINARY REASSESSMENT OF THE RHINOCEROTID DIVERSITY (RHINOCEROTIDAE, MAMMALIA) AT THE LATE MIOCENE LOCALITY OF HÖWENEGG (HEGAU, GERMANY)

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***Keywords**: Mammalia, Rhinocerotidae, Late Miocene, Höwenegg, Germany.*

The Late Miocene (Vallesian, MN9) locality of Höwenegg (Hegau, Germany) is renowned for the extraordinary preservation of complete skeletons of extinct mammals. It is believed that the skeletons have been accumulated over a relatively short geochorological interval in a shallow lake, by low velocity riverine currents and under anaerobic bottom conditions. Among the most impressive findings are two nearly complete skeletons of the hornless rhinocerotid *Aceratherium incisivum*, which have been formerly described in detail. Based on few isolated postcranial elements, the occurrence of a second rhinocerotid has been also reported, though its taxonomic status had remained unsettled.

The ongoing reassessment of the complete Höwenegg rhinocerotid collection, including material from the new excavations, has documented the presence of two different hornless rhinocerotid taxa (Subfamily Aceratheriinae): the smaller and relatively more robust *Aceratherium incisivum*, and the larger but slender *Hoploaceratherium* sp.. In addition, the occurrence of a third, horned rhinocerotid species (Subfamily Rhinocerotinae), *Lartetotherium* cf. *sansaniense*, has been also recognised. All three species are low-crowned browsers that have favoured forested habitats with dense cover and abundant water.

The biostraticraphical implications of the rhinocerotid assemblage at Höwenegg are of particular interest, since its fossil-bearing volcano-sedimentary deposits have been radiometrically dated at ca. 10.29 (+/-0.07) Ma. The Höwenegg rhinocerotid assemblage differs from the one at the classic Vallesian (MN9-10?) locality of Eppelsheim (Germany), where the more advanced two-horned *Dihoplus schleiermacheri* has replaced *Lartetotherium sansaniense*. On the contrary, it resembles closely the rhinocerotid association from the early Vallesian (MN9) vertebrate locality of Rudabánya (Hungary).

A LATE PLEISTOCENE FAUNAL ASSEMBLAGE FROM THE FLUVIAL TERRACES OF TIANGUISTENGO, OAXACA, SOUTHERN MEXICO

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***Keywords**: continental mollusks, freshwater mollusks, fluvial environments, Rancholabrean.*

Late Pleistocene deposits are widespread in central Mexico. However, Pleistocene invertebrate faunas have been poorly studied, and their records remain practically unknown for this epoch.

The aim of this research is to report a new faunal assemblage from several fluvial terraces developed on the margins of the Acatlán river, near Tianguistengo town, in the limits of Puebla and Oaxaca states.

Limestone and sandstone fragments from Cretaceous sequences were deposited in the terraces during the Pleistocene. Sediment sequences from terraces range from 5 to 25 m in thickness. Conglomerates and sandy conglomerates appear at the base. The faunal assemblage of the southern terrace contains a moderate diversity of freshwater mollusks (Hydrobiidae, Planorbidae, Lymnaeidae and Sphaeriidae), and terrestrial gastropods (Succineidae and Limacidae). The northern terrace contains a faunal assemblage composed by terrestrial gastropods (Zonitidae, Helicinidae and Polygyridae), aquatic mollusks (Sphaeriidae and Planorbidae), and vertebrate taxa (Equidae and Cervidae indet.).

The faunal assemblage was developed in a patchy habitat. Several freshwater deposits indicate the development of ephemeral and semi-permanent water bodies.

With the exception of Limacidae specimens, all the malacological families were previously reported in other localities at 60 km to the SE of Tianguistengo. Alluvial sequences from Tianguistengo area could be correlated with another reported deposits from MIS3 period. It can be possible that during interglacial periods the distribution areas of terrestrial mollusks were more extensive than nowadays, because of the levels of humidity and presence of extensive water bodies, resulting in diverse vegetation types.

CORALLINE ALGAE AND BENTHIC FORAMINIFERA FROM THE EARLY MIOCENE GHARAMUL FORMATION OF THE GULF OF SUEZ REGION, EGYPT: SYSTEMATICS AND PALAEOENVIRONMENTAL IMPLICATIONS

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Keywords*: coralline algae, Gharamul Formation, Miocene, Gabal Abu Shaar El Qabili, Gulf of Suez, Egypt.*

The Early Miocene Gharamul Formation exposed in Gabal Abu Shaar El Qabili plateau, western side of the Gulf of Suez region, contains rich assemblages of coralline algae and benthic foraminifera with moderate abundance of corals, gastropods, echinoderms, molluscs, bryozoans and barnacles. The systematic and taxonomic investigations carried out on the collected samples led to the recognition of seventeen coralline algal species belonging mainly to Rhodophyta (Corallinaceae). Seventeen non-geniculate coralline algal species (mainly belonging to subfamilies Mastophoroideae, Lithophylloideae and Melobesioideae) are recognized. The geniculated coralline algae are relatively scarce and represented by a single genus *Corallina* sp. The Mastophoroids (*Neogoniolithon* and *Spongites*) and Lithophylloids (*Lithophyllum*) are the most abundant coralline algal species and dominate the shallower coralline algal assemblages. On the other hand, Melobesioids (*Mesophyllum* and *Lithothamnion*) and sporolithales (*Sporolithon*) are characteristic of deeper-water assemblages. Rhodoliths, loose-branching and foliose coralline algae were the main sediment producers together with larger foraminifers.

The fossil benthic communities are indicative of a meso-oligotrophic regime. Dominance of coralline algae and benthic foraminifera indicates deposition in the upper photic zone to the upper part of the lower photic zone. Lower-energy facies (argillaceous foraminiferal wackestones) alternate with higher-energy deposits (grainstones, packstones and rudstones) suggesting the influence of cyclones/storms during the depositional period.

ON THE TAXONOMIC STATUS OF *NEURYURUS RUDIS* (GERVAIS) (XENARTHRA, GLYPTODONTIDAE) AND SOME CONSIDERATIONS ABOUT ONTOGENETIC CHANGES IN GLYPTODONTIDAE

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Keywords: *vertebrate paleontology, Xenarthra, taxonomy, glyptodonts.*

Diversity reached by Pleistocene glyptodonts in Southern South America was probably lower than previously believed, as recent evidence suggested. In relation to it, one of the intriguing aspects of the group has been the supposed absence of juvenile specimens in the fossiliferous record. However, the increase of knowledge about the morphologic ontogenetic variations of glyptodonts had shown that several of the recognized Pliocene and Quaternary taxa actually belong to juvenile specimens. We present evidence supporting that the type specimen (MHNN n/n) of the enigmatic *Neuryurus rudis* Gervais, integrating the biozone of the Ensenadan Age/Stage (early-middle Pleistocene), belongs to a juvenile specimen of *Panochthus* sp. The osteoderms of the carapace present an exposed surface consisting of a finely spongy tissue with small foramina and absence of defined figures, while the internal surface shows wide neurovascular foramina (~2mm) and the articular areas are poorly developed, characteristics observed in juvenile specimens of some Glyptodontidae. The caudal tube, conformed by contiguous osteoderms and similar to those of the carapace, also presents the typical design of lateral, dorsal and marginal figures of species of *Panochthus* Burmeister. These observations indicate that *Neuryurus rudis* correspond to a different ontogenetic stage of this taxon; in addition, the progressive transformation of this caudal tube into a rigid structure could represent a more derived evolutionary pattern of some Glyptodontidae. From the stratigraphic viewpoint, our field observations indicate that type material of this species (from the surroundings of Carcarañá, Santa Fe province) comes from the Tezanos Pinto Formation (late Pleistocene).

A REVISED (EARLY ARIKAREEAN) AGE FOR THE LATE PALEOGENE INIYOO LOCAL FAUNA OF OAXACA STATE, SOUTHERN MEXICO

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***Keywords**: Oligocene, Arikareean, mammals, Oaxaca, Yolomécatl.*

Paleontological research on the fossil-bearing beds at Yolomécatl (Iniyoo in Mixtec language), resulted in the recovery of additional mammal specimens. They were recently compared with those representing taxa associated with higher-latitude assemblages of the USA. The latter specimens were housed in the American Museum of Natural History, the Natural History Museum of Los Angeles County, and the Florida Museum of Natural History. The Iniyoo Local Fauna (LF), originally regarded as Chadronian or late Eocene in age, is now considered to be of early Arikareean (Ar1) or late early Oligocene age. Arikareean index taxa found in the Iniyoo LF and shared with assemblages from the USA include the canid *Cormocyon* and the dominantly early Arikareean oreodont *Oreodontoides oregonensis*. Taxa with Arikareean first appearance datums (FADs) consist of the lagomorph *Archaeolagus*, *Gregorymys*, Jimomyidae, *Mammacyon*, and "Nothokematinae" camels. Taxa with Arikareean last appearance datums (LADs) comprise *Perchoerus probus*, *Leptochoerus*, *Nanotragulus*, and *Subhyracodon*. The absolute age of the Iniyoo LF, 28–29 Ma, is constrained by the amphicyonid *Mammacyon* FAD and the LADs for the tayassuid *Perchoerus probus* and *Subhyracodon*. That absolute age is supported by a U-Pb zircon maximum depositional age determination of 30.6 Ma for a sandstone bed that overlies the fossiliferous beds. The Iniyoo LF is the southernmost land mammal assemblage of early Arikareean (early Oligocene) age in North America and the first of that age from Mexico. It can be correlated on faunal grounds with LFs of similar age from the central Great Plains and north-central Oregon in the USA.

ANALYSIS OF THE EFFECTS OF CLIMATE CHANGE ON THE CURRENT AND HISTORICAL DISTRIBUTION AREA OF *MICROTUS CABRERAE* (RODENTIA; CRICETIDAE) AND RELATED SPECIES

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Keywords: Microtus cabrerae, *micromammals, Climate Change, Mediterranean climate, anthropic effects*.

The ongoing climate change has a profound effect on global biodiversity. It is known that some species, especially small mammals, were strongly affected by environmental changes taken place in the past. In this study we focused mainly on the Cabrera´s vole (*Microtus cabrerae*) since this species presents unique ecological and regressive populational trends. Also, Cabrera´s vole is a Mediterranean species endemic to the Iberian Peninsula, where lies the primary focus of our study. The ecological traits of the Cabrera´s vole and other species of micro-mammals that share a similar climatic niche were analysed in order to identify climatic factors that affected their distribution areas, as well as the anthropic factors that were playing a role in the past. To achieve that, the climatic development of the distribution area from the Last Interglacial Period to present was predicted and described. In addition, the influence of anthropic factors in the distribution area was studied by comparing the obtained climatic potential distribution areas with others derived from species occurrences in archaeological sites. This comparison allowed for discrimination between climatic and anthropic factors, as well as to assess how they individually affected the analysed species during different periods of time. Our results show that both, climatic and anthropic factors had a significative influence. However, anthropic factors predominantly explained population trends from the Holocene onwards. Furthermore, this study allows us to infer the probable effects of climate change on Mediterranean species and perform well-grounded conservation and reintroduction actions.

REMAINS OF A LARGE FLIGHTLESS BIRD FROM KERASSIA (NORTHERN EUBOEA, GREECE)

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***Keywords*:** Struthio, *Late Miocene, Kerassia, Greece.*

The presence of ostriches in the fossil record of Greece has been known since the 19th century. During the Late Miocene of Greece the genus *Struthio* (Aves, Struthioniformes) was represented by *S. karatheodoris*, which was initially described from Samos Island. Over the last few decades, remains of *S. karatheodoris* have been identified from many other localities in Greece and in the broader Greco-Iranian zoogeographical province.

The material studied consists of twelve cervical vertebrae from the Late Miocene localities Kerassia-1 and Kerassia-4 in Greece. The specimens were compared to cervical vertebrae of the extant *S. camelus*, as they are similar both in size and morphology. Comparisons with other Late Miocene large flightless birds were not possible because no cervical vertebrae have been discovered so far for these species. Other Miocene flightless birds such as *Urmiornis* and *Amphipelargus*, which are known from various skeletal elements, are considerably smaller than *Struthio*.

On the basis of size and proportions, the material most likely belongs to *S. karatheodoris*. However, a direct comparison is not possible and is therefore referred to as *Struthio* sp. This is the first report of *Struthio* sp. from the Late Miocene of Kerassia. These fossils are also the first cervical vertebrae from the Late Miocene that can be attributed to *Struthio*, providing further insight into aspects of its anatomy.

The excavations that took place in Kerassia from 1992 to 2015, under the supervision of G. Theodorou, were funded by the NKUA-SARG 70/4/1394, 70/3/2842, 70/3/3922, 70/3/8567 and 70/3/12301.

THE PETROSAL BONE MORPHOLOGY OF *HIPPOPOTAMUS CREUTZBURGI*, WITH THE USE OF CT

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Keywords: *petrosal, CT,* Hippopotamus creutzburgi, *Crete*.

CT scanning has proven to be a helpful tool for identifying micro-structures. The overall structure of the petrosal bone is difficult to be studied, yet computed tomographic methods allow the digital representation of the internal structures, providing also a close up of the external morphology. The petrosal bone and its inner components represent the sensory systems of balance and hearing. This study focuses on the petrosal bone of the extinct endemic *Hippopotamus creutzburgi*; material excavated from Pleistocene localities of Katharo plateau, located at the eastern part of the island of Crete (Greece).

Eight petrosal bones of *H. creutzburgi* were CT scanned revealing internal structures such as the cochlea and parts of the labyrinth. Measurements on these structures (linear and angular) could highlight certain abilities concerning locomotive behaviour and auditory perception. The results yielded and observations on the material were juxtaposed with previous studies performed on the two extant species of hippopotamuses As the structures described here vary between species in terms of size and shape, this comparison contributes to the phylogenetic analyses that has persistent doubts about the place of *H. creutzburgi* within the Hippopotamidae. This species petrosal bone has never been properly described before; therefore mapping its structures is the basis of a research that will lead to a full description of the species inner ear components.

FIRST VIRTUAL ENDOCAST OF A FOSSIL RABBIT: *MEGALAGUS TURGIDUS* (LAGOMORPHA, MAMMALIA) AND BRAIN EVOLUTION IN EUARCHONTOGLIRANS

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Keywords: *brain evolution*, *neocortex*, *paraflocculi*, *Oligocene*, *Nebraska*.

Euarchontoglires is a clade of mammals that is composed of primates, scandentians, dermopterans, rodents, lagomorphs, and their fossil relatives. There is a growing literature centred on the study of brain evolution in the early members of this group, primarily focusing on plesiadapiforms, early primates, and early rodents (e.g., Ischyromyidae). Whereas no fossil cranial remains have been recovered for scandentians and dermopterans, there is a good record of skulls for fossil lagomorphs. Here we present the first brain endocast of a fossil rabbit, *Megalagus turgidus*, from Grime's Ranch in the Brule Formation (early Oligocene of Nebraska, USA). Recent analyses have placed *Megalagus* in stem Lagomorpha, which makes this taxon particularly relevant for reconstructing the form of the ancestral euarchontogliran brain. The cranium of *Megalagus* was micro-CT scanned and an endocast was generated using Avizo software. The virtual endocast volume is 7.1 cm^3 and the encephalization quotient is 0.39 using Eisenberg's equation, and 0.31 using Jerison's equation (based on a body mass estimate of 2.3kg using the width of the occipital condyles). The olfactory bulbs represent 4.0% of the total endocast volume, whereas the petrosal lobules make up 2.3% of the total volume. The neocortical ratio is 19%. These parameters show that *Megalagus* had a primitive brain relative to living euarchontoglirans (e.g., low neocortical ratio), resembling that of ischyromyids or plesiadapiforms. However, the external cranial morphology is derived, with *Megalagus* displaying typical lagomorph traits (e.g., fenestrated maxilla, short hard palate). This suggests that the external and internal cranial morphology evolved at different rates.

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THE LAST WHALE OF THE MESSINIAN. FIRST RECORD OF A MYSTICETE CETACEAN FROM THE MEDITERRANEAN MESSINIAN SALINITY CRISIS

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***Keywords**: Mysticeti, Messinian Salinity Crisis, Terminal Carbonate Complex, Mallorca, Western Mediterranean.*

In this communication, we report about the discovery of a mysticete cetacean neurocranium, probably belonging to the family Balaenopteridae, located inside a block of oolitic limestone, corresponding to the Terminal Carbonate Complex (TCC) of the of Mallorca (Balearic Islands, Western Mediterranean). This unit is directly related to the Messinian Salinity Crisis (MSC) that occurred in the Mediterranean at the end of the Miocene, 5.97-5.33 Ma ago. It is generally assumed that, as a consequence of extreme environmental conditions during the MSC, the great cetaceans went temporarily extinct from the Mediterranean, until the restoration of normal marine conditions at the beginning of the Pliocene. Therefore, the importance of the present finding lies mainly in that it is the only record so far of a fossil whale from Mediterranean deposits of the MSC. The record of the MSC in the Balearic Islands is consistent with the models that propose two evaporitic episodes (the so-called "two-step MSC scenario"). During the first episode (5.97-5.77 Ma) only a minor forced sea-level drawdown would have occurred. The second evaporitic episode (5.60-5.33 Ma) would correspond to the main sea-level drawdown which would have provoked the basin desiccation, resulting in the deposition of abyssal evaporites and the erosion (MES) of the marginal deposits. Between these evaporitic episodes, a brief event of restoration of the pre-MSC sea-level would have occurred (5.77-5.60 Ma), likely provoked the last deposition of carbonates ((TCC) in the marginal zones, thus possibly allowing the sporadic entrance of cetaceans in the Mediterranean Basin.

COMPARING PIGMENTED ENAMEL IN MAMMALS: FOSSIL AND EXTANT SHREWS AND RODENTS

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***Keywords**: iron, biomineral, Soricidae, Rodentia, microstructure.*

Several vertebrates have teeth with pigmented enamel due to the presence of iron compounds. Among mammals, there are species from different orders with this characteristic. In the present study we have analysed and compared the enamel of the incisors of extinct big sized soricids from the Early Pleistocene (*Dolinasorex glyphodon* and *Beremendia fissidens*) as well as some extant soricids (*Crocidura russula* and *Sorex coronatus*) and rodents (*Terricola*). All the soricids species included in this study have red enamel -except one of them without pigmentation-, while rodents display orange pigmentation in their incisors. We obtained sections of the incisors of both groups in different orientations and took compositional images of them with scanning electron microscopy (SEM) to make sketches of the structure. Finally we performed energy-dispersive analyses (EDS) to see the distribution of Fe. We observed that the enamel structure is similar among the shrews, including living and fossil species and independently whether they have coloured enamel or not. However, this structure found in shrews is different from that of rodents. The Fe proportions, respect to Fe+Ca+P, are higher in the enamel of the biggest and darkest pigmented shrews and lower in rodents. The distribution of Fe is similar in the two big -fossil- soricids, with the highest proportions in the outermost layer. In the smaller -extant- shrews, the highest proportions of Fe are found in an inner layer. In rodents, Fe is also in the outermost layer and disappears from the pigmented part towards the root (in the region of the enamel in formation), where there are holes in the same position. It is also interesting that in the larger shrews the big size of the enamel prisms allowed seeing that the Fe compounds are accumulated in the interprismatic matrix and not in the prisms.

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NEW MEGAFAUNA FOSSIL REMAINS FROM THE URUGUAYAN CONTINENTAL SHELF

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***Keywords**: megafauna, Pleistocene, Last Glacial Maximum, submerged fossils.*

The Quaternary is characterized by a succession of glacial-interglacial cycles. During glacial times, as water is locked in ice sheets, sea levels significantly dropped and large parts of continental platforms were above sea level. On the eastern side of South America, those now submerged lands must have housed members of the Pleistocene megafauna such as glyptodonts, ground sloths, sabre-toothed tigers, and mastodonts, among other., as their remains are washed on the shores and commonly found on the beaches of Uruguay and southern Brazil. Remains from sloths and proboscideans have also been collected underwater, in the territorial seas of Uruguay and Argentina. Here we present new records of megafaunal fossils from the continental shelf of Uruguay, namely a nearly complete skull of *Doedicurus* and a tibia of *Lestodon*, collected during fishing activities 7 nautical miles away from the present coastline. Both specimens show signs of having been exposed on the marine floor, with multiple crustacean and mollusc shells on their surface. However, they show little signs of pre-burial transport. They are tentatively assigned to the Lujanian South American Land Mammal Age, probably associated with the Last Glacial Maximum. These findings represent new information regarding potentially submerged fossil-bearing outcrops, as well as the fauna that inhabited these lands and their habitat. The study of submerged fossils could enhance our understanding of the mobility patterns of Pleistocene megamammals during periods of changing climate. This highlights the biogeographical importance of these emerged lands in relation to the ecology of the Pleistocene megafauna.

CRETACEOUS AND MIOCENE HARVESTMEN (ARACHNIDA: OPILIONES) FROM SPAIN AND A REVIEW OF THE FOSSIL RECORD OF THE GROUP

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Keywords: *Arachnida, compression fossils, Early Cretaceous, Early Miocene, Spain.*

Fossil harvestmen (Archnida: Opiliones) are scarce in the fossil record, thus the description of the first fossil representatives from two Konservat-Lagerstätten in Spain is of relevance for enhancing our knowledge of the group.

A Cretaceous (Barremian) specimen comes from the Las Hoyas outcrop (Province of Cuenca); it is preserved in finely laminated limestones, but without detailed anatomical features and, thus, considered a Harvestmen of indeterminate suborder. A specimen from the lacustrine oil-shales of the Rubielos de Mora outcrop (Province of Teruel), Miocene (Burdigalian) in age, is finely preserved and belongs to the Recent genus *Cosmobunus* (Sclerosomatidae). It will be described as new species, based on its unique set of cuticle sculpturing within the genus.

A review of harvestmen fossil record reveals their scarcity and low diversity, 42 species from 15 localities, different from many other arthropod orders. It is remarkable that the group is especially preserved in Cenozoic (Paleogene) amber, mainly from the Baltic region and Bitterfeld. The oldest fossil harvestmen come from the Devonian, the youngest from the Neogene. It has been estimated that the harvestmen suborders originated during the Carboniferous, but Cyphophthalmi and Laniatores lack Carboniferous fossils (Cretaceous). The scarce fossil record of harvestmen is probably due to their terrestrial lifestyle, their low sclerotization and tendency to disarticulation.

A NEW SKULL OF *DECENNATHERIUM REX* RÍOS, SÁNCHEZ & MORALES, 2017 FROM BATALLONES-4 (UPPER VALLESIAN, MN10, MADRID, SPAIN)

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Keywords: *Giraffidae, Artiodactyla, Ruminantia, Miocene, Cerro de los Batallones.*

Giraffids are pecoran ruminants with bi-lobed canines and a special type of cranial appendage called ossicones, which are epiphyseal in origin and don't fuse completely to the skull until later in life. Although the family Giraffidae has only two extant living African genera, in the past this family was much more diverse and widespread. Today we can recognize more than 40 fossil species, from multiple sites in Eurasia and Africa, which range from the early Miocene (20Ma) until today. Here we describe the exceptionally well preserved remains of the giraffid found in the late Miocene deposits of Batallones-4 (upper Vallesian, MN10, Torrejón de Velasco, Madrid, Spain). Batallones-4 is part of the Cerro de los Batallones fossil site complex and although it was excavated during the year 2000 there is no published results. The specimen from Batallones-4 has been identified as an old male of *Decennatherium rex* first identified from Batallones-10 as they share key morphological cranial similarities. This new skull helps us to better understand this species cranial anatomy, as well as its morphological development and variability.

THE EARLY PLEISTOCENE ECTOTHERMIC VERTEBRATES OF PIETRAFITTA (ITALY), WITH THE LAST OCCURRENCE OF *LATONIA* IN EUROPE

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***Keywords**: herpetofauna, ichthyofauna, Pleistocene, Italy, Latonia.*

The early Pleistocene (Late Villafranchian Land Mammal Age, Farneta Faunal Unit) site of Pietrafitta yielded a very rich vertebrate assemblage, now kept in the local Paleontological Museum 'Luigi Boldrini'. Geological and palynological data show that during the early Pleistocene, the area was characterized by a lacustrine environment surrounded by a humid deciduous broadleaved forest. The collection consists of at least 40 vertebrate taxa (bony fishes, amphibians, reptiles, birds, and mammals). The approx. 100 ichthyofaunal remains from Pietrafitta are attributed to the genera *Tinca*, *Scardinius*, *Barbus* and aff. *Leuciscus*. Moreover, 185 herpetofaunistic remains were recovered, including two anuran and four reptile species. The anuran collection comprises 80 bones belonging to the large-sized alytid frog *Latonia ragei* and about 50 remains belonging to the "green frog" *Pelophylax*. Three precloacal vertebrae of snakes were recognized, the largest and most complete of which is here referred to the genus *Vipera* (cf. gr. "Oriental vipers") while the others to Colubrinae indet. More than 20 specimens, including some complete carapaces and plastra, are attributed to the European pond turtle (*Emys orbicularis*). The remains of *Latonia* from Pietrafitta represent the last European occurrence of this genus, which was previously thought to have disappeared from the continent at the end of the Miocene. Moreover, the presence of an "Oriental viper" in the Pleistocene of Italy is one of the last occurrences of this group in continental Europe. These remains confirm the hypothesis that during the early Pleistocene, Italy acted as a "refuge" for a number of "warm-climate adapted" vertebrates, which survived the Plio-Pleistocene climatic cooling trend.

GROUND SLOTH VERTEBRA IDENTIFICATION THROUGH MULTIVARIATE ANALYSIS

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***Keywords**: Xenarthra, sloths, axial skeleton, Pleistocene, discriminant analysis.*

Extinct sloths (Xenarthra, Folivora) present a wide morphological diversity, although some genera, particularly from the Pleistocene, are morphologically similar to one another. When cranial and/or some diagnostic post-cranial elements (e.g., humerus, femur, or astragalus) are missing, assigning isolated bones to a taxa might prove difficult. This is the case for the axial skeleton and especially vertebrae. Properly assigning vertebral remains becomes important when these are the only elements found or when genera of a same subfamily or genus are found together. Here, 25 linear and angular measurements of presacral axial skeletons from 6 genera of Late Pleistocene ground sloths are analysed through multivariate methods to classify the vertebrae of those taxa, as well as identify the position of each vertebra along the vertebral column. Mostly complete presacral column of each genus were included, along with isolated elements, for a total of 198 vertebrae. Principal components and discriminant analyses show a very high percentage (over 90%) of correct taxonomic reclassification, even when the whole column is used for the comparison. For the position of vertebrae, the accuracy of the analyses is lower when the whole vertebral column is considered. However, when the analysis is carried out for each region of the presacral column (cervical, thoracic and lumbar) the accuracy improves significantly, misclassifying the position of the vertebrae by few places in most cases. Therefore, the database generated here is useful for assigning isolated vertebrae of extinct sloths to a specific genus and position with a high level of confidence.

DISTRIBUTION AND MORPHOMETRY OF MOLARS OF LATE PLEISTOCENE *MAMMUTHUS COLUMBI* (MAMMALIA PROBOSCIDEA ELEPHANTIDAE) FROM THE STATES OF PUEBLA AND MORELOS, CENTRAL REGION OF MÉXICO.

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Keywords: *megafauna, mammoths, paleobiogeography, systematic, morphometry.*

Mammmuthus columbi, an endemic, Late Pleistocene, North American mammoth is relatively abundant across its' broad range, extending throughout much of North America from Canada to Mexico. In Mexico, there remain many records identified to genus but not species. In 2001, I described the morphological, taxonomic and stratigraphic basis for *M. columbi* and *Mastodon americanum* in Mexico. These results, along with five new specimens, are reviewed in this paper. Simple and Multivariate correlation were used as methods of analysis.

M. columbi, was adapted to different environments by decreasing the number of plates and the increasing the thickness of the enamel (Saunders, 1970, 1999; Shoshani, 1976, 1998; Agenbroad, 1994; Lister and Bahn, 2007) So the unit sustained matriarchal –condition of evolutionary behavior- inferred by the association of deciduous molars -milk teeth- and, compared with the individual age of African Elephants. Behavior and morphological processes referring to Evolutionary History and Paleo Biogeography -alternative to the genetic and molecular evolution- of the ancestral population of *M. columbi* extinct at the end of the Pleistocene (11 000 years before present) and, there are radiocarbon dates (8270 y b p. *Ibidem,* 1970). Sedimentological, palynological, and radiometric analyses will potentially yield new insights into regional climate change and the regional paleoecology of this species.

PALEOENVIRONMENTAL AND BIOSTRATIGRAPHICAL ASPECTS OF MARINE MIDDLE MIOCENE FORAMINIFERA FROM THE SOUTH OF THE VALENCIA PROVINCE (EASTERN SPAIN)

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***Keywords**: Foraminifera, Miocene, biostratigraphy, paleoenvironment, Valencia.*

The main goal of this work is to complete the study of the marine Miocene foraminifera from the south of the Valencia province. The studied materials were sampled along the road between Ontinyent and La Font de la Figuera (coordinates: 38° 48' 59" N and 0° 40' 08" W). They consist of compact whitish marls, locally known as Miocene "Tap marls".

Samples were washed on 400, 125 and 63 μm mesh-sieves and dried with the aid of hot lamps. At least 300 foraminifera tests per sample were picked from the >125 μm fraction under a stereoscopic microscope, taxonomically determined, counted and fixed on micropaleontological slides.

A total of 11 species of planktonic foraminifera were identified. In particular, the occurrences of the biostratigraphic markers *Globorotalia praemenardii* Cushman & Stainforth and *Paragloborotalia mayeri* (Cushman & Ellisor) indicate a Serravallian age for the studied outcrops.

The benthic foraminifera are abundant and many belong to the order Lagenida, including some relatively large-sized (>1 mm long) specimens of *Lenticulina*, *Dentalina* or *Stillostomella*. Calcareous agglutinated foraminifera (e.g. *Textularia* spp.) are also frequent. Up to 58 different species have been identified in the highly diverse assemblages, which in addition to the aforementioned include the genera *Nodosaria*, *Planularia*, *Cibicides*, *Bulimina*, *Uvigerina*, *Gyroidina*, etc. Numerous sponge spicules and less common diatoms and radiolaria have also been noted. This suggests a relatively well-oxygenated (~0.3-1.5 ml/l O_2) outer shelf environment, rich in nutrients – with temperate waters (~13-20 °C), as deduced from the ocurrence of *G. praemenardii* and *Globoquadrina dehiscens* Chapman, Parr & Collins – and probably subject to occasional upwelling episodes.

CONTRIBUTIONS TO THE STUDY OF FORAMINIFERAL ASSEMBLAGES AND THE CHANGES OF THE MARINE DYNAMICS DURING THE HOLOCENE IN EL PLA DE BARCELONA

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Keywords: *Foraminifera, Holocene, Barcelona, coastal dynamics.*

The main goal of this work is to increase the knowledge of environmental changes in the littoral area of Catalonia during the Holocene post-glacial context and, basing on the variation of the foraminiferal assemblages, to identify episodes of sea level maxima. Two continental cores, S-2 and S-3, which respectively reached 36 and 40 m depth, were drilled with a rotation-coring device in the locality of Sant Adrià de Besòs (El Barcelonès), very close to Barcelona. We present here the results of the micropaleontological analysis of 10 samples from core S-2 and 13 samples from core S-3.

Samples were washed with hot water on a 63 µm-mesh sieve and dried under hot lamps. Foraminifera tests were then picked under a stereoscopic microscope, classified, counted and fixed on micropaleontogical slides.

In addition, three radiocarbon ^{14}C dates were determined in core S-2 and two in core S-3, which yielded the following results: Core S-2: 6399–6286 cal BP at 26.70 m depth, 3260–3110 cal BP at 20 m, and 1185–1055 cal BP at 17.57 m; Core S-3: 6945–6760 cal BP at 26.80 m depth and 3157–2958 cal BP at 23.92 m. All obtained ages correspond to the middle and late Holocene. Cores S-2 and S-3 can be partially correlated at 27-26 m depth by the radiocarbon dates and by littoral foraminiferal assemblages at 26-25 m (25.30 m in core S-2 and 25.65-25.50 m in core S-3).

In general, foraminifera are very scarce in both cores. Most samples were barren or yielded <20 specimens belonging to littoral species (e.g. *Ammonia* spp.). Some levels show more abundant foraminiferal assemblages with up to 36 benthic species, with a strong presence of miliolids (~40-50%) and occasional planktonic tests. This assemblage is very similar to those found in the present day coasts of Catalonia and Mallorca. The occurrence of abundant miliolids such as *Siphonaperta aspera* (d'Orbigny), *Siphonaperta quadrata* (Norvang) or *Triloculina trigonula* (Lamarck) and rotaliids like *Ammonia punctatogranosa* (Seguenza), *Elphidium crispum* (Linné), *Elphidium advenum* (Cushman) and *Cibicidoides lobatulus* (Walker & Jacob), together with the lack of typical marsh species or organic agglutinated foraminifera, suggests a littoral environment with temperate well-oxygenated waters, not far from a sea-grass meadow and subject to some degree of horizontal transport.

FORTY YEARS AFTER HENDEY'S MUSTELIDS FROM LANGEBAANWEG (SOUTH AFRICA, EARLY PLIOCENE): STATE OF THE ART

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Keywords: *Mustelidae, Miocene, Pliocene,* Mellivora, Plesiogulo, Sivaonyx.

Langebaanweg (LBW) is a paleontological site from the early Pliocene (5.2 Ma) located on the southwestern coast of South Africa. It has yielded one of the largest Mio-Pliocene collections of vertebrates from Africa, including at least 19 carnivoran taxa. Hendey during the 1970´s, described remains of the mustelids *Mellivora benfieldi*, a close relative of the living honey badger; the giant wolverine *Plesiogulo monspessulanus*, and the bunodont otter *Sivaonyx hendeyi* (previously *Enhydriodon africanus*). The current study reanalyses the classic material and the new dentognathic and postcranial remains of these mustelids to better understand their taxonomy, and palaeobiology. Hendey described remains of 3 large individuals of *Plesiogulo*, including crania and abundant postcrania. Among the new remains of *Plesiogulo* are 2 edentulous maxillae, and postcranial remains (fragmentary humerus, radius and ulna), which probably belong to a fourth individual. So far there is no M1 and better-preserved P4, to comparison with the other African *P. botori*, therefore we preliminary refer this sample to *Plesiogulo* aff. *monspessulanus*. We also report some new teeth of *S. hendeyi* and new fragmentary postcrania, which adds significant information to the hypodigm of this taxon. This otter is smaller than the Late Miocene Chadian *S. beyi*, but remarkably larger to the living *Aonyx capensis*. Additionally, we present abundant fossils of *M. benfieldi*, including several hemimandibles, the unknown upper dentition (C and P3) aside from an incompletes forelimb and femur. Those fossils suggest semifossorial abilities, as retains its living relative.

SEXUAL DIMORPHISM IN THE EXTINCT GROUND SLOTH *LESTODON ARMATUS* (MAMMALIA: XENARTHRA)

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Keywords: *Xenarthra, Folivora,* Lestodon*, Sexual dimorphism, Late Pleistocene*.

Mylodontidae (Folivora, Xenarthra) is a family of ground sloths widely distributed in the South American fossil record, with members also present in Central and North America. Within the Mylodontidae, *Lestodon armatus* is the largest species, with an estimated body mass of more than three tonnes. This work focuses on the enlarged lower caniniform of *L. armatus* as possibly exaggerated sexually dimorphic structure, as previously suggested for North American *Paramylodon*. Lower caniniforms of this taxon from the late Pleistocene of Argentina, Uruguay, and Bolivia were studied using specimens from seven paleontological collections. Morphometric analyses were performed in order to study the possible sexual dimorphism in the caniniforms and its implications regarding the existence of sexual selection. The results support the existence of sexual dimorphism in *Lestodon armatus*. Dimorphism in the size of the lower caniniform was observed in most fossil collections and was statistically significant even in the smaller sample from Arroyo del Vizcaíno, a paleontological site with a narrowly defined age and geographical extent. Sexual dimorphism in a large mammal suggests the existence of sexual selection, via competition between males or female mate choice, resulting in the evolution of the dimorphic structure. By extension, in *L. armatus*, the enlarged caniniforms would be indicative of males and could have functioned as armaments in intraspecific fights or ornaments for sexual display. Based on observations in extant mammal species, a polygynous mating system is proposed as highly probable in *L. armatus*, although the existence or composition of social groups cannot be certainly determined.

A PECULIAR SPECIMEN OF *PANOCHTHUS* (XENARTHRA, GLYPTODONTIDAE) FROM BOLIVIAN ALTIPLANO

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Keywords: Panochthus, *Pleistocene, glyptodonts, Bolivia.*

Panochthus Burmeister is one of the most diversified and widely distributed glyptodonts in the Pleistocene of South America, reaching the Chaco-Pampean and intertropical regions up to more than 4000 m in high elevation areas. Six species (*P. intermedius* Lydekker, *P. subintermedius* Castellanos, *P. tuberculatus* (Owen), *P. frenzelianus* Ameghino, *P. greslebini* Castellanos, and *P. jaguaribensis* Moreira) are currently recognized. In Bolivia, a new species was recently described (*P. hipsilis* Zurita, Zamorano, Scillato-Yané, Fidel, Iriondo and Gillette), in addition to an occurrence of *P. intermedius*, both coming from the center-south region. Here we report a dorsal carapace (UATF-V s/n) from the Pleistocene of the surroundings of Potosí, Bolivia, showing a peculiar combinations of features: **a)** the total length is similar to *P. hipsilis*; **b)** its maximum dorso-ventral diameter is at the level of the anterior half; **c)** the dorsal profile is different from the remaining species in which this structure is known (*P. intermedius, P. frenzelianus, P. subintermedius, P. tuberculatus*); **d)** the ornamentation pattern of the osteoderms shows a central figure surrounded by small polygonal figures throughout the carapace, in contrast to the remaining species, in which central figures are only present in the caudal/cephalic and most lateral regions of the carapace. The specimen here described could belong to *P. jaguaribensis* in which the carapace is not known; alternatively, it could correspond to a new species or shows that the intraspecifc variation in *Panochthus* is not sufficiently studied. In any case, further studies and findings are necessary to confirm or refute these hypotheses.

EXCEPTIONAL PRESERVATION OF TRACHEAL RINGS IN A FOSSIL MAMMAL: THE CASE OF *PANOCHTHUS* SP. (XENARTHRA, GLYPTODONTIDAE)

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Keywords:*"tracheal rings",* Panochthus*, late Pleistocene, glyptodonts*.

In mammals, the trachea is a relatively non-collapsible tube that extends from the cricoid cartilage of the larynx to its bifurcation, where the bronchial tree begins. The skeleton of the trachea is formed by C-shaped hyaline tracheal cartilages ("tracheal rings") that form a tube that connects the larynx with the bronchial tree, providing air flow to and from the lungs for respiration. In this contribution, we describe the presence of "tracheal rings" in a glyptodont (Cingulata), an extremely rare occurrence in a fossil mammal. The exceptional preservation of specimen MHM-P87, assigned to *Panochthus* sp. (Glyptodontidae), allowed us to identify elements of the hyoid apparatus, fragments of the cricoid cartilage, and several tracheal rings. The specimen also includes mandible, postcranial bones, and the dorsal carapace, and was found in the margin of the Salado River (General Belgrano, Buenos Aires Province, Argentina; 35° 45' 5.52" S-58° 37' 35.96" W) in sediments of the Luján Formation dated between ca. 14 and 12 ky BP (late Pleistocene). Twenty-three fragments of tracheal rings were found, and most of them (16/23) correspond to lateral segments that vary from 19 to 54 mm in length and 6 to 8 mm in width. Some of the fragments correspond to ventral portions of rings, and some of them (the largest) could correspond to the cricoid cartilage. We reconstructe more than one tracheal ring and compared it with tracheal rings of common domestic animals (e.g., dog, horse, sheep); the specimens are transversely ovoid in shape and very similar to those of the horse in general aspect. Although there are no studies on this structure, with future analyses we could obtain information about paleobiological implications of this structure in glyptodonts.

Ist Palaeontological Virtual Congress

Advances on conodont biostratigraphy

Moderators:
Pilar Navas-Parejo
Estación Regional del Noroeste, Instituto de Geología, Universidad Nacional Autónoma de México (Mexico)
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CONODONT DIVERSITY FROM THE SILURIAN/DEVONIAN BOUNDARY INTERVAL FROM THE PRAHA-RADOTÍN SECTION

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***Keywords**: Praha-Radotín, conodont biostratigraphy, Spathognathodontidae, Icriodontidae.*

The Praha-Radotín section lies in the south-east part of the Prague Synform (Czech Republic), and encompassing a carbonate succession through the Silurian/Devonian boundary interval. The uppermost Přídolí is characterized by dark grey thinly bedded limestones with shale intercalations, while the lowermost Devonian is represented by coarse-grained limestones (the "*Scyphocrinites* Horizon") alternating with graptolite shales. Various faunal groups occur commonly: graptolites, cephalopods, eurypterids, ostracodes, acritarchs and bivalves. Here we provide the first data on conodont diversity and biostratigraphy from the section. In total 13 samples were taken; the abundance of recovered conodonts is relatively high: several thousands of elements belong mainly to the families Spathognathodontidae and Icriodontidae. Spathognathodontids dominate most of the samples, but more remarkable is a huge radiation of icriodontids, which can be observed in the lowermost Devonian. In addition to several known taxa of *Icriodus* and *Pedavis*, we identify many different morphotypes of these two genera.

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1st Palaeontological Virtual Congress

Big equipment, small structures: modernised, new, and innovative techniques in fossil microanalysis

Moderators:
Bryan Shirley
Friedrich-Alexander-Universität Erlangen-Nürnberg (Germany)
Carlos Martínez-Pérez
Universitat de València (Spain)
University of Bristol (United Kingdom)

ELECTRON BACKSCATTER DIFFRACTION AND PTYCHOGRAPHIC X-RAY COMPUTED TOMOGRAPHY APPLIED TO THE PHYSICAL CHARACTERIZATION OF THE CONODONTS TISSUES

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***Keywords**: EBSD, ptychographic tomography, conodont white matter, geochemical archive.*

Conodonts are a group of marine animals with an abundant record from the late Cambrian to the latest Triassic. Their conodont elements, manifest as a feeding apparatus in the head of the animal, are composed of calcium phosphate mineral, which traditionally have been studied as archives of seawater chemistry and temperature, providing fundamental understanding of the past climates. Conodont elements are composed of two different units, a microcrystalline and organic rich basal body, and a crystalline crown composed of transparent crown tissue and the enigmatic white matter, that has been the principal tissue targeted in geochemical analyses. Interestingly, there is little agreement on the physical nature of this tissue, which has variably been interpreted as megacrystalline, microcrystalline, and non-crystalline. In this work we attempt to characterize the nature of the white matter based on physical characterization of crystal dimensions, orientation, porosity and permeability using Electron Back-Scatter Diffraction (EBSD) and Ptychographic X-ray computed tomography (PXCT). Our PXCT results show that while white matter is extremely porous, the pores are not, generally, connected. On the other hand, EBSD analyses demonstrate that white matter is comprised of a single crystal typically tens of microns in dimension. Taking into account that conodont elements grew episodically, these data suggest that white matter, which comprises the denticles of conodont elements, grew syntactically. Thus, while this tissue is a closed system and, therefore, a good potential geochemical archive, it is an archive representative of different growth stages of the conodont element and organism. These insights should inform the interpretation of geochemical data derived from conodont elements, implying that bulk samples are time averaged, but also affording an opportunity to discriminate ontogenetic shifts in the ecology of habitat of these long extinct early vertebrates.

BIOMINERAL NANOSTRUCTURES AND THEIR DIAGENESIS: INSIGHTS FROM USING ATOMIC FORCE MICROSCOPY (AFM)

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***Keywords**: biomineralization, nanogranules, pristine skeletons, diagenesis.*

Biologically controlled calcareous mineralization forms skeletons (e.g. coral skeletons and brachiopod shells) and skeletal parts (e.g. echinoderm ossicles and spines) self-assembled in several hierarchical levels, from macro- to nanoscale. Although single units of a skeleton, or skeletal parts, are in appearance formed by single crystals at microscale, exhibit a distinctive nanotexture at nanoscale level, characteristic of a mesocrystal grown via particle attachment. Crystalline nanoparticles are the building blocks of skeletons of different calcifying phyla such as molluscs, brachiopods, sponges, arthropods, echinoderms and corals. The discovery of these nanotextures in the fossil record (even in Palaeozoic skeletons) may help to identify primary biominerals in fossil remains. Atomic force microscopy (AFM), a routine technique in material science, has become essential to elucidate the nanotexture in biomineralization studies due to its versatility, spatial resolution, accuracy and working conditions both in Recent and fossil skeletons. The combination of AFM with other material science techniques such as scanning electron microscopy (SEM), cathodoluminescence (CL), electron backscatter diffraction (EBSD) and computer-integrated polarization microscopy (CIP), among others, helps to characterize and to understand the processes of biocrystallization of extinct groups, to recognize distinctive taxonomic features in fossil structures, and to assess diagenetic changes produced in fossil skeletons. This contribution reviews the state-of-the-art of AFM applied to palaeontology, preparation of $CaCO_3$ samples, height and phase images, technical tips, common errors and several cases of study (aragonite and calcite mineralogies) in cnidarians, brachiopods, molluscs and echinoderms.

GEOCHEMICAL COMPOSITION OF CONODONTS AS THE RECORD OF THEIR GROWTH DYNAMICS

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Keywords: *conodonts, growth dynamics, geochemistry, EDX.*

Conodonts are extinct jawless, eel-like vertebrates, whose remains are commonly found in marine facies from the Cambrian to the Triassic. Despite their wide use in biostratigraphy, little is known about their actual biology. Conodonts were the first vertebrates to produce mineralized skeletal tissue. Their teeth analogues, called elements, are composed of an apatite-organic composite biomineral and grew through outer periodical accretion of new growth lamellae. Our high-resolution backscattered-electron (BSE) imaging technique provides a new way to analyze conodont growth dynamics by making alternations of dark and light bands forming these growth lamellae visible. The observed growth stages are linked to distinct geochemical changes, mainly of the element strontium, which are measured with energy dispersive X-ray spectroscopy (EDX). These changes might reflect a transition in the conodont's mode of feeding and/or living. The early life stage of the conodont is characterized by a specific morphology, the lack of wear patterns and high Sr values, which leads to the interpretation as the first, larval stage. Based on the observation of following patterns of wear and repair, as well as low Sr values, a drastic change in the conodont's mode of living towards a more mature type of feeding, possibly as a predator or scavenger, is proposed.

MIDDLE TRIASSIC CONODONT APPARATUS FROM THE LUOPING BIOTA, SOUTHWEST CHINA

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***Keywords**: conodonts, synchrotron tomography, apparatus reconstruction, Middle Triassic.*

Conodonts are an extinct clade of jawless vertebrates that occur abundantly in carbonate deposits from the upper Cambrian to the uppermost Triassic. The conodont skeleton is formed by a series of phosphatised tooth-like elements situated in the oral region of the animal that have been widely used for biostratigraphic correlation, dating, inferring evolutionary patterns and palaeoenvironmental interpretation. However, as the first evidence of skeleton mineralization in jawless vertebrates, the feeding mechanisms of conodonts, reflected in the anatomy and architecture of their feeding apparatuses, have attracted considerable attention. Although several apparatus models have been reconstructed for different conodont species based on discrete elements, fused clusters, bedding plane assemblages and articulated assemblages associated with the soft-tissues of conodonts, discrepancies remain among these models. In large part, this is because even in natural assemblages (bedding plane assemblages and fused clusters) the component elements are obscured by one another and/or the surrounding matrix. In this context, we used SEM and non-destructive tomographic techniques (synchrotron radiation X-ray tomographic microscopy-SRXTM) to study the morphology, apparatus composition and architecture of the Middle Triassic conodont materials recorded from the Luoping fossil Lagerstätte in the Yunnan province, southwest China. Here we present our preliminary results combining analyses of an extraordinary fossil record of fused clusters, bedding plane assemblages and isolated elements to accurately describe the morphology, composition and architecture of the conodont apparatus. In this sense, our work confirms that the apparatus of *Nicoraella* was composed of eight types of elements, comprising a total of 15 elements. Furthermore, the SRXTM analysis and posterior 3D reconstruction of the apparatus based on several clusters suggested us to propose an accurate reconstruction of the spatial architecture of the apparatus, allowing us to test previous kinematic hypotheses. In addition, it is important to highlight that after our work the apparatus of *Nicoraella* is among the most completely characterised of all conodonts and will serve as a template for the reconstruction for other conodont apparatus, mainly during the Triassic.

THE USE OF ELECTRON BACKSCATTERED DIFFRACTION TO STUDY THE FOSSILIZATION OF TRIASSIC WOODS AND BONES FROM SOUTH BRAZIL

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Keywords: *EBSD, gymnosperm wood, Dicynodontia bone, Santa Maria Supersequence, Triassic.*

The electron backscattered diffraction (EBSD) is a technique used to characterize grain individual orientations, its correlations with the texture, as well as for the identification of different mineral phases. Therefore, the study of paleontological materials using EBSD could inform us about the formation of biominerals, fossilization, palaeoenvironment, and sedimentation. Here we study remains of Gymnosperms woods and Dicynodontia ribs from the Triassic of Rio Grande do Sul State (Santa Maria Supersequence), Brazil, for a better understanding of their fossilization process. The preservation of the wood is entirely by quartz, while bones have mainly calcite, with some secondary dolomite and quartz. The EBSD maps show that none of the fossils has any preferential grain growth. The wood shows different sizes of quartz grains through the entire sample. Probably this happened due a late permineralization, when the grains started to nucleate after the decomposition of several cells. Later, some of the silica was dissolved and reprecipitated, destroying the preserved anatomy. The bones went through a more complex process. First, $CaCO_3$ started to precipitate in the interior and as a layer around them, followed by quartz. Lastly, calcite replaced the apatite in the bones, and quartz and dolomite replaced the calcite previously precipitated. The mode and tempo of mineralization can be related with the palaeoclimate, which was probably warm and seasonal, with dry and wet seasons. In the wet season, SiO_2 and $CaCO_3$, from rock weathering, dissolved in waters, while during the dry season, due to evaporation, these waters became saturated in these minerals showing different taphonomical processes.

SYNCHROTON-BASED ANALYSES OF THE EARLIEST VERTEBRATE SKELETON: A FUNCTIONAL APPROACH

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***Keywords**: Synchrotron, conodont, functional analyses.*

Conodonts are an extinct group of jawless vertebrates, the first in our evolutionary lineage to develop biomineralized tissues. As such, conodont elements are of great significance because of the insights it provides information about the biology and function of the primitive vertebrate skeleton. Conodont function has been debated for more than a century, however, due to the lack of extant analogues their functional analyses has been traditionally restricted to analogy. In the last decades, qualitative approaches have been developed, facilitating tests of element function based on occlusal performance and analysis of microwear and microstructure. In this work, we summarise our last results of the applications of novel quantitative experimental methods including Synchrotron Radiation X-ray Tomographic Microscopy and Finite Element Analysis to test previous hypotheses of conodont function.

The development of high resolution virtual models of conodont elements, together with biomechanical approaches using Finite Element analysis, informed by occlusal and microwear analyses, provided conclusive support to test hypothesis of structural adaptation within the crown tissue microstructure, showing a close co-variation patterns between the stress distribution and the different crystallite orientations, strongly supporting a tooth-like function for many conodont species. Above all, our study establishes a framework (experimental approach) in which the functional ecology of conodonts can be read from their rich taxonomy and phylogeny, representing an important attempt to understand the role of this abundant and diverse clade in the Phanerozoic marine ecosystems.

DISTINGUISHING BETWEEN BIOLOGICALLY INDUCED AND BIOLOGICALLY CONTROLLED MINERALIZATION IN FOSSIL ORGANISMS USING ELECTRON BACKSCATTER DIFFRACTION (EBSD)

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***Keywords**: biomineralization, cyanobacteria, fossil, microproblematica, EBSD, crystallography, carbonate.*

Although carbonate-precipitating cyanobacteria are ubiquitous in aquatic ecosystems today, the criteria used to identify them in the geological record are rarely testable. Differences in the mode of biomineralization between cyanobacteria and eukaryotes, i.e. biologically induced calcification (BIM) vs. biologically controlled calcification (BCM) result in different crystallographic structures which might be used to test cyanobacterial affinities. We employed electron backscatter diffraction (EBSD) to investigate the structure of calcareous skeletons in two microproblematica widespread in Paleozoic marine ecosystems: *Rothpletzella* Wood 1945, and *Allonema* Ulrich & Bassler 1904. We used a calcareous trilobite shell as a reference.

The shell of *Allonema* has a single-layered structure of acicular crystals perpendicular to the surface of the organism. The crystals *c*-axes are parallel to the elongation and thereby normal to the surface of the organism. EBSD pole figures and misorientation axes distribution reveal a fiber texture around the *c*-axis with a small degree of variation (up to 30°), indicating a highly ordered structure. A comparable pattern was found in the trilobite shell. This structure allows excluding BIM as the mechanism of shell formation in *Allonema*. In *Rothpletzella* the *c*-axes of the microcrystalline sheath show a broader clustering compared to *Allonema*, with crystals tending to be perpendicular to the surface of the organism. The misorientation axes of adjacent crystals show an approximately random distribution. *Rothpletzella* also shares other morphological similarities with extant cyanobacteria. We propose that the occurrence of a strong misorientation relationship between adjacent crystals can be used as a proxy for the degree of control exerted by an organism on its mineralized structures.

SAMPLE PREPARATION FOR SEM BASED MICROANALYSIS

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***Keywords**: microanalysis, conodont, preparation, SEM, EDX.*

The analysis of microstructure yields valuable information on mechanical and chemical properties. Scanning Electron Microscopy (SEM) and associated analytical methods allow the observation of internal microstructure, shedding light on function, growth and chemistry. Sample preparation is the process by which material is fixed within a medium, a transect created and surface defects removed. This step is arguably the most important in any SEM based analysis, allowing for the acquisition of reliable, high quality data sets. Techniques from material science are continuously adapted to palaeontological applications, in particular with respect to calcareous microfossils. However, similar studies have not been extensively conducted on phosphatic remains, due in part to the difficulties faced in sample preparation alongside their susceptibility to electron beam damage. This case study focuses on conodonts, a marine vertebrate group ranging from the late Cambrian to Late Triassic. They have been chosen as a model due to the abundance of material, complexity of internal tissues and previous work focused histological features. With these phosphatic microfossils, we attempt to outline the process of sample preparation and provide information on how to avoid and overcome common pitfalls. Furthermore, energy-dispersive X-ray analysis (EDX) is demonstrated outlining data collection, quantification and quality assurance.

3D RECONSTRUCTION OF THE APPARATUS OF THE CONODONT GENUS *CLYDAGNATHUS*

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Keywords: *conodont, apparatus, 3D models, tomography.*

Conodonts, since their first discovery, have been of paramount importance for biostratigraphy, due to their almost ubiquitarian distribution in marine Palaeozoic and early Mesozoic sediments their abundance and their rapid morphological evolution. Conodonts affinity with vertebrates have been generally recognized, making conodont phosphatic elements the first experiment with skeletal biomineralization within the vertebrate lineage. Despite to their importance, knowledge about conodonts feeding apparatus architecture is still incomplete This is because of two main reasons: the first one is that conodont articulated elements are very rare and the second is that is impossible to separate the single elements without destroying the clusters and losing information about relative position of the elements.

If nothing can be done against the rarity of conodont natural assemblages, nowadays is possible to overcome the obstacle of extracting spatial information without destroying the clusters. This is possible because of the introduction of new, non- destructive techniques that allow us to extract the necessary information without destroying the samples.

For our study we worked on five clusters of conodont genus *Clydagnathus*: our main aim was to reconstruct its apparatus architecture using modern techniques. We used synchrotron-based tomography (SRXTM) to scan the clusters without destroying them and Avizo to work on the scans and realize 3D models of the elements.

In order to reconstruct the spatial relationship between the elements we used the pictures of the bedding planes to simulate the collapsing pattern of the apparatus and the relative position of the elements.

Fossil insect-names, publications, databases

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NEWLY ARISEN NOMENCLATURAL CONFUSION WITH THE ONLINE PRE-PUBLICATION PAPERS

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***Keywords**: nomenclature, taxonomy, ICZN, ZooBank.*

Today the palaeoentomology is in its golden age, due to the international growth of the interest in this subject (mainly in relation to the use of fossil insects as calibration points for dating the clades in phylogenetic analyses) and the remarkable technological imaging progress, in parallel to the increasing number of discoveries of new fossil insects' outcrops during the past twenty five years. Accordingly, nowadays the number of scientific publications (mainly of taxonomic aspect in relation with this field) has grown exponentially comparatively with what was published a decade ago. Moreover with the advance of the cyber and web technologies in the present time and since about five years, most (if not all) of the paleontological, zoological and biological journals put online accepted but not yet officially published papers, creating as such large confusions in nomenclatural acts. In reality, it frequently happens today that a name (which is usually not valid until its publication) of a newly described taxon (fossils or recent) is used and cited by other papers, well before the real publication of the paper describing it, sometimes even not in the same year. This fact is obviously against the rules of the International Code of Zoological Nomenclature. In regard with this perplexing newly arisen nomenclatural problematic, we propose that: 1) every nomenclatural act must mandatory be registered online in the ZooBank after final acceptance of the concerned paper; 2) the date of the registration must be considered as the date of publication of the studied taxon; 3) recommendations must be sent to the International Commission on Zoological Nomenclature which must propose serious regulations aiming to resolve this problem.

ADDRESSING PALAEOENTOMOLOGICAL TAXONOMIC DATA: OPEN NOMENCLATURE QUALIFIERS FOR SPECIMENS, NAMES AND IN TAXON GRAPHICAL DISPLAY

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***Keywords**: taxonomy, nomenclature, chresonymy, qualifiers, databases.*

Difficulties of accessing diagnostic characters that might be poorly preserved or simply lacking in palaeoentomological specimens due to their state of preservation, coupled with the intrinsic variability of the species, often give rise to various degrees of uncertainty in their attribution to a given taxon and is sometimes tentatively evaluated/qualified. Although the International Code of Zoological Nomenclature does not regulate usage of such Open Nomenclature Qualifiers (ONQ), their use in palaeontological taxonomic practices is relatively more common than in neontology, although their application still requires standardization. Particularly, ONQ have been indiscriminately used for specimens, names or taxa, sometimes leading to more taxonomic uncertainty than the precision desired.

Chresonyms, which include all published uses of a given taxon name (e.g. synonyms, homonyms, etc.) cover also these cases. However, documenting them in taxonomic databases is most often challenging, approximated, or just impossible. As presented in palaeoentomology particularly, reporting these names applied to specific specimens and allocating them to a given taxon varies in meaning, content and authors' practices.

To complement or make quicker and more explicit a usually arid textual enumeration of chresonyms, taxon name history can also be displayed by graphical presentations such as in FLOW – Fulgoromorpha Lists on the Web. With a clear definition of the type of entity to which an ONQ is applied – either a specimen, a name or a taxon – such visual displays could be adapted for use with Open Nomenclature (ON) taxonomic names for a better understanding of a fossil insect taxon.

MUSEUM OF AMBER INCLUSIONS UNIVERSITY OF GDAŃSK – COLLECTIONS AND DATABASES

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Keywords: *collections, fossil resins, syninclusions, database, website.*

Museum of Amber Inclusions (MAI UG) which established in 1998, is an integral part of the Laboratory of Evolutionary Entomology and Museum of Amber Inclusions of the Department of Invertebrate Zoology and Parasitology, Faculty of Biology, University of Gdańsk, (Poland). University's collection of amber inclusions is a collection of natural history which preserve amber pieces and amber with biological inclusions for taxonomic research. In addition, it is a fundamental tool for understanding of the Cenozoic biodiversity, palaeobiology and palaeoecology. During 20 years of Museum's activities, nearly 6000 amber pieces with over 14000 zooinclusions were gathered. Eocene Baltic amber is the main component of the collection of the MAI UG. Moreover, other fossil resins with bioinclusions or not, are also housed there.

Now, the collection is databased in a simple spreadsheet. The main achievement of the database is the record of not only the more important bioinclusions, if the rest of inclusions when the pieces show more than one– the syninclusions. The collection data contains several fields such as the acquisition number, the genus and the species (if identified), the family and/or higher taxonomic levels to which the inclusions are placed. The database contains also additional data as the name of the collector/donor/seller of the pieces and the date of join into the collection. As the collection is integrated by research material, other data are also gathered, e.g. the weight of the lumps, the structure of the piece (layered, not layered), and if the piece is cut or polished. All these data are unique and provide a reliable base for the knowledge of the palaeobiodiversity, palaeobiology and palaeoecology of the amberigenous forests, as well as to carry out taphonomical studies about amber and its inclusions.

More data here: http://muzeum.gda.pl

Foundations of biological systematics

Moderator:
Rafael G. Souza
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THE NATURAL SELECTION PRESENT DURING THE MASS EXTINCTION EVENTS

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Keywords: *mass extinction, evolution, paleontology.*

The biological diversity at any time span is the result of the balance between extinction and speciation. Traditionally the mass extinction events (MEE) are famous as they drove the most famous biodiversity turnovers in our planet (e.g., K–Pg), and usually associated with bottleneck Population. However, recent works demonstrated that MEE are not caused by an isolated catastrophic event and usually take considerable long time to truly affect the biodiversity leading to the extinction of some species or to differential selection of others. Here we advocate in favor of the tendency of differential survival on the biodiversity during and after a MEE highlighting the importance of the natural selection on the different species affected by this kind of events. Eurytopic species could tolerate a wide range of ecological and environmental conditions. Also, species which have little demand for the environment and present, intrinsically, adaptations to extreme environmental conditions (e.g., resistance to water and food restriction and desiccation) present an advantage on the run for survival. Species of Tardigrade and cyanobacteria are extreme examples. We postulate that the species that present those characteristics could survive to harsh environmental conditions during a MEE. Moreover, the MEE consequences must be seen individually for each species affected, where, e.g., the eurytopic species will just be affected by differential natural selection pressures while other more specialized species must pass by Population bottleneck or completely extinction as consequence of catastrophic associated events, without natural selection.

WHY FOSSILS ARE NOT EVIDENCE FOR EVOLUTION

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Keywords: *theory, testing, evidence, support.*

Ever since Charles Darwin published his *Origin of Species* in 1859, the popular opinion has persisted that fossils provide evidence for evolution. This view is incorrect, being based on two misconceptions: (1) predictions of fossil occurrences serve as test evidence for evolutionary theories, and (2) fossils offer evidential support for evolutionary hypotheses explaining those fossils. Theories stipulate general relations between cause(s) and effect(s), such that theories are spatio-temporally unrestricted. Thus, testing a theory cannot rely on just seeking effects thought to be explained by that theory. Proper testing requires that one first outline what specific effect(s) should be observed if a particular causal event occurs; this being an instance of prediction by way of deductive reasoning. What is then needed is to witness the causal event(s), as well as whether or not the predicted effect(s) is/are the case, from which a conclusion is reached that the theory has or has not received positive test support. The act of testing involves inductive reasoning. Hypotheses differ from theories in that they are unique explanatory statements presenting specific possible causes accounting for observed effects. Since hypotheses are constructs inferred with the use of theories, fossils are effects explained by evolutionary hypotheses, thus cannot serve as evidence supporting such hypotheses. Using the theory of natural selection as an example, I show what is required for testing an evolutionary theory, and why fossils cannot serve as evidence in that process. Then I present a simple example showing why fossils cannot be evidence supporting evolutionary hypotheses.

DISCUSSION OF EVOLUTIONARY PALAEOBIOLOGY IN EARLY PSEUDOSUCHIA: HOW A PRIORI WEIGHTING METHODS AFFECT PHYLOGENETIC HYPOTHESES.

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Keywords: *Pseudosuchia, a priori weighting methods (AWM), biological systematics.*

Recent phylogenetic analyses of archosaurs have resulted in different topologies. Particularly remarkable are conflicts in the phylogenetic positions of early pseudosuchian clades, such as the relationships of Erpetosuchidae and Ornithosuchidae. One dataset produced a topology with Ornithosuchidae at the base of Pseudosuchia as a sister taxon of Suchia, whilst another recovered Ornithosuchidae within a suchian clade that also includes Erpetosuchidae and Aetosauria. These differences in phylogenetic hypotheses between datasets result from differing character lists and the inclusion of different species. Most of the previously published phylogenetic analyses used a priory weighting methods (AWM), such as additive multistate characters. Here we conducted several phylogenetic analyses combining different AWMs (i.e., implied weighting) on a published dataset. Using different standardised values of K, we obtained, in some cases, the two competing topologies for these basal pseudosuchian clades. Such results complement the biological discussion (i.e., origin and fixation) regarding the synapomorphies of those clades. In addition, it will be useful to observe whether or not there exists any biological rationale for giving different weights to characters. For methodological purposes of the present work, we furnish the proper theoretical basis for conducting a cladogram comparison. Therefore, a discussion of which phylogenetic hypotheses for those clades are more plausible *a priori* is provided because of the parsimony criteria.

THE LOGICAL RELATIONSHIP BETWEEN CHARACTER AND HOMOLOGUES

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Keywords: *biological systematics*, *systematic phylogenetics, why-questions*.

The main basis for all sciences is the descriptive hypothesis. This work aims to establish the logical relationship between character and homologues. The descriptive act and first step in Biological Systematics culminates in what we known as characters (i.e., subject–predicate proposition that refers specifically to the state of being an object). With the characters establishment starts the second step, the comparison phase, in which all the characters that refer to the same organ in different animals under every variety of form and function are contrasted. The resulting hypotheses derived from the comparison step are known as homologues. The contrasted characters that are justified by the same homologue hypothesis culminate on the represent the contrasting classes, i.e., fact and foil, of the why-questions, that are the basis for phylogenetic inference. This logical relationship between characters and homologues improves the understanding of the two step process of homologue proposition, which is obscured by the use of terms such as 'characters statement', 'character', 'character states'. Therefore, the descriptive step is the basis for all science where facts are converted to phenomena in the form of descriptive hypotheses known as characters. With characters the comparative step enables the proposition of homologue hypotheses, where the descriptive similarities (i.e., equivalent characters) has an ontogenetic hypothesis explaining their developmental similarities. Those characters tied by homologue hypothesis are the fact and foil for the why-questions that are the basis for phylogenetic inference and their answers come in the form of homogeny/homoplasy hypothesis.

1st Palaeontological Virtual Congress

Inside the fossils: a palaeohistological point of view

Moderators:

Francesc Gascó

Grupo de Biología Evolutiva, UNED, Spain

Koen Stein

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WEAR, TEAR, AND SYSTEMATIC REPAIR: TESTING GROWTH DYNAMIC MODELS IN EUCONODONTS.

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Keywords: *microanalysis, conodont, histology, EDX, growth dynamics*.

Conodonts are the first vertebrates to have developed mineralised, enamel-like tissues of unparalleled hardness. These teeth are unique as they are able to repair both fractures and surface scores that occur during regular function. Euconodonts, the most derived group of conodonts, grew in a series of concentric layers deposited on the outer surface of the dental element. The reconstruction of conodont growth dynamics has been impeded by the difficulties in resolving individual growth layers (1 to 5 µm thick) in histological thin sections. We propose a different approach based on SEM imaging, which reveals the individual episodes of growth and allows for reconstruction of growth dynamics including episodes of in vivo repair. This, compiled with EDX measurements of chemical composition, can be used to define 3 stages of conodont ontogenetic development. We apply this approach to *Ozarkodina confluens*, which results in high resolution images of lamellar tissues and provides an insight into the mechanism of biomineralisation of these dental tools. Changes in strontium content coincident with distinct morphology and lack of wear in the early life stage indicate that conodonts might have assumed their mature feeding habit of predators or scavengers after an initial larval stage characterised by a different feeding mode.

1st Palaeontological Virtual Congress

New insight about ambers: Mesozoic resin producers and productions

Moderators:

Eduardo Barrón

Museo Geominero, Instituto Geológico y Minero de España

Enrique Peñalver

Museo Geominero, Instituto Geológico y Minero de España

SPANISH AMBERS AND THEIR ORIGINS: DIVERSE APPROACHES TO ESTABLISH THE CRETACEOUS RESIN-PRODUCING TREES

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Keywords: *resin production, taphonomy, gymnosperms, Albian, Spain.*

During the Mesozoic, conifers were the resin producers of the forest ecosystems. Geochemical data (FTIR and GC-MS) of the Spanish ambers, Early Cretaceous (Albian) in age, suggest a variety of resin-producing conifers.

Trees of the family Araucariaceae seem to be related to ambers from the Peñacerrada outcrop (Álava-Burgos area). In addition, araucariaceous remains of the species *Brachyphyllum obesum* (foliage) and *Rabagostrobus hispanicus* (male cones) occur as bioinclusions in these ambers, reinforcing an araucariacean origin.

Analyses of ambers from the El Soplao outcrop (Cantabria region) suggest a cupressaceous/ podocarpaceous origin or, less likely, a cheirolepidiaceous origin. The analyses of ambers from the San Just outcrop (Teruel Province) also remain uncertain, suggesting, perhaps, an araucariaceous/ cheirolepidiaceous origin. No relevant plant inclusions have been reported in ambers from these last two outcrops. However, *Brachyphyllum obesum* (foliage) and *Rabagostrobus hispanicus* (male cones) are present as compression fossils in the El Soplao amber-bearing rock.

Except, perhaps, for the Late Cretaceous ambers from Czech Republic and France, which has been related to Cupressaceae and Araucariaceae with some confidence, physical-chemical analyses of European Cretaceous ambers do not allow accurate palaeobotanical placement. Apparently, the abundant presence of remains of Cheirolepidiaceae in the Cretaceous European amber-bearing outcrops relates the ambers to this conifer family, but the Cretaceous remains do not exhibit resiniferous anatomical structures or amber residues.

In general, we consider that the geochemical data is not suitable to address adequately the question of the amber origin, a key question for the reconstruction of the Mesozoic forests.

Acknowledgements: This is a contribution of the project "CRE" (Spanish AEI/FEDER, UE Grant CGL2017-84419).

CRETACEOUS ACHILIDAE (HEMIPTERA: FULGOROIDEA) FROM MYANMAR - A STRANGE MEDLEY OF BASAL AND CROWN TRIBE-LEVEL GROUPS

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Keywords: *Burmese amber, planthoppers, inclusions, taxonomy, systematics.*

The Achilidae Stål, 1866 (Insecta: Hemiptera: Fulgoromorpha) is one of the smaller planthopper families, containing a total of 160 genera, of which 13 genera and 16 species are recorded as fossils. Fossil achilids are known from Cenozoic and late Mesozoic sedimentary and amber deposits, including the Isle of Wight, Crato Formation, and Baltic and Myanmar ambers. Amber Achilidae inclusions are particularly abundant and often well preserved, which suggests the family has a strong affinity with warm, resin-producing forest habitats.

The family's internal systematics are quite complicated. Currently, the three supertribes comprise 11 extant and two fossil tribes. Many of these tribes — especially those considered to be the most advanced — are small, with monotypic genera quite common. The relationships among the tribes are resolved only tentatively.

Examination of mid-Cretaceous Myanmar amber Achildae inclusions resulted in discovery of surprising taxonomic diversity of the group, enabling discrimination of the new tribes, but also in forms associable to the most basal (and diverse) extant Achilidae tribes — such as Plectoderini Fennah, 1950 — or to the tribes treated as crown groups, such as Amphignomini Emeljanov, 1991 and Apatesonini Metcalf, 1938. That this high level of morphological disparity and taxonomic diversity is present in such old material (ca 99 Ma) results in many new questions about the definitions of, and relations between, the tribes of Achilidae; the definition, circumscription and content of the family; and its place among other basal planthopper families, such as its presumed sister-group, Derbidae, and other related families, including Cixiidae, Lalacidae and Neazoniidae.

THE VOLATILE AND SEMI-VOLATILE COMPOSITION OF CRETACEOUS AMBER, AND COMPARISON TO MODERN RESIN

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***Keywords**: solid phase microextraction GC-MS, amber, resin.*

Cretaceous amber is a valuable record of ancient life on Earth: it contains a diverse assemblage of soft bodied fossils; and the amber itself, as fossilized tree resin, provides information about the tree that produced it. However, the botanic source of many Cretaceous amber deposits is not completely resolved, making it difficult to place the amber within a broader paleobotanic and environmental context. There are two primary lines of evidence for the botanic origin of amber: 1. paleobotany, where the most common associated leaves and wood are assumed to represent the amber tree; and 2. chemistry, where the botanic source of the amber is suggested to be (or to be closely related to) the modern or fossil tree with the most chemically similar resin. Here we investigate the botanic origin of a number of Cretaceous ambers, from Spain, Portugal, and the USA, using solid-phase microextraction gas chromatography/mass spectrometry, a relatively new and very sensitive technique to analyze volatile and semi-volatile composition. Most chemical techniques used to investigate the botanic origin of amber (e.g. FTIR, NMR, pyrolysis GC/MS) reveal the macromolecular structure of the amber, but ignore the volatile and semi-volatile fraction. By focusing on these compounds, we hope to provide data that can complement information about the macromolecular structure of the amber, thereby providing a more complete characterization of the chemical composition. We also make an initial comparison of these results to modern resin, focusing on comparing the volatile and semi-volatile composition of these amber samples to modern resin from the family Araucariaceae. As we analyse more samples of modern resin, we will expand these analyses to a more comprehensive comparison between Cretaceous amber and modern resin from various families.

CRETACEOUS AMBERS: A DISCUSSION OF THEIR PHYSICOCHEMICAL CHARACTERISTICS AND BOTANICAL ORIGINS, WITH SPECIAL REFERENCE TO FOSSIL RESINS FROM THE NORTH AMERICAN CONTINENT

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Keywords: *amber, fossil resin, coniferous, cupressaceous / taxodiaceous.*

Ancient tree resin, or amber, is a natural polymer produced during the Mesozoic by gymnosperms (conifers), and later also by angiosperms (possibly as early as the Late Cretaceous). Pyrolysis gas chromatography-mass spectrometry (Py-GC-MS) is widely used to determine a resin's botanical origin or affinity. This test was performed on Late Triassic amber from Northern Italy (~230 Ma, of the extinct conifer family Cheirolepidiaceae), designating the amber Class Ib (Anderson, unpublished), based on its chemical structure within the classification system created by Anderson and Crelling (1995).

Deposits containing Cretaceous coniferous resins are found throughout the Northern Hemisphere (and in a few Southern Hemisphere localities). Definitive Cretaceous ambers subjected to Py-GC-MS have been designated Class Ib. The botanical source trees for most, if not all, North American ambers appear to be cupressaceous / taxodiaceous. This applies to ambers from the Atlantic Coastal Plain (e.g. New Jersey, Staten Island, North Carolina), as well as to those from Northern Alaska, Wyoming, South Dakota, and Canada. Burmese amber has also been tested (Anderson, unpublished), and has been assigned a possible botanical origin of or near *Metasequoia* (Cupressaceae).

Examining the microstructural characteristics of any fossil wood associated *in situ* with amber, as well as recovering pollen, even finding host tree inclusions (flowers, leaves, seeds, and the like) in amber or the surrounding matrix, can provide critical evidence of botanical affinity. Chemistry alone is insufficient, since the taxonomic and chemical interrelationships of early conifers in particular are complex and can sometimes confound results.

THE RESIN-PRODUCING TREES DURING THE CRETACEOUS: A TOPIC NOT WELL RESOLVED TO DATE

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***Keywords**: taphonomy, resin, plant remains, gymnosperms.*

The taxonomical determination of the Cretaceous gymnosperm trees that produced abundant resin outpourings, some of them containing specimens of the forest biota in the form of bioinclusions, is critical for paleoenvironmental reconstructions but is still not fully solved.

The different approaches generally considered to address this question are: 1) diverse geochemical analyses, and 2) the study of the palynological and/or associated paleobotanical meso- and macroremains (plant cuticles and fusinized or lignitic wood) from the amber-bearing rocks. Of special interest are two Cretaceous records of lignitic wood showing fine cellular details and preserving amber in situ (Raritan and Charentese ambers). For Cenozoic ambers the plant bioinclusions is an aspect that has been considered, unlike most Cretaceous ambers which are poor in such remains.

Indeed, there are various problems making it difficult to obtain conclusive results and typically there is no consensus between geochemistry and paleobotany, as is the case for the potential plant source of Burmese amber. For example, carbonized wood with associated amber remains lacks well-preserved cellular anatomy virtually in all the cases, and fusinized wood showing fine cellular details lacks amber remains due to evident reasons. To date, no wood fragment embedded in amber, providing taphonomic evidence that it was produced by the same tree as the resin, has been discovered. The study of palynomorphs and/or plant cuticles has not been conclusive either due to strong taphonomic biases which occurred during transport to the burial deposit.

The botanical origin of few Cenozoic ambers appears well resolved, as is the case of the Dominican amber which originated from the leguminous genus *Hymenaea*, due to the concordance between the geochemical data and the abundance of *Hymenaea* bioinclusions. In our opinion, new approaches and new discoveries are necessary to determine the origin(s) of the Cretaceous ambers.

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A NEW APPROACH TO DETERMINE THE RESINIFEROUS TREES INVOLVED IN THE ORIGIN OF THE CRETACEOUS AMBER DEPOSITS

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***Keywords**: actuotaphonomy, resin, plant inclusions, Hymenaea, Madagascar.*

In order to determine the resiniferous trees involved in the origin of the Cretaceous amber deposits, researchers usually consider the biomarker and infrared spectrum data from the amber pieces. However, these results are not conclusive and are sometimes contradictory, due in part to the absence of suitable Recent correlates to compare.

Here we propose a taphonomic hypothesis: "The most abundant taxon in the plant assemblage of bioinclusions in amber corresponds to the resiniferous tree that was involved in the origin of the amber deposit." We propose this hypothesis based on a plausible idea, but, to date, it is not corroborated by quantified field observations: "The resin trapping of plant remains from the same resiniferous tree could be remarkably favoured – over resin trapping of plant remains from other trees -- by their temporal and spatial correspondence, particularly considering that the fall of the detached remains from the tree itself could easily bring them into contact with its resin emissions."

We tested this hypothesis by analysing the assemblage of plant remains trapped in yellow sticky traps (n= 525) attached at three different heights to the trunks of 12 *Hymenaea verrucosa* trees in Malagasy forests located in three regions (four trees in each region). A total of 2,962 plant remains were counted.

Our hypothesis was not refuted for either the total assemblage or for any of the three regional assemblages. *Hymenaea* is not a gymnosperm, but this result is nonetheless valid for Mesozoic and Cenozoic ambers, because it involves a taphonomic process that is taxon-independent. However, this approach may be of limited use for specific Cretaceous ambers with scarce plant inclusions, as is the case for Spanish amber.

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ISOLATED AMBER DROPS AND AMBER BODIES IN LEAVES FROM THE CRETACEOUS OF PATAGONIA

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***Keywords**: idioblasts, amber drops, middle Cenomanian, Santa Cruz Province, Argentina.*

The aim of the communication is to denote the incipient and promising presence of the first amber record from the Mesozoic of Patagonia. To describe leaf amber bodies and isolated amber tiny drops and to question about the difficulty to find Mesozoic ambers in the southern part of South America. Mata Amarilla Formation crops out in Santa Cruz Province and is middle Cenomanian in age. Among a diverse gymnosperm and angiosperm leaf flora, three angiosperm leaf species (Lauraceae, Magnoliaceae, and Bignoniaceae) were found preserving dense fluorescent idioblasts inside the mesophyll. There are ≈ 40 µm amber-coloured bodies, sometimes intracellular and others in greater glomerules (100 µm). These bodies could be interpreted as the fossilized resiniferous (nonvolatile) fraction of cell contents. On the other hand, we found isolated amber drops, rounded, about 2 mm diameter, light yellow and translucent, included within layers of sedimentary rocks associated to rich plant debris. Both leaves and resin drops are not directly associated but in the same fossiliferous layers. There are also insects and insect damages on leaves, including endophytic ovipositions of Odonata, recorded in the same layers. The presence of amber and fluorescent bodies in these Patagonian leaves is promissory for the potential discovery not only of bioinclusions but also of the resin-producing tree taxon.

BLOOD-SUCKING GENUS *CULICOIDES* (DIPTERA: CERATOPOGONIDAE) IN THE UPPER CRETACEOUS FOSSIL RECORD

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***Keywords**: amber, biting-midges, Ceratopogonidae, Cretaceous, haematophagy.*

Biting-midges (Diptera: Ceratopogonidae Newman, 1834) belonging to the suborder Nematocera are small insects resembling non-biting midges (Chironomidae) or mosquitoes (Culicidae). The characters distinguishing it from other nematocerans were given by Edwards (1926). Fossil record of the family reaches Lower Cretaceous.

The genus *Culicoides* Latreille, 1809 is the most speciose containing about 1400 described species, covering more than 20% of the Ceratopogonidae fauna. Adult females of *Culicoides* are haematophagous on vertebrates, this way of nutrition is considered plesiomorphic. *Culicoides* belongs to Culicoidini: Ceratopogoninae, but relationships between subgenera and groups of species recognised within are unclear.

Fossil biting-midges are most often described from amber inclusions, whose unquestionable advantage is the very good preservation of morphological features, which allows the examination of fossil using similar criteria as for extant specimens.

So far, the oldest record of the genus *Culicoides* was *C. doyeni* CHOUFANI *et al.* 2014, from the French amber of Vendée (89,8-93,9 Mya). Currently, fossil records of the genus includes 49 species; fossil resins, inclusions, exclusively from the Upper Cretaceous (72-100 Mya), covers 18 species.

Culicoides inclusions come successively from ambers: Turonian French amber of Vendée with 1 species, New Jersey amber (also Turonian, 89.8-93.9 Mya) with 5 species, Siberian amber (Santonian, 84-86 Mya) with 4 species, French amber of Provence (also Santonian, 84-86 Mya) with 1 species, and Canadian amber (Campanian, 72-84 Mya) with 7 species. Presently, two new species in Burmese amber (Cenomanian, 99 Mya) have been found, which are coeval to the oldest records of *Culicoides*. Moreover, these fossils share number of morphological features with extant, European *Culicoides cameroni* Campbell *et* Pelham-Clinton, 1960, suggesting the recent species may be "living fossil" among Ceratopogonidae.

TERRESTRIAL ISOPODS FROM SPANISH AMBER: NOVEL INSIGHTS INTO THE CRETACEOUS SOIL BIOTA

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***Keywords**: Arthropoda, Crustacea, woodlice, Albian, amber.*

The Oniscidea (terrestrial isopods), a suborder of the Isopoda, are distinct from the rest of the predominantly marine isopods by their terrestrial way of life. They are widely represented in various terrestrial habitats, preferably moist ones, but some are able to live in arid regions, while others are amphibious along the seashore, and a few species have secondarily adapted to aquatic habitats. Most species often constitute an important part of the soil fauna. The fossil record of Oniscidea is scant and largely biased towards preservation in amber with its high fidelity and, until recently, mostly restricted to the Cenozoic. The earliest oniscidean described is a single individual from Late Albian to Early Cenomanian amber of Myanmar, while the fossil French oniscidean fauna has not yet been documented. However, there are younger Cenozoic deposits that shed light on early woodlice history, and have records of all the major families. We document the discovery of 11 terrestrial isopod specimens in Albian-aged amber from the Peñacerrada I outcrop, Burgos Province, northern Spain, which constitutes the oldest assemblage of Cretaceous Oniscidea yet described. Collectively these taxa make the fauna of Oniscidea in Spanish amber the most thoroughly documented source of information on Mesozoic Oniscidea, both in terms of numbers of species and available specimens. The specimens identified belong to three out of five major groups of the Oniscidea: Ligiidae, Synocheta, and Crinocheta. These discoveries shed new light on the soil biota of the Cretaceous forests.

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Paleoart: reconstructing extinct life

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PALEOARTISTIC VIEWS ON THE RECONSTRUCTION OF *PARARHABDODON ISONENSIS*

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***Keywords**: Dinosauria, Hadrosauria, Ornithopoda, paleoart, art.*

Paleoart is a valuable diffusion tool to paleontological knowledge. Currently, paleoart is often specialized on create by itself restorations of images from past rather than only serve to illustrate merely scientific data. This work compiles information from scientific literature to provide an example of how paleoart involves reviewing current hypotheses. *Pararhabdodon isonensis* has been chosen due to be suitable for this review. This taxon has been represented here on a digital paint, with the support of three-dimensional models. Representation of full anatomy, soft tissues, coloration, paleoethology, paleoecology and paleoenvironment, requires testing scientific hypotheses and even could contribute to the proposal of new hypotheses too. Phylogenetic bracketing and comparative anatomy with both extinct and extant taxa, have been used to complete unknown characters, in addition to considering ontogenic studies in hadrosaurs. There are also studies of several remains with taphonomic and paleoecologic implications to *P. isonensis* and other hadrosaurs, used to configure a more accurate image of such animals. Finally, this process has been repeated with taxa from contemporary paleofauna and paleoflora, selected according to a paleoenvironment coherent with *P. isonensis*. Although it's not the main objective, the result is compatible to serve as a scientific illustration useful to diffusion of paleontological knowledge.

1st Palaeontological Virtual Congress

Paleobiology and evolution of dinosaurs

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AN ISOLATED DINOSAUR TOOTH FROM THE UPPER CRETACEOUS BAURU BASIN, BRAZIL

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***Keywords**: theropod tooth, Unenlagiinae, Bauru Basin.*

Theropod shed teeth are frequently described and reveal a high morphological and taxonomic diversity. Here we described the specimen MN 4502-V, an isolated dinosaur tooth from the Upper Cretaceous Bauru Basin (Campanian-Maastrichtian, Presidente Prudente Formation) found in the Álvares Machado city, southeastern State of São Paulo, Brazil. This tooth is characterized by a labiolingual narrowness of the crown with a distal curvature and longitudinal flutes, a total absence of carinae and denticles on both mesial and distal parts. Most of the enamel surface is abraded and the root is broken. This exemplary was compared with more than 20 theropod´s teeth, including other records of the same place, to increase the overall comprehension of its morphology and taxonomy. Our preliminary analyzes suggest morphological similarities between the dentition of *Buitreraptor* and *Austroraptor*, which is consistent with the record of Unenlagiinae from South America. Up to date, as this clade is represented only by these two species, it is possible that future investigations may reveal a more widespread distribution than currently recognized.

THE MORPHOLOGY OF SOUTH AMERICAN TITANOSAUR FEMORA

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Keywords: *Sauropoda, Titanosauria, morphotypes, anatomy.*

Titanosauria is a worldspread clade of dinosaurs with more than 90 species, most of them from Gondwana. Despite this well-documented diversity, several aspects of titanosaurian anatomy remain described primarily on the highly derived forms. Among that anatomical regions, one of most overlooked are the appendicular bones, such as the femora. Although several authors have contributed important systematic features, these characters often only help identify main clades. Here, 54 South American specimens have had their femora observed first-hand and been compared in order to confirm if there are synapomorphies on those bones. Within the sample, nine femora are excluded due their fragmentary nature. The study used three areas of morphological variation, which culminated in the separation of three new distinct morphotypes (excluding the well know saltasaurine femur morphotype). The femora show variation such as the elevation of the femoral head, the positioning of fourth trochanter and the progressively beveled distal condyles . This combination of character states is distributed among small and large femora, excluding ontogenetic variation as an explanation for them. Finally, those features probably comprise a linked set of character states related to future systematic identification and also for hindlimb stance studies.

IN VIVO DINOSAUR BONE FRACTURES WITH BEHAVIORAL IMPLICATIONS

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Keywords: *pathology, fractures, dinosaur, behaviour.*

Bone Fractures are uncommon in the Mesozoic dinosaurian record but, when present, provide unique insights to ancient behavior. Fractures were macroscopically examined as to type within the dinosaurian fossil record of major museum fossil collections in order to provide insight as to their derivation and behavioral implications.

Such fractures can be classified as related to a single traumatic event or to repetitive stresses. Those related to a single traumatic event include: 1) Full fractures, with loss of continuity,which may result in either loss of the distal portion or a pseudo-arthrosis. 2) Partial fractures involving full or partial detachment of a bone fragment. These are divided into chip and pilon fractures, defined by joint margin and diaphyseal location (e.g. the metatarsal fracture in ornithomimid SMP VP-971), respectively. 3) Greenstick fractures, which are incomplete, resulting in exostoses in juvenile individuals (e.g. some metapodials of *Apatosaurus* Tate-001). 4) Impact fractures, wherein one bone penetrates another, resulting in traumatic subsidence (e.g. the pedal fractures in a basal ornithischian YPM 5819 and 5875). These are distinguishable from avascular necrosis or osteochondritis because the latter only localize to vascular watershed regions (areas of bone with a single arterial source, blockage of which results in bone death). Fractures attributable to repetitive stress include:1) Fatigue fractures due to biomechanical responses to repetitive stresses which exceed the elastic modulus of normal bone.2) Insufficiency fractures involving failure of abnormal bone. The result of either is production of microfractures and cleft formation.

Thus, the presence and character of fractures can provide unique insights into Mesozoic dinosaurian behaviour. From speed to predator-avoidance, defensive and offensive use of feet, and repetitive behavior as involved in migration, specific fracture pattern and character allow an otherwise unknowable understanding of Mesozoic vertebrate behavior.

NON-AVIAN DINOSAURS WERE NOT IN TERMINAL DECLINE DURING THE EARLY LATE CRETACEOUS

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***Keywords**: phylogenetic analysis, dinosaurs, K-Pg extinction, speciation, GLMM.*

The tempo and mode of non-avian dinosaur extinction remains contentious and several different interpretations of this event have been proposed. These scenarios are all based on the same basic data sets but differ primarily in the methods applied to address this question. Nevertheless, a broad consensus had been reached with respect to the timing of this extinction, with many studies converging on a relatively rapid demise. By contrast, a recent analysis of speciation/extinction rates using phylogenetic generalised linear mixed models (GLMMs) within a Bayesian framework proposed that non-avian dinosaurs were in decline well before the K-Pg boundary, with their terminal decline commencing during the early Late Cretaceous. To test this hypothesis, we re-assessed speciation/extinction events using a published dinosaur supertree containing 420 taxa and examined speciation/extinction rates under three GLMMs; a null model, a speciation slowdown model, and a slowdown to asymptote model. Best model fits were determined by calculating the Deviance Information Criterion (DIC) value. In the majority of cases our results indicate that although dinosaur evolutionary rates reached asymptotes prior to the K-Pg boundary, the proposed early Late Cretaceous decline was not supported. This is consistent with the high levels of taxonomic diversity observed in many late occurring dinosaur communities and other results based on sampling-based techniques such as rarefaction. These results also caution against making broad generalisations when fitting large sets of complex models that display a diversity of results.

A NEW *DASPLETOSAURUS HORNERI* (DINOSAURIA: THEROPODA) FROM TWO MEDICINE FORMATION, UPPER CRETACEOUS, USA

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Keywords: *theropod, Tyrannosauridae, Campanian, axial series.*

Daspletosaurus horneri is a Eutyrannosauria from the Campanian of Montana, USA. It was described for the first time based on several elements including an almost complete skull and a partial postcranial skeleton as well as juvenile specimens. *D. horneri* is an anagenetic variation of *D. torosus*. The first one is younger (~75.1 – 74.4 Ma) than the last (~76.7 – 75.2 Ma), both from the Two Medicine Formation and Dinosaur Park Formation, respectively. Here we report a new *D. horneri* (AMNH FARB 5468) based on an axial series with 23 presacral vertebrae and based on distal pubes and proximal ischium. These materials were collected in 1916 by Mr. Brown, Kaisen and Johnson at Two Medicine River, Cut Bank Montana (USA). We performed two phylogenetic analyses based on a modified data-matrix from the description of Pantyrannosauria and Eutyrannosauria. Our analyses suggest a close relationship with Tyrannosaurinae (TBR: 807; 10 MPTs; CI: 0.555; RI: 0.820). In the first analysis, it was recovered in a polytomy within Tyrannosaurinae (but not Alioramini). Nevertheless, using implied weighting method (k = 5) we recovered AMNH FARB 5468 in a polytomy within *Tyrannosaurus rex*, *T. bataar* and *Zhuchengtyrannus* instead within the clade of *Daspletosaurus*. This result might be due to the incompleteness in vertebral series of *D. horneri* and because AMNH FARB 5468 has several vertebral characters more derived than *D. torosus*. Our results suggest a closer relationship between the vertebral series of Tyrannosaurus than *D. torosus*. A complete description of AMNH FARB 5468 will be published soon.

SAUROLOPHINAE HADROSAUR FROM THE UPPER CRETACEOUS CABULLONA GROUP, SONORA, MÉXICO

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Keywords: *systematics, Saurolophinae, Hadrosauridae, Cabullona Group, Campanian.*

The Campanian-aged (Upper Cretaceous) fluvial deposits from the Fronteras section of the Cabullona Group in northeastern Sonora (Mexico) have yielded many continental vertebrate fossils. However, this vertebrate fauna has not been examined in depth. In this study we provided a comparative anatomical study of a partial skeleton of an ornithopod dinosaur referred to Hadrosauridae that was found in flood plain deposits. The specimen consists of cervical, dorsal and caudal vertebrae, dorsal ribs, a nearly complete hip and a partial femur and tibia. All of the remains were disjointed, but close enough to each other to resemble their anatomical position, suggesting that they belong to one individual. The remains were morphologically described and are kept in the "Museo de Fronteras" of the municipality, near the excavation site. Due to the lack of equipment the fossils were not well prepared and therefore were not measured. Based on the synapomorphies of the pubic bones that show the presence of a short and wide prepubic "neck", a ventrally deflected prepubic "blade" and ischial bones, with an ischial shaft that terminates in a rounded knob. These features show that this specimen is comparable to an adult member of Saurolophinae. The Fronteras Saurolophinae represents the first occurrence of this group for the Cabullona Group and the state of Sonora, México. However a detailed study of the herein examined specimen and a better preparation of the material is required to improve our taxonomic approach.

COMPARATIVE HISTOLOGY OF DWARF TITANOSAURIANS FROM THE LATE CRETACEOUS OF FRANCE

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Keywords: *insular dwarfism, Titanosauria,* Atsinganosaurus velauciensis*, bone histology.*

The derived sauropod clade Titanosauria encompasses the largest land animals that ever roamed the Earth as well as dwarfed species that evolved in restricted, insular habitats. Here, we report on the long bone histology (humeri and femora) of several mature individuals belonging to a new, small-sized titanosaur from the Upper Cretaceous of Velaux – La Bastide Neuve (Provence, France).

The main osteohistological feature of the new titanosaur is the heavy remodelling of the cortex, from the outermost cortex retaining some primary vascular canals with traces of External Fundamental System onsets (F to G bone tissue types) to the complete remodelling of the cortex (H bone tissue type). Histological Ontogenetic Stages (HOS) of the samples range from HOS 12 to 14, meaning these bones belong to mature close to or at final body size. Overall long bone histology of the new taxon is strikingly similar to that *Atsinganosaurus velauciensis*, another titanosaur from the same site and time period.

A mature osteohistology combined with femora and humeri that are markedly reduced in size compared to more basal macronarians indicates an earlier onset of the remodelling process during ontogeny at a rate that surpassed the apposition one. Insular dwarfism is a consistent hypothesis for this combination of features, raising the number of dwarfed titanosaurs lineages in the European archipelago.

LATE CRETACEOUS TITANOSAURS OF THE IBERO-ARMORICAN DOMAIN, A SYSTEMATIC OVERVIEW AND NEW DATA FROM LO HUECO FOSSIL SITE

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Keywords: *Campanian-Maastrichtian, phylogeny, Titanosauria, Lithostrotia, Iberian Peninsula.*

The Campanian-Maastrichtian strata of the Ibero-Armorican domain are rich in titanosaur remains with four described genera: *Lirainosaurus*, *Ampelosaurus*, *Atsinganosaurus*, and *Lohuecotitan*. However, a higher diversity has been suggested for this domain during this period, followed by its decline in the early late Maastrichtian. The evolutionary history of the Late Cretaceous Ibero-Armorican titanosaurs is uncertain. Some taxa have been considered as members of Saltasauridae, however more recent studies are recovering the Ibero-Armorican forms as closely related to the Gondwanan clades Aeolosaurini, Rinconsauria and Lognkosauria. These new phylogenetic hypotheses are also suggesting the presence of possible dispersal events between Europe and Africa through the Afro-Arabian Plate, which should justify this relationship between African and South American taxa. Lo Hueco (Cuenca, Spain) represents a Campanian-Maastrichtian multitaxic bonebed, with several partial titanosaurian skeletons, mostly articulated or with low dispersion, and key for the phylogenetic study of the European titanosaurs. Preliminary studies suggested for the presence of at least two different taxa in this site. The titanosaurian specimens of Lo Hueco share several features with Lithostrotia. Although European forms have been placed within Saltasauridae, some specimens from Lo Hueco exhibit features traditionally considered as aeolosaurine synapomorphies, fact never reported in the Upper Cretaceous of Europe. Further incorporation of the complete set of European titanosaurs in revised morphological data matrices are still necessary to understand their phylogeny. Recent phylogenetic proposals show discrepancies in the consideration of Ibero-Armorican titanosaurs either as distantly related forms or as members of a single European taxon that excludes Lo Hueco representatives.

TAXONOMIC APPROACH OF DIAGNOSTIC CHARACTERS USED TO DEFINE MEGALOSAUROIDEA TAXA

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***Keywords**: Dinosauria, Theropoda, Megalosauroidea, taxonomy.*

Megalosauroidea is a clade of theropod dinosaurs are medium to large sized animals that lived on the Middle and Upper Jurassic of Africa, Asia, Brazil and North America. Although this group is well-known worldwide, several megalosauroid taxa are only based on incomplete or disarticulated specimens. In this work we used the diagnoses of each species in order to verify which were the most frequent characters to designate new species and the study of morphological characters was carried out to find out which of these characters were most used to designate new taxa up to now. A total of 34 characters were analyzed on this survey, and an average number of approximately five characters was found to be most used to identify new Megalosauroidea taxa. Cranial characters (15) were found to be more informative than the postcranial (19) ones. The most commonly used cranial characters to erect new megalosauroid taxa were: tooth (9), premaxilla (9) and maxilla (6). Moreover, the most significant postcranial characters were based on vertebrae (23) and pubes (5). Thus, we conclude that postcranial elements (especially the vertebrae) are the most used diagnostic elements for the determination of new Megalosauroidea taxa. Future research should be focused on detecting new diagnostic characters in postcranial bone elements.

SAUROPOD DIVERSITY FROM THE VILLAR DEL ARZOBISPO FORMATION (KIMMERIDGIAN-EARLY BERRIASIAN) OF LOS SERRANOS REGION (VALENCIA PROVINCE, SPAIN).

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***Keywords**: dinosaur, sauropod, Villar del Arzobispo Formation, Kimmeridgian, Berriasian.*

Deposits from the Kimmeridgian-early Berriasian in the South Iberian Basin (Spain), specifically in the northwest of Valencia province and the south of Teruel province, have yielded a large quantity of vertebrate fossils, testifying to the great diversity of taxa. Evidence of stegosaur and ornithopod dinosaurs together with other vertebrates, particularly turtles and crocodyliforms, have been recovered. The most abundant remains are the sauropod dinosaurs, mainly postcranial bones. From this area, one genus and species has been defined: the turiasaur *Losillasaurus giganteus*. Los Serranos region is close to the sites where *Turiasaurus riodevensis* was found in Riodeva (Teruel), in the same stratigraphic unit.

The aim of this work is to revise the present state of sauropod diversity in the Villar del Arzobispo Formation, focusing our attention on the outcrops of the Los Serranos region and in the more than 20 fossil sites with sauropod remains from the municipality of Alpuente. Here we present the revision of several older occurrences and the study of some new isolated findings.

The phylogenetic affinities of some of these specimens are, presently, not easy to establish due to the low taxonomic resolution obtained for some clades in the phylogenetic hypotheses and to the fragmentary nature of some of the remains. Up to now, the basal eusauropods turiasaurs are the best represented; nevertheless, diplodocines, basal macronarians, titanosauriforms and other indeterminate eusauropod taxa are present too. All of them indicate a high diversity which is typical for the European sauropod dinosaur diversity at the end of the Jurassic, (e.g. the Lusitanian Basin).

WHAT DO WE MEAN BY THE DIRECTIONS "CRANIAL" AND "CAUDAL" ON A VERTEBRA?

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***Keywords**: vertebra, orientation, cranial, caudal, horizontal, neural canal.*

In illustrating vertebrae, it is important to consistently depict their orientation, so we can objectively assess and compare the slope of the neural arch, neural canal, or articular surfaces. However, differing vertebral shapes across taxa and across regions of the spinal column make it difficult to maintain consistency, or even define what we mean by the directions "cranial" and "caudal". Consequently, characters such as "Neural arch slopes cranially 30° relative to the vertical" are disputable rather than objective measurements.

Cranial and caudal are defined as directed along the horizontal, but several different notions of "horizontal" are possible:

1. Long axis of centrum is horizontal. This is appealing for elongate vertebrae such as sauropod cervicals, but is difficult to determine for craniocaudally short vertebrae such as most caudals.
2. Articular facets of centrum are vertical. Difficult to determine when dealing with facets that are concave or (worse) convex; and ambiguous for "keystoned" vertebrae in which the facets are not parallel.
3. Neural canal is horizontal. Anatomically informative, but difficult to determine in vertebrae that have not been fully prepared or CT-scanned, and impossible to see in lateral view. Ambiguous for vertebrae where the dorsal and ventral margins of the canal are not parallel.
4. When two instances of the vertebra are optimally articulated, the same points are at the same height on both. This is less intuitive than definitions 1–3, but more precise and can be determined for *any* vertebra.

We advocate explicitly stating a definition and using it consistently.

RECONSTRUCTING AN UNUSUAL SPECIMEN OF *HAPLOCANTHOSAURUS* USING A BLEND OF PHYSICAL AND DIGITAL TECHNIQUES

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Keywords: *dinosaur, sauropod, vertebra, spinal cord, intervertebral disc*.

A partial skeleton of a sauropod dinosaur, Museum of Western Colorado 8028, was recovered from the Upper Jurassic Morrison Formation near Snowmass, Colorado, USA, and in 2014 it was referred to *Haplocanthosaurus* sp. The material includes four proximal caudal vertebrae, which are unique in having strongly amphicoelous vertebral bodies, in which the centrum is reduced to a thin vertical plate of bone between the concave articular surfaces, and neural canals that are laterally and ventrally expanded and strongly sloped relative to the centrum. To reconstruct the soft tissues that left these traces on the skeleton, we rebuilt these vertebrae using both physical and digital techniques. We CT scanned the specimens, generated digital models, 3D-printed the vertebrae, physically sculpted missing material onto the printed models, optically scanned the sculpted vertebrae to create second-generation digital models, and finally, retro-deformed and articulated those digital versions of the vertebrae. The spaces between the deeply amphicoelous caudal centra were likely filled by large, ellipsoidal intervertebral discs, as in the amphicoelous vertebrae of *Sphenodon* and gekkotan lizards. The expanded neural canals remain enigmatic. In ostriches, the lumbosacral spinal cord is expanded laterally and ventrally in each vertebra, lending the spinal cord a shape that roughly resembles beads on a string. Similar spinal cord morphology might explain the expanded neural canals in the Snowmass *Haplocanthosaurus*, but it is not clear why a relatively small-bodied, small-tailed sauropod would need such a spinal expansion, given that similar expansions have not been reported in larger-bodied and larger-tailed taxa.

1st Palaeontological Virtual Congress

Paleobotany: biostratigraphy, paleogeography, paleoenvironmental reconstructions and climatic change

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THE MESOFOSSIL FLORA OF IHARKÚT (LATE CRETACEOUS HUNGARY) INCLUDING AQUATIC ELEMENTS

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***Keywords**: Iharkút, Santonian, aquatic plant mesofossils.*

Plant mesofossils (mainly seeds and fruits) are usually studied for terrestrial palaeoenvironment reconstruction. In the Late Cretaceous terrestrial (swamp and fluvial) formations of the Bakony Mts. (Hungary) plant mesofossils are common.

Recent studies are focused on two formations: Ajka Coal Fm. and the heteropic fluvial Csehbánya Fm. A famous vertebrate locality is exposed at the abandoned Iharkút open-pit bauxite mine. The Santonian Csehbánya Formation, consisting of 30 to 50 m thick freshwater alluvial deposits, has yielded a rich and diverse assemblage of continental vertebrates as mosasaurs, pterosaurs, and dinosaurs.

The aim of first plant study is to identify the dominant forms and propose a preliminary palaeoenvironment reconstruction. Based on these preliminary results on plant remains, Normapolles-related forests with herbaceous angiosperm- and fern-dominated underwood under tropical or subtropical climate can be reconstructed in this locality.

The salinity of the localities is still questionable because of the pyritised bones. Within the plant mesofossil material also aquatic forms were detected. Strictly fresh water resistant Charales oogonia were found in the paleosol layers of the locality. From the bonebed layers Nymphaeales seeds were also found.

The macrospores described by László RÁKOSI during the 1980's from the same palino horizont (*Oculopollis zaklinskaiae- Brecolpites globosus*) are related to in Salviniales and Isoetales.

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STORAGE, MANAGEMENT AND ANALYSIS OF MORPHOLOGICAL DATA: XPER³ AND ITS UTILISATION IN PALAEOBOTANY

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***Keywords**: Xper² -Xper³ software, Identification, PalmID, Icacinaceae, ABleS.*

Classifying and naming taxa is crucial in all biological sciences, and palaeontology is not an exception. With the advent of computer sciences and digitized information, Computer Aided Identification systems are of particular interest for paleo-taxonomists dealing with large fossil collections or sampling. Computer-stored and managed knowledge databases allow the exploration of morphological data themselves, but also their relation with ecological or distribution information. Thus, these databases have plentiful applications in systematics, palaeoecology or palaeoclimatology. Among all available tools, Xper² is a user-friendly application, which can be used to store, edit, analyse and distribute structured descriptive data. Lately, an online interface (Xper³) was introduced to develop online collaboration and diffusion of knowledge databases. Our contribution aims to introduce this tool and to illustrate its helpfulness in several aspects and issues in palaeontology, by giving relevant examples of applications in palaeobotany: (i) an Icacinaceae database and its application in phylogenetic studies, (ii) PalmID, an online identification tool for modern and fossil palms, (iii) ABleS, an ongoing project proposing a tool for fossil softwoods identification and (iv) the potential use of Xper² and Xper³ in palaeoclimatic studies based on fossil leaves. Additionally, the relevance of Xper³ in teaching applications and knowledge transfer to the public will be discussed.

THE KUNGURIAN (CISURALIAN, LOWER PERMIAN) PALAEOENVIRONMENT OF TREGIOVO:AN INTEGRATED STUDY OF PALAEOBOTANY AND GEOCHEMISTRY

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***Keywords**: Cisuralian, conifers, Tregiovo, $\delta^{13}C_{org}$*

During the Kungurian (Cisuralian, lower Permian) the small sedimentary basin of Tregiovo (upper Val di Non, Trento Province, NE-Italy) was located in the eastern palaeoequatorial Pangea (~0–5°N). In the fossil locality of Le Fraine (Tregiovo Formation) two rich plant assemblages, respectively A (the lower) and B (the upper one) have been identified. The integration of the palaeobotanical, sedimentological and geochemical study of the dispersed organic carbon and of the plant fossils coalified tissues allowed to provide a palaeoenvironmental reconstruction of Tregiovo. Both plant assemblages consist of sphenophytes, taeniopterids, seed ferns and/or ferns, ginkgophytes, and conifers, but with different quantitative compositions. The geochemical analysis on the stable organic carbon dispersed in the sediments shows a negative shift along the Le Fraine section with the most negative values that correspond with the plant assemblage B. The taxon-specific analyses, performed on the coalified tissues of conifers, allowed to exclude that the negative shift resulted from the change in the flora composition, but showed no significant differences between different taxa from the same plant assemblage. Conifers of the same taxon differ instead from an assemblage to another, having lighter isotopic composition in the upper plant assemblage (B). These results support thus the negative trend recorded along the Le Fraine section. Moreover, the similarity of the Tregiovo $\delta^{13}C_{org}$ negative shift and the Kungurian trend from other continental records suggests that it may represent a global signal due to a change of the atmospheric CO_2 composition.

PALEOENVIRONMENTAL RECONSTRUCTION OF THE MIDDLE JURASSIC OTLALTEPEC FORMATION OF OAXACA, MÉXICO

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***Keywords**: paleopalynology, Jurassic, Otlaltepec Formation, Mexico.*

The breakup of Pangea favored the generation of numerous basins in Mexico which were filled up with continental to marine sedimentary successions during the Jurassic. Oaxaca is a state with well-known Jurassic deposits containing fossil plants of excellent preservation. The palynological assemblage together with the results of the macroflora and sedimentological studies from Santo Domingo Tianguistengo in Oaxaca, allowed us to make a paleoenvironmental reconstruction of the Otlalteped Formation. According to sedimentological and petrographical studies, paleobotanical remains come from an overbank environment within a floodplain area with anastomosed rivers that was intermittently flooded during high-water stages and with subaerial exposition during low-water periods, favoring the development of paleosols under humid climatic conditions. Macroflora and microflora remains are related to flooded areas or ephemeral lakes in this context. The macroflora shows a predominance of Cycadales and Bennettitales while ferns remain a minor group. The palynological assemblages also indicates a dominance of gymnosperms (*Inaperturopollenites*, *Spheripollenites*, *Araucariacites*), and small proportion of pteridophytes (*Cicatricosisporites*, *Cyathidites*, *Deltoidospora*, *Klukisporites*, *Leptolepidites*, *Manumia* and *Nodosisporites*), as well as spores of freshwater zygnematacean green algae (*Ovoidites* and *Chomotriletes*).

PALYNOLOGICAL RECORD FROM PALEOZOIC MATZITZI FORMATION OF MEXICO

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Keywords: *paleobotany, paleopalynology, Matzitzi Formation, Mexico.*

This study is focused on the palynological record from the Matzitzi Formation of Puebla and Oaxaca States in Mexico. This unit has been interpreted to have been deposited in fluvial sedimentary environment containing well-known fossil plants in floodplain environments (Silva-Pineda, 1970). There is a general controversy relating to the age of this formation, including ages ranging from Pennsylvanian (Silva-Pineda, 1970) to Permian (Weber, 1997) based on fossil plants. A Leonardian age (Kungurian, 279.3-272.3 Ma) is the age accepted by the majority of researchers today by the presence of the gigantopterid *Lonesomia mexicana* and correlation with southern United States (Weber, 1997). However, this fossil taxon has been excluded from many works as the venation characters do not permit its assignment to gigantopterids. The palynological assemblage presented herein contains the genera *Acanthotriletes*, *Calamospora*, *Deltoidospora, Densoisporites*, *Laevigatosporites*, *Punctatisporites*, *Triquitrites*, and *Thymospora*. This assemblage represents an age no older than late Carboniferous and no younger than Early Permian. Microflora record together with recent geochronological data for this formation suggest an early Permian age.

THE IMPORTANCE OF PALAEOXYLOTOMY AS A TOOL FOR THE IDENTIFICATION OF THE MACROFLORISTICALLY BASED RESPONSES TO THE CLIMATIC CHANGE: CASE STUDIES FROM THE MIOCENE OF GREECE.

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***Keywords**: Fossil Wood Anatomy, Lauraceae,* Laurinoxylon, Cinnamomoxylon, Cryptocaryoxylon.

Palaeoxylotomy is a very important branch of palaeobotany dealing with the wood anatomy of the once living stems, which are found fossilized. Palaeoxylotomy shares the same objectives as palaeobotany: plants' reconstruction and their evolution & function, as well as biostratigraphy, palaeoecology and palaeoclimate based on them.

The detailed and careful work while working in palaeoxylotomy is a necessity for the identification of the specimens and for the determination of their palaeoenvironment. There are two approaches concerning the methods for reconstruction of climate and vegetation based on fossil wood: a) the "Subjective" (where the taxonomic attribution is needed, e.g. CA-NLR, IPR) and b) the "Objective" (where there is no need of taxonomic attribution, e.g. Wiemann's statistical model, PFT), and both are discussed here. Although it is not directly obvious, a very important "Subjective" phase is however included in both approaches being based on the skilled knowledge of anatomical characteristics, e.g., preliminary choice of the wood types in Wiemann's statistical model.

Numerous lauraceous fossil wood specimens from the Miocene of Greece have been studied microscopically and minor details of their wood anatomy (regarding e.g. the type of rays, porosity, axial parenchyma, occurrence of marginal bands, and exact occurrence of the idioblasts) have revealed major differences in fossil species, their botanical affinities, and palaeoenvironmental requirements. This detailed taxonomic work of the fossil lauraceous findings from Lesbos and Lemnos Islands (Greece) is presented here as an example of the application of palaeoxylotomy for estimating the macrofloristic traits and climatic change from Cenozoic to present.

PALYNOLOGY OF THE PASO AGUIAR AND YAGUARÍ FORMATIONS (PERMIAN, PARANÁ BASIN, URUGUAY): PALAEOCLIMATIC AND BIOSTRATIGRAPHIC IMPLICATIONS

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***Keywords**: spore, pollen, biostratigraphy, late Cisuralian–Guadalupian age, Paraná Basin.*

Palynofloras from the lower Permian strata of Uruguay have been intensively studied. However, the palynological information of the Paso Aguiar Formation is scarce and the palynological content of the Yaguarí Formation has not been analysed. In this study, palynological core-samples recovered from borehole N°943 (DINAMIGE), drilled in the Cerro Largo Department (northeastern Uruguay), were analysed. Ten samples were obtained from the Paso Aguiar Formation and three samples from the base of the overlying Yaguarí Formation. Palynological assemblages are dominated by striate bisaccate pollen grains, mainly *Staurosaccites* and *Lueckisporites*, and subordinated monolete and cavate spores, essentially represented by *Thymospora* and *Lundbladispora*, *Gondisporites*, and *Spelaeotriletes,* respectively. The assemblages also include non-striate and plicate pollen grains, laevigate and apiculate trilete spores, and algae. Comparing palynological results with those previously obtained for the underlying Mangrullo Formation, an important increase in spores is observed at the lower levels of the Paso Aguiar Formation. The abundance of spores related to hygro-mesophytic plants along with pollen grains of meso-xerophic plants suggests seasonally warmer and humid climates. These assemblages are assigned to the *Striatoabieites anaverrucosus-Staurosaccites cordubensis* Biozone of late Cisuralian-Guadalupian age, in Uruguay, based on the presence of *Lueckisporites agoulaensis*, *L. balmei*, *L. nyakapendensis*, *L. stenotaeniatus*, *L. virkkiae*, *Striatoabieites anaverrucosus*, *Staurosaccites cordubensis*, *S. quadrifidus*, *Lunatisporites paliensis*, *L. variesectus*, *Corisaccites alutas*, *Alisporites parvus*, *Alisporites rioclarensis*, *Colpisaccites granulosus*, *Convolutispora archangelskyi,* and *Gondisporites serrulatus*. Although the assemblages are closely related to other biozones from South America, a better correlation with informal proposals for the Paraná Basin in Brazil is suggested.

WELTRICHIA FABREI, A BENNETTITALEAN REPRODUCTIVE STRUCTURE FROM THE RHAETIAN?/ HETTANGIAN OF SOUTHERN FRANCE

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Keywords: *Bennettitalean, Williamsoniaceae,* Weltrichia fabrei*, Early Jurassic, Causses Basin.*

Although the holotype of *Weltrichia fabrei* Saporta, 1891 has been considered destroyed since the end of the 20th century, the specimen was recently rediscovered during investigations led in the buildings of the old Musée Ignon-Fabre (Mende, southern France) which were closed in 1995. Here, we revise the species, discuss the chronostratigraphic assignment of the type locality and the depositional palaeoenvironment. *W. fabrei* was discovered by Georges Fabre at Chirac (Lozère). He collected the specimen in the Detrital sandstones-variegated mudstones Formation. Age of this formation was initially interpreted as Rhaetian. We assign a Rhaetian?/early Hettangian age to the *W. fabrei* bearing sandstone for the following reason: based on palynology, previous studies demonstrated what the Detrital Formation is diachronic and not exclusively Upper Triassic but also Hettangian in the northern part of the Causse Basin. *W. fabrei* consists of a cup with one whorl of at least seven, slender and elongated sporophylls that apically curve inwards. Sporophylls display a dorsal median ridge, an acute apex and look leathery. Distally, the adaxial surface of sporophylls bears up to seven, elongated, tips forming branched structures comparable to the large pollen bearing organs observed among Upper Triassic/Lower Jurassic Bennettitalean fructifications. The depositional environment of *W. fabrei* is interpreted as a vast floodplain in which channels periodically occurred.

INTERREGIONAL CORRELATION OF PALYNOZONES FROM THE LOPINGIAN TO THE MIDDLE TRIASSIC

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***Keywords**: Permian, Triassic, land plants, palynomorphs, biostratigraphy.*

The Lopingian, Early and Middle Triassic were times of important changes in faunas and floras over the course of the end-Permian mass extinction, but also before and after. A reliable stratigraphic correlation between regions is required for an accurate account of these developments. Macrofossils of land plants can only provide a low-resolution biostratigraphy, while detailed biozonation schemes based on palynomorphs are available for many regions. Their applicability is limited by factors such as (micro-) floral provincialism, a lack of suitable marker taxa commonly occurring at important boundaries, and in many cases a lack of independent age control. Nevertheless, these palynostratigraphic schemes are regularly used for dating and correlation of successions between different regions. To support such efforts, palynological biozones from the Lopingian up to and including the Middle Triassic from across the world are summarized and revised. A consistent correlation with the currently recognized international stages is established, but not all chronostratigraphic stages are equally well aligned with palynozones. The bases of the Wuchiapingian and Changhsingian are rather indistinct with respect to palynology. The Permian–Triassic boundary by itself is also not always recognizable, but the latest Permian is marked by important changes in palynofloras, which are reflected in palynozones. Spores and pollen might be useful as approximate indicators of the Induan–Olenekian boundary in several regions, but this boundary is not yet defined by a GSSP. In contrast to the Lopingian and Early Triassic stages, the bases of the Anisian, Ladinian, and Carnian are palynostratigraphically distinct in many regions.

LATE QUATERNARY PALEOENVIRONMENTAL AND PALEOCLIMATE RECONSTRUCTION OF NORTHERN DRYGALSKY BASIN (ROSS SEA, ANTARCTICA) TRHOUGH SEDIMENT CHARACTERISTICS AND DIATOM ASSEMBLAGES: PRELIMINARY RESULTS.

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Keywords: *Ross Sea, sediments, diatoms.*

Diatoms are one of the major phytoplankton groups blooming in cold, nutrient rich regions, such as Antarctica, where silica is not limited. The high diatom productivity and the good preservation in Antarctica marine sediments, allow to use diatoms to study the late Quaternary environmental changes We present a study of diatoms assemblages associated to the sedimentological and compositional characteristics in two piston cores collected in the northern Drygalski Basin (Western Ross Sea) in the framework of the PNRA-Project TRACERS (TephRochronology and mArker events for the Correlation of natural archives in the Ross Sea), Antarctica. Core TR1703_PC is characterized by alternating muddy sand and sandy mud with some levels containing abundant foraminifers. Two distinct tephra layers are present along this core. Core TR1704 _PC is characterized by sandy silt alternating with clayey silt. Four tephra layers have been described in the sediment sequence.

Preliminary data allowed to recognize three different facies. Facies 1 is a glaciomarine diamicton present at the bottom of both cores. Facies 2, which represents a transition from glacial to open sea environments is present only in core TR1703_PC. Facies 3, recognized at the top of both cores, represents open water environmental conditions with evidences of seasonal sea ice.

Physical (magnetic susceptibility), chemical-geochemical (organic and total carbon, major and trace elements) and micropaleontological (foraminifera) analyses support the results based on diatom assemblages and sedimentological data.

CHARCOALIFIED PLANT REMAINS FROM THE GOLFO SAN JORGE BASIN, ARGENTINE: EVIDENCE OF WILDFIRE DURING THE LATE CRETACEOUS

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***Keywords**: charcoal, wildfire, Maastrichtian, Lago Colhué Huapi Formation, Golfo San Jorge Basin.*

Vegetal charcoal, which can be considered an unambiguous product of wildfires, was recovered from two outcrops of the upper levels of the Lago Colhué Huapi Formation (Cerro del Hadro and Zanjón del Valle Hermoso), at the headwaters of the Río Chico in the Golfo San Jorge Basin. An upper Maastrichtian age was proposed for the studied beds taking into account the presence of biostratigraphically significant pollen species (such as *Quadraplanus brossus* and *Tubulifloridites lilliei*) as well as a basalt flow with a radiometric age of 67.31 ± 0.55 Ma that lies on top of the unit. The recovered particles correspond to mesocharcoal (125µm-1mm) suggesting paleofires that reached temperatures near 300°C and affected the local vegetation. The charcoalified plant material was studied under a Scanning Electronic Microscope. Most of the charcoal comes from a white marlstone bed, laterally associated to a calcite stromatolite in the Cerro del Hadro. This level presents, among other charcoalified remains, coniferous wood with uniseriate and biseriate bordered pits and different types of crossing fields and angiosperm fragments including floral parts as a dithecous anther with longitudinal dehiscence. The principal morphologies of the charred wood are stem-like and elongate forms.

These wildfires were probable favored by the high concentration levels of Oxygen during the Cretaceous (high-fire world). Locally, the volcanic activity represented by the basalt flows recognized in the upper part of the unit is proposed as the more probable trigger factor of the paleofires. These Maastrichtian wildfires could have also been induced by the lightining activity.

LATE CRETACEOUS CHAROPHYTE PALAEOECOLOGY AND PALAEOBIOGEOGRAPHY OF NORTHERN MEXICO

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Keywords: *Characeae, palaeoecology, palaeobiogeography, Northern Mexico, Cretaceous*.

Mexican non-marine deposits are well-known from the sedimentological and stratigraphical viewpoints. However, knowledge on fossil charophytes from the Upper Cretaceous of North America is still very limited in comparison with Europe and Asia (China).

Recent field and bibliographic analyses enable the comparison of two charophyte assemblages found in the Cabullona (north-eastern Sonora) and the Parras (south-eastern Coahuila) basins (northern Mexico), respectively. The first charophyte assemblage was obtained after the systematic sampling of a ca. 500 meters-thick Fronteras section (Sonora) about 77 Ma ago (González-León et al., 2017). Dark grey lutites and siltstones alternated with abundant sandstones are interpreted as fluvial and lacustrine deposits and contain an assemblage dominated by *Lychnothamnus tenuis* along with other characeans such as *Sphaerochara* aff. *parvula* and *Microchara* aff. *laevigata*. A different assemblage of charophytes was reported from the nearly contemporaneous (late Campanian, Eberth et al., 2004) Cerro del Pueblo Formation (Saltillo, Coahuila) and interpreted as being deltaic and lacustrine in origin (Aguillón-Martínez, 2010). It is formed by the porocharacean *Feistiella gildemeisteri* and the characean *Platychara* sp.

The palaeoecology of these two assemblages show two different environmental preferences. While *Lychnothamnus* and the associated characeans would characterize freshwater deposits, the occurrence of generally monospecific porocharacean assemblages, sometimes associated with *Platychara* species, indicates instead brackish environments. Charophyte palaeoecology supports the occurrence of brackish environments at the south-eastern Laramidia, close to the Western Interior Seaway, while fluvial and freshwater deposits occurred in the continental western area. These interpretations agree with the sedimentological descriptions of both areas and with the paleogeographic distribution of the Laramidia landmass.

1st Palaeontological Virtual Congress

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TAXONOMIC REVIEW OF THE PTERANODONTIDAE (PTEROSAURIA, PTERODACTYLOIDEA) BASED ON GEOMETRIC MORPHOMETRICS

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Keywords: *Pteranodontidae, geometric morphometrics, sexual dimorphism.*

Pteranodontids are edentulous, large-bodied pterosaurs exclusive to the Cretaceous whose taxonomy is controversial. The most inclusive review of its North American species (1994) resulted in only two: *Pteranodon longiceps* and *Pteranodon sternbergi*. It has recently been followed (2010) by a taxonomic revision that increased their number to four, adding the genera and species *Dawndraco kanzai* and *Geosternbergia maiseyi*, and proposing a new combination, *Geosternbergia sternbergi*. The aim of this work is to review the taxonomy of these species. We used geometric morphometrics, which allow accounting for intra- and interspecific morphological variations. Twenty pteranodontid cranial specimens were analyzed. Reconstructions of the skulls in lateral view were made, because most of them are incomplete and crushed. Vectorial drawings were generated and 51 *landmarks* designated for all skulls. Procrustes Fit, Principal Component Analyses, and Canonical Variate Analyses were performed using MorphoJ. In the PCA, the holotype of *D. kanzai* resulted as separated from all other specimens in morphospace and formed a cluster with a second specimen (KUVP 967, previously identified as *Pteranodon sternbergi*). There is no strong evidence supporting *Geosternbergia* as a separate genus and there is support to consider *G. maiseyi* as a junior synonym of *Pteranodon sternbergi*. A Canonical Analysis supports the validity of only three species: *Pteranodon longiceps, Pteranodon sternbergi* and *Dawndraco kanzai*. Qualitative comparisons with pterodactyloids in which the largest individuals with the largest cranial crests are considered males (such as *Hamipterus tianshanensis*) allow us to infer the same pattern for *Pteranodon,* with sexual dimorphism driven by sexual selection.

ARE THE TAPEJARINAE PAEDOMORPHIC? POSSIBLE OSTEOLOGICAL CORRELATES OF HETEROCHRONIC DEVELOPMENT

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Keywords: *Tapejarinae, paedomorphosis, heterochrony, osteological correlates, pterosaurs.*

Tapejarines are toothless pterodactyloid pterosaurs characterised by some distinctive features, such as their shortened and ventrally deflected rostrum and anteriorly high premaxillary sagittal crests. Most tapejarines are relatively small-sized, not exceeding 2.4 meters in wingspan, with the exception of the ~3 m wingspan *Caupedactylus ybaka* and *Tupandactylus imperator*. This contrasts with the ~4 m wingspan thalassodromines and azhdarchids that range from ~3 to ~12 m. Here, we discuss on some of these tapejarine features that might be related to paedomorphosis. Paedomorphosis is a type of heterochrony—developmental change in the timing or rate of size and/or shape development of structures—characterised by the retention in adults of juvenile features. Firstly, small size and shortened rostra are recurring features of paedomorphosis. We note that other azhdarchoids (thalassodromines, chaoyangopterids and azhdarchids) possess longer rostra compared to tapejarines. Furthermore, the losses of the notarium and sacral supraneural plate have been proposed as synapomorphies of the group. Loss of ossification in some structures can also be related to paedomorphosis in vertebrates. However, this observation must be viewed with caution until complete adult specimens are found. In *Caiuajara dobruskii*, the shape of the humerus does not change significantly from juveniles to adults, (i.e., the development of the deltopectoral crest corresponds to ~40% of the humerus length). These features could represent paedomorphic traits. These possible osteological correlates of heterochronic development, combined with histological correlates and geometric morphometry analysis of the skulls, could help shed further light on this hypothesis.

ON THE PHYLOGENETIC RELATIONSHIPS OF *BARBOSANIA GRACILIROSTRIS* (PTERODACTYLOIDEA, PTERANODONTOIDEA) FROM THE ROMUALDO FORMATION (ALBIAN, NE BRAZIL)

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Keywords: *Pteranodontoidea, Anhangueria*, Barbosania, *phylogeny, pterosaurs*.

Barbosania gracilirostris is represented by a partially prepared holotype including skull and mandible (and several postcranial elements) from the Albian Romualdo Formation (NE Brazil) and was originally assigned to the waste-basket group Ornithocheiridae. It has not been included in any phylogenetic analysis so far. In a recent revision, the family has been limited to *Ornithocheirus* instead of englobing *Anhanguera* and related genera, with most species previously referred to this family having thus been interpreted as closer to *Anhanguera* than to *Ornithocheirus* in the family Anhangueridae. Furthermore, the clade Anhangueria was proposed forall species closer to anhanguerids than to *Cimoliopterus*, with *Ornithocheirus* falling outside of it. In our phylogenetic analysis, *Barbosania gracilirostris* was recovered outside of the Anhangueria (as it lacks a premaxillary lateral expansion, their synapomorphy), oppositely to other toothed pteranodontoids from the Romualdo Formation (*Anhanguera*, *Tropeognathus*, *Maaradactylus*, *Cearadactylus* and *Brasileodactylus*). *Barbosania* was recovered in our analysis as the sister-group of *Cimoliopterus* + Anhangueria (which are joined by a dorsal deflection of the palate, which is lacking in *Barbosania*). The clade *Barbosania* + (*Cimoliopterus* + Anhangueria) is supported by the long axis of the first pair of upper teeth being anteroventrally oriented relative to posterior teeth. The sister-group to the clade comprised of *Barbosania* + (*Cimoliopterus* + Anhangueria) was *Ornithocheirus*. In *Ornithocheirus* the first pair is as ventrally oriented as the other pairs. In the future, final preparation of the holotype of *Barbosania gracilirostris* is paramount for the coding of further characters and confirmation of its phylogenetic position.

A NOVEL PHYLOGENETIC ANALYSIS OF AZHDARCHOID PTEROSAURS, WITH COMMENTS ON THEIR BIOGEOGRAPHY AND PALEOECOLOGY

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Keywords: *Azhdarchoidea, pterosauria, phylogeny, biogeography.*

The Azhdarchoidea are a derived and successful group of pterodactyloid pterosaurs. To date, there have been few studies focusing on azhdarchoid phylogeny or biogeography. The fragmentary or poorly preserved nature of many azhdarchoid specimens has limited their placement in large-scale phylogenetic analyses. Here I present a preliminary phylogenetic analysis of azhdarchoid pterosaurs. The novel dataset consists of 105 OTUs, many of which do not yet bear scientific names, and over 300 characters, primarily focused on the skull, cervical vertebrae, and humerus. This analysis recovers a Thalassodromidae-Tapejaridae clade and resolves the internal relationships of the Azhdarchidae, identifying distinct lineages and potentially multiple acquisitions of giant size (>8-meter wingspan) within the clade. Several "wildcard" taxa, including *Alanqa* and *Montanazhdarcho* are recovered at the base of the azhdarchid branch. Dsungaripteridae is recovered as a fourth major lineage of pterodactyloids, and isolated Jurassic/Early Cretaceous "azhdarchid" vertebrae are more likely to belong to Ctenochasmatoidea. Numerous recovered clades, including Thalassodromidae, Chaoyangopteridae, and Quetzalcoatlinae comprise members primarily or exclusively from one geographic location. Although the influence of sampling bias cannot be excluded, this suggests dispersion patterns in azhdarchoids may be more reflective of terrestrial ecologies than aerial capacity.

1st Palaeontological Virtual Congress

Stratigraphic Palaeobiology: developing a toolbox for palaeobiologists

Moderators:

Emilia Jarochowska

GeoZentrum Nordbayern, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

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PRESERVATION OF ENVIRONMENTAL SIGNALS WITHIN FOSSIL BODY SIZE DISTRIBUTIONS

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***Keywords**: stratigraphic palaeobiology, taphonomy, collection biases, size studies, palaeoecology.*

Differences in size distribution of populations of fossil macroinvertebrates are often interpreted to be the results of palaeoenvironmental stressors, but various collection, facies and taphonomic biases could contribute to these patterns. We studied the size distribution within samples of the Famennian (Late Devonian) sporadoceratid ammonoids from various regions (Rhenish Mountains of Germany in the equatorial zone; Anti-Atlas of Morocco, Saoura Valley of Algeria in the temperate zone) to test the relative contributions of geographic and temporal differences, sampling, and preservation. Despite of the latitudinal differences, the size distribution within samples is more controlled by lithology than by region, taxonomy, or collection style. These results caution against interpreting ammonoids as facies-independent and interpreting size differences across extinction events in terms of physiological stress when they are recorded across facies changes.

BINNING BY FORMATION: A NEW METHOD FOR INCREASED TEMPORAL RESOLUTION IN REGIONAL STUDIES

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***Keywords**: chronostratigraphy, Western Interior, time binning, formations, Dinosauria.*

The advent of palaeontological occurrence databases has allowed for detailed reconstruction and analyses of species richness through deep time. Whilst a substantial literature has evolved ensuring that taxa are fairly counted and represented within and between different time periods, how time itself is divided has received relatively less attention. Stage-level or equal-interval age bins have been frequently utilised for regional and global studies in vertebrate palaeontology. However, when accessing diversity at a regional scale, these resolutions can prove inappropriate with the data that are available. Herein, we propose a new method of binning geological time for regional studies that intrinsically incorporates the chronostratigraphic heterogeneity of different rock formations to generate unique stratigraphic bins. Script written in R uses a list of formations with their respective start and end points to repeatedly check the suitability to draw a time bin boundary in intervals, by assessing the position of each formation relative to the proposed time bin boundary. The most suitable boundaries are compiled to form a new series of time bins, to which formations and respective occurrences are assigned. Variations on this methodology are presented which can additionally deal with formations that cross bin boundaries. We use this method to produce diversity curves of dinosaur fauna from the Cretaceous (Aptian-Maastrichtian) of the Western Interior of North America, which reveal diversity patterns missed using traditional stage-level bins. This study helps to illustrate the utility of high-resolution, regional studies to supplement our understanding of factors governing global diversity in deep time.

THE ROLE OF TAPHONOMY AND FACIES DISTRIBUTION ON THE FOSSIL RECORD OF NEOGENE AND QUATERNARY CETACEANS: A STRATIGRAPHIC PALEOBIOLOGY APPROACH

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***Keywords**: cetaceans, Neogene, taphonomy, biodiversity.*

Evolution and ecology of cetaceans, including the largest tetrapods in history, are widely studied. The nature and distribution of their fossil record, key factors to make macroevolutionary and ecological inferences, are however less explored. To fill this gap, we carried out a survey of global literature to check for facies control in the taphonomy and distribution of Neogene and Quaternary cetaceans. We matched individual specimens with sedimentary facies and time interval, ranging from the Aquitanian to the Calabrian. We found a strongly skewed distribution of findings, both in space (seven facies) and time (six time bins). The majority of fossils are found in offshore mudstones and sandstones, whereas lowest abundances are recorded in shoreface sandstones. When plotting number of findings per time interval, standardized for time-bin duration, a slight increase is recorded during the Miocene, a stepwise increase at the late Miocene-Zanclean transition, followed by a Piacenzian peak and a dramatic Pleistocene drop. Miocene specimens are preferentially associated with condensed deposits and are more fragmentary in nature (to the exclusion of South American specimens). Pliocene specimens are mostly found in offshore sediments, indicating that the Piacenzian peak in abundance and diversity could be, in part, a taphonomic artefact related to depth. At offshore depths, carcasses sink and remain on the seafloor due to higher water pressure; they are thus preferentially preserved. The Gelasian-Calabrian drop is unexpected, considering the abundance of offshore sediments worldwide, and might be explained by the average-size increase of cetaceans, which potentially triggered a radiation of bone-eaters.

REVERSING TIME AVERAGING AND RECONSTRUCTING EXTINCTION RATES WITH APPROACHES FROM IMAGE PROCESSING

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***Keywords**: stratigraphic palaeobiology, time averaging, Signor-Lipps effect, image processing, data reconstruction.*

Last fossil occurrences and fossil abundance are used to infer about the ecology in the deep past, be it the success of a taxon in a particular environment, or the temporal development of extinction rates throughout a mass extinction. However, the Signor-Lipps effect and time averaging make this type of data only circumstantial evidence of the ecological process that generated them in the first place. I present a model that is based on the idea that empirical data as it is generated by fieldwork is a blurred version of the original ecological signal, which can accordingly be obtained by reversing the blurring effect. Generating and reversing these effects is a common task in image processing, which offers a number of algorithms for these tasks that can be deployed for the proposed model. The presented reconstruction method can be also expanded to incorporate the effects of changing deposition rates and to model the Signor-Lipps effect as well as different types of time averaging.

QUANTIFYING THE EFFECTS OF CHANGING DEPOSITION RATES ON THE STRATIGRAPHIC DISTRIBUTION OF FOSSILS

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***Keywords**: stratigraphic palaeobiology, statistics, sequence stratigraphy.*

The fossil record is inevitably controlled by the sedimentary processes that formed it, and it can only be understood within the context of these processes. This makes the incorporation of knowledge about sedimentary conditions into statistical analysis of the fossil record necessary to obtain exact results. I present a statistical method that allows the investigator to quantify the effects of changing depositional rates on the stratigraphic distribution of fossils on the scale of single sections. This method can be used to correct data for effects of changing depositional rates, and to assess how the interpretation of palaeontological hypotheses changes under different depositional models. It can also be used to optimize sampling procedures, is backwards compatible with previous statistical methods that use the stratigraphic distribution of fossils, and allows modelling of the effects of changing depositional rates on the fossil record. This demonstrates how sequence stratigraphic architecture influences the fossil record and emphasizes the importance of a sampling procedure that not only documents the distribution of fossils, but also the depositional environment.

AN EXTINCTION FOR EVERY OCCASION: RECONCILING CONODONT BIOSTRATIGRAPHY WITH STRATIGRAPHIC PALAEOBIOLOGY

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Keywords: *extinctions, sequence stratigraphy, conodonts, Palaeozoic, sequence boundaries.*

Conodonts are extensively used in Cambrian through Triassic biostratigraphy and fossil-based geochemistry. However, their distribution in rock successions is commonly taken at face value, without considering their ecology. A series of conodont extinction events have been proposed during the Silurian Period – the so called Ireviken, Mulde and Lau events. These events have been based on qualitative observations of local extirpations of open-marine pelagic or nekto-benthic taxa and temporary dominance of shallow-water species. These changes coincided with positive carbon isotope excursions, abrupt facies shifts, "blooms" of benthic fauna, and changes in reef communities, which have all been combined into a general view of Silurian bio-geochemical events. This view posits a deterministic, reproducible pattern in Silurian conodont diversity, attributed to recurrent ecological or geochemical conditions. The growing body of sequence-stratigraphic interpretations across these events indicate that in all cases the Silurian "events" are associated with rapid global regressions. This suggests that faunal changes such as the dominance of shallow-water, low-diversity conodont fauna and the increase of benthic invertebrate diversity and abundance represent predictable consequences of the variation in the completeness of the rock record and preservation potential of different environments. Quantitative data on facies distribution of individual conodont species combined with sequence stratigraphic architecture provides a testable model for the impact of sea-level changes on perceived conodont diversity in a section or basin.

BIOSTRATIGRAPHY OF *DISCOSCAPHITES* AS A TOOL FOR INTERPRETING THE SEQUENCE STRATIGRAPHY IN THE GULF COASTAL PLAIN (MISSISSIPPI EMBAYMENT, SOUTHERN USA).

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Keywords: *ammonite biostratigraphy, Maastrichtian, sequence stratigraphy, Gulf Coastal Plain, Mississippi Embayment.*

The upper Maastrichtian *Discoscaphites* zones in the Gulf Coastal Plain (GCP) facilitate the interbasin correlation of discrete upper Maastrichtian units and the placement of sequence stratigraphic boundaries. The lowest *Discoscaphites conradi* Zone spans the lower part of the upper Maastrichtian, nannofossil subzones CC25b/UC20a^{TP} and the lower part of CC26a/UC20c^{TP}. The middle *D. minardi* Zone spans the middle part of the upper Maastrichtian, upper part of subzone CC26a/UC20c^{TP}. The upper *D. iris* Zone spans the uppermost Maastrichtian, subzones CC26b/UC20c^{TP}. Ammonite distribution supported by co-occurring dinoflagellates and calcareous nannofossil assemblages suggest that the occurrence of *D. iris*, *D. minardi* and *D. conradi* are isochronous across the Atlantic and Gulf Coastal Plain and are facies-independent varying from siliciclastic to mixed carbonate-siliciclastic sediments.

Previous studies recognized the uppermost Cretaceous transgressive-regressive cycle in the GCP as T-R K8 where a rise in base level terminated by a maximum flooding event during the early to early-late Maastrichtian, followed by a regressive phase. Distinct shell beds at the Moscow Landing and Mooseland localities in Alabama are interpreted as a maximum flooding surface (MFS) and serve as the most reliable tool for chronostratigraphic correlation in the Mississippi Embayment. The occurrence of *D. conradi* is consistently present below this synchronous horizon and overlain by *D. minardi* and *D. iris* assemblages. Stratigraphic distribution of *Discoscaphites* suggests that *D. iris* and *D. minardi* Zones were deposited within the Highstand Systems Tract and *D. conradi* Zone was deposited within the Transgressive Systems Tract in the GCP.

EXPRESSIONS OF EXTINCTION EVENTS AS EMERGENT ECO-STRATIGRAPHIC EPIPHENOMENA

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Keywords: *mass extinction, sequence stratigraphy, Signor–Lipps effect, sampling bias, Holocene.*

Stratigraphic patterns of last occurrences of fossil taxa (LOs) potentially fingerprint mass extinctions and delineate rates and geometries of those events. Empirical studies of mass extinctions recognize that random sampling causes LOs to occur earlier than the time of extinction (Signor–Lipps effect). To correct for this effect, estimates of time and pattern of extinctions typically relied on the assumption of random distribution of fossils (uniform recovery potential). Such methods, however, may be sensitive to sequence stratigraphic controls on fossil occurrences suggested by recent modelling efforts.

By tracing stratigraphic occurrences of extant mollusc species in the Holocene succession of the Po Plain (Italy), we demonstrate that sea-level driven shifts in local community composition and non-random variation in the abundance of skeletal remains produce systematic changes in occurrence rates and sampling probabilities of fossils. The resulting non-random truncation of stratigraphic ranges leads to clustering of LOs within intervals of stratigraphic condensation and strong facies shifts mimicking sudden extinction pulses. Consequently, if mass extinction took place today, the preserved LO patterns would suggest complex but entirely false extinction scenarios. Methods assuming uniform recovery potential of fossils falsely supported stepwise extinction patterns among studied species and systematically underestimated their stratigraphic ranges.

Such patterns, which reflect interactions between ecological and stratigraphic processes, can easily confound interpretations of the timing, duration and selectivity of mass extinction events. Our results highlight the necessity of accounting for palaeoenvironmental and sequence stratigraphic contexts when inferring extinction dynamics from the fossil record.

CHANGES IN QUALITY AND TIME RESOLUTION OF THE MACROFOSSIL RECORD: INSIGHTS FROM HOLOCENE TRANSGRESSIVE DEPOSITS, PO COASTAL PLAIN, ITALY

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Keywords *benthic invertebrates, Holocene, Po Plain, stratigraphic paleobiology.*

In siliciclastic marine settings, skeletal concentrations are a typical feature of transgressive sedimentary intervals that provide insights into biological and stratigraphic processes. Taphonomic signatures of a transgressive interval were analyzed along a depositional profile from the Holocene Po Plain stratigraphic framework (Italy). Integration of taphonomic and bathymetric analyses, and fossil density trends derived from three sampled cores suggests that the quality and resolution of the macrobenthic record predictably vary along the onshore-offshore gradient. These three types of environmental proxies provide distinctive signatures useful in characterizing facies associations and determining surfaces and intervals of sequence-stratigraphic significance. In the study area, taphonomic degradation of macrofossils increases from proximal/nearshore to distal/offshore locations. Compared to the up-dip (most proximal) core, the down-dip core is characterized by shell-rich lithosomes affected by ecological condensation (co-occurrence of environmentally non-overlapping taxa) and by higher biologically and physically driven alterations. The onshore-offshore taphonomic trend likely reflects variation in sediment-accumulation along the depositional profile of the Holocene Adriatic shelf, with surface/near-surface residence-time of macroskeletal remains increasing down-dip due to lower accumulation rates. Radiocarbon-calibrated amino acid racemization dates on bivalve specimens and the chronostratigraphic framework for this profile jointly suggest that the high levels of taphonomic degradation observed distally developed over millennial time scale (~8 ky). On the other hand, in the proximal setting, overall low taphonomic degradation and geochronologic constrains point to centennial-scale time-averaging during the late transgression phase. Patterns documented in the targeted Holocene deposits of the Po Plain may be characteristic of siliciclastic-dominated depositional systems that experience high-frequency base-level fluctuations.

FIELD-BASED DIGITIZATION OF MORPHOLOGY WITHIN A SEQUENCE STRATIGRAPHIC ARCHITECTURE

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***Keywords**: brachiopods, Late Ordovician, structure-from-motion, 3D geometric morphometrics, stratigraphic paleobiology.*

Changes in disparity provide important clues about the impact of environmental change on organisms throughout the fossil record. Most quantitative disparity studies have focused on 2-dimensional landmark data, but 3-dimensional surface data might provide a more complete assessment of how shell shape relates to environment.

We used Structure-from-Motion (SfM), a photogrammetry technique, to digitize brachiopod shell shape and applied it to quantify morphological change within the sequence stratigraphic framework of the Late Ordovician Cincinnati Arch (Indiana, Ohio, Kentucky; USA). SfM uses 2D photographs taken from different angles to reconstruct a 3D shape. We photographed external valves of brachiopods in the field in 360 degrees (approximately 24 photos per specimen) and used the SfM software 'Agisoft Photoscan' to make 3D models of those specimens. We exported these models into R and used the package 'morpho' to generate a set of semi-landmarks and create a morphospace to explore the effects of environment and time on 3D shape.

Results indicate that brachiopod shells separate in morphospace according to how flat/inflated and square/round they are. These differences are likely controlled by environmental conditions at each position along a water depth gradient. Additionally, the amount of variability in morphospace decreases in response to a regional extinction and invasion. SfM makes gathering 3D morphological data from the field possible. Because this is a low-cost and easily accessible method, possibilities of applying it more broadly within paleobiology abound. Further development of this technique will not only provide a better understanding of the distribution of morphological form within stratigraphic architecture, but also increase the quantity of morphological data from key intervals throughout the Phanerozoic. These data can be stored as a digital archive that could facilitate large-scale meta-analyses as well as education and outreach activities.

Taphonomy

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CHARACTERISING LEOPARD (*PANTHERA PARDUS*) AS TAPHONOMIC AGENT THROUGH THE USE OF MICRO-PHOTOGRAMMETRIC RECONSTRUCTION OF TOOTH MARKS

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***Keywords**: leopard, pits, scores, micro-photogrammetry, geometric morphometrics.*

Leopards have been the focus of taphonomic research due to their capability to create bone accumulations, to be regarded as competitors for same resources as others predators (carnivores or hominins), prey on some hominin groups such as Australopiths, or potentially provide scavenging opportunities to early hominins in the savannah ecosystem. Some of the variables explored to characterise felids as taphonomic agents showed the problem of equifinality, such as the frequency of tooth marks on shafts of long bones or the pit and score dimensions. Recently, new methodologies have been developed for the internal morphologic characterization of taphonomic marks, such as tooth marks, through the use of micro-photogrammetry and geometric morphometry. The present study applies these new techniques to reconstruct leopard tooth marks from the C.K. Brain's neotaphonomic collection housed at the Ditsong Museum (Pretoria, South Africa) and compare these with tooth marks from lions and spotted hyenas. Results show that tooth marks inflicted by the leopard, spotted hyena and lion can be statistically differentiated. The potential application of this variable in the analysis of early African archaeological sites is also explored, such as Sterkfontein Member 4 (Cradle of Humankind, Gauteng, South Africa). This variable may be also useful for differentiating bone accumulations produced by cave hyenas or leopards during the Pleistocene.

WHAT IS BORING IN FOSSIL RESIN?

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Keywords: *fossil resins, ichnofossils, taphonomy, trace fossils*.

Most of the fossil resins are known from their inclusions: animals, plants or fungi and microorganisms preserved as fossils. However, those are not the only traces of life preserved in fossilised resins, alongside with inclusions, resins may contain also ichnofossils (trace fossils), but these are poorly known, often overlooked or misinterpreted by researchers. There are only a few ichnofossils reported from fossil resins (like bivalve borings in Burmese amber), sometimes described as inclusions themselves (like fossilized insects larval cases). Baltic amber specimens from the collection of Museum of Amber Inclusions, University of Gdańsk (Poland) alongside with raw material deposited there, were subject of investigation in search of types of trace fossils that could be found in and on fossilised resins: animal borings, plant root traces, fecal pellets (coprolites), invertebrates nests or imprints of both animal and plant origins. The key reason of ichnotaxonomic studies on fossil resins are: better knowledge of taphonomy and sedimentology of resins, understanding the taxonomic and taphonomic context, assessment and reconstructions of palaeoenvironments of resin exudation and deposition areas, and estimation of resin and resin-deposits age.

AN EXPERIMENT OF RECENT STROMATOLITES PRESERVATION FROM LAGOA SALGADA, BRAZIL, FOR STUDY OF ANCIENT ANALOGUES

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***Keywords**: stromatolites, carbonates, Lagoa Salgada (Brazil), Holocene.*

Stromatolites are today restricted to a few places on the planet but were largely expanded in all continents during Precambrian. Their fossil documentation is of the major importance because stromatolites are the macroscopic evidence of the beginning of the life and its evolution in the earth. In laboratory favourable conditions for stromatolitic development were simulate in order to define the best analogues for the study of the fossil ones. Stromatolite samples were collected from Lagoa Salgada, in Campo dos Goytacazes city, localized in southeastern of Brazil. The simulation of the hypersaline environment in an aquarium was done by adding 35 ‰ of sea salt dissolved in deionized water. Monthly water analyses were carried to define pH, temperature, salinity and dissolved oxygen. Such data were compared with those from the source lagoon. As a result, the controlled environment showed to be alkaline, with pH ranging from 7.8 to 8.3, salinity from 52 to 86 ‰, and the average temperature of 29 °C. As a whole these parameters are close to those measured in Lagoa Salgada. X-ray diffraction analysis revealed the precipitation of Mg-calcite, halite and gypsum in the stromatolite layers, confirming that the geochemical conditions of the lagoon were replicated. Analyses of stable isotopes revealed a variation in the isotopic ratio of 18O in the different layers of the stromatolite, providing support for interpretations of paleoenvironment changes in the lagoon, during the last two thousand years: possible some ancient connections with the sea in the first stages of structure growth and climatic variation which were registered in the layers.

BIOEROSION ON VALVES OF MOLLUSKS IN LOS POCITOS (LATE PLEISTOCENE) SOUTH OF BUENOS AIRES PROVINCE, ARGENTINA

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***Keywords**: bioerosion, marine mollusks, Late Pleistocene, Buenos Aires, Argentina.*

Bioerosion traces are abundant on marine mollusks in Late Quaternary deposits along the South American Atlantic coast. The study of biogenic traces in fossil mollusk shells of the South Atlantic coasts has been significant in recent years, providing clues for the study of palaeoenvironmental and palaeoecological conditions as well as for the evolution of hard substrate communities. The aim of this contribution is to report the first Late Pleistocene bioerosion traces on marine bivalves and gastropods of Los Pocitos (40°26´S - 62°25´W), in the south of Buenos Aires Province. The marine deposit is dated in 43, 38.8 and 31 Ky(^{14}C) with heights of 8.6 m. These dates are at the limit of the method, and hence, they are considered as minimum ages. The marine deposits are associated with fauna that indicate warm conditions; thus the deposits were correlated with the Interglacial (MIS 5e). Bioerosion traces were recorded in 38.9 % of the 298 valves of attributed to 18 species (9 gastropods and 9 bivalves). Five ichnogenera were reported: Four Domichnia: *Maeandropolydora* (33.3%), *Pinaceocladichnus* (25%), *Entobia* (16.6%), *Iramena* (8.3%), and one Praedichnia: *Oichnus* (8.33%). In addition, a new biogenic hole trace was found in this area, characterized by a multiradiate star-shaped outline. This trace is *Stellatichnus radiates* but about 2000 - 3000 µm length. The benthonic marine community is composed of polychaete annelids, cheilostome bryozoans, clionaid sponges and predator gastropods, associated with warm marine mollusks. The area was described as a sublittoral environment, with low-energy and sandy bottoms in the Late Pleistocene.

VERTEBRATE TAPHONOMY OF THE FOSSIL REMAINS FORM THE CORRAL DE ENMEDIO FORMATION (UPPER CRETACEOUS) CABULLONA GROUP, SONORA, MÉXICO

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***Keywords**: taphonomy, Cabullona Group, Campanian.*

The Corral de Enmedio Formation has been the most fossiliferous unit in the Cabullona Group. This unit is part of the Naco section of the Upper Cretaceous Cabullona Group and its age has been constrained between ca. 73 and 72 Ma. This 230-m thick formation consists of sandstone, siltstone, mudstone, subordinate limestone and conglomerate that were accumulated in mostly fluvial and lacustrine environments while a previously unrecognized thin interval of mudstone, and minor limestone beds that record a brief marine incursion into the Cabullona basin is present in the middle part of the formation. Four depositional environments were recognized: river channels, flood plains, shallow lakes and marginal marine. The river channels, flood plains and shallow lake deposits yield actinopterygian fish (Amiidae and Lepisosteidae), turtle (Adocidae, and Trionychidae), and archosaur remains, i.e. crocodylomorphs (Eusuchia) and dinosaurs (Ceratopsidae, Hadrosauridae, Ornithomimidae and Tyrannosauridae). The marginal marine strata did not yield vertebrate remains but scarce and poorly diverse marine microforaminifera mixed with charophyte and ostracodes. A thin conglomerate representing a debris flow within the marine strata yielded an abundant continental and marine mixed fauna. In this study we attempt to identify the taphonomic signatures; such as spatio-temporal determination, Voorhies Group, weathering, abrasion and fracturing, of the fossil assemblages in order to characterise the different depositional environments in which they were found. While the river channels were dominated by hadrosaurid remains with medium weathering, the flood plains were dominated by trionychid turtles mostly unaffected by abrasion, and the shallow lakes contain few vertebrate remains, all resedimented.

ACTUALISTIC TAPHONOMY OF SOUTH AMERICAN SMALL MAMMALS INGESTED BY PREDATORS. ITS IMPORTANCE IN THE INTERPRETATION OF THE FOSSIL RECORD

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Keywords: *neotaphonomy, predation, actualistic analogous, Argentina.*

Neogene and Quaternary small mammal assemblages constitute a particular part of the fossil record. This type of accumulations is well represented through all South America, and they are very important in several zooarchaeological and palaeontological localities in Argentina. It is interesting to explain the mechanisms that intervened in the production of these fossil or zooarchaeological assemblages, since this allows adjusting the interval of their formation, and to make more precise paleoecological interpretations. Predation is one of the most recurring causes of small mammal accumulations. In this opportunity, the current state of knowledge of the taphonomic characteristics of rodents and marsupials remains accumulated by the action of the different avian raptors and carnivore mammals of Argentina -as example of South American predators- known through actualistic studies, is reviewed. The taphonomic attributes analyzed, allowed the adjustment, through large comparisons among different groups of predators and prey, of the modification categories indicated in the original papers by different authors. The data here revised and assessed suggest that predators evaluated may be gathered into four categories of modification: a. Light (*Tyto alba*, *Bubo virginianus*, *Strix chacoensis* and *Asio flammeus*); b. Moderate (*Athene cunicularia*, *Geranoaetus melanoleucus*, *Geranoaetus polyosoma* and *Pseudoscops clamator*); c. Heavy (*Circus buffoni*, *Caracara plancus*, *Elanus leucurus*, *Didelphys albiventris*, *Leopardus geoffroyi* and *Lontra longicaudis*); d. Extreme (*Milvago chimango*, *Puma concolor*, *Puma yagoaurondi*, *Conepatus chinga* and *Lycalopex griseus*).

HOLOCENE SMALL MAMMALS HUNTED BY OWLS AND HUMANS IN THREE ARCHAEOLOGICAL SITES OF SOUTHERN BRAZIL

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Keywords: *taphonomy, human subsistence, strigiforms, caviomorphs, cricetids.*

Understanding resources utilization and economic diversification among Holocene pre-Columbian populations in southern Brazil requires in-depth taphonomic analysis of faunal assemblages. Three pre-Columbian Early to Late Holocene archaeological sites (Garivaldino, Pilger and Sangão) from Rio Grande do Sul State, southern Brazil, revealed large assemblages of small mammal (<1 kg) remains. To appreciate depositional processes of the fauna in relation to human consumption, taphonomical attributes and processes were evaluated. Results indicate that the remains were accumulations through different ante-mortem taphonomic pathways, dependent on the size of the species. The small and medium-sized Cricetidae rodents (*e.g.*, *Pseudoryzomys simplex* and *Sooretamys angouya*) are represented by a low proportion of teeth with light digestive corrosion suggesting the predatory activity of owls, possibly *Tyto alba*. In contrast, large-sized Cricetidae rodents (*Kunsia tomentosus*, *Gyldenstolpia* sp. and *Holochilus* sp.), and several caviomorph rodents with social habits and diurnal activity (Echimyidae [†*Dicolpomys fossor*, *Phyllomys* sp., †*Clyomys riograndensis* and †*Euryzygomatomys mordax*], Caviidae [*Cavia* sp.], and Ctenomyidae [*Ctenomys* sp.]) show evidence of patterns of thermalteration and cut marks on bones suggesting human exploitation. Post mortem depositional environment is deduced from dendritic and branched patterns of rootlet etching, apparent mostly at Garivaldino and Pilger; polish and holes in bones surface, and impregnations of manganese had moderate (Sangão) or low (Garivaldino and Pilger) incidence which point to hydraulic transports under moderate (Pilger) and low (Garivaldino and Sangão) energies over short distances. This provides the first clear evidence of human pre-Columbian exploitation of small mammals of southern Brazil suggesting a diversification of economies. [proyect CNPq 444508/2014-7]

ROLLING RODENTS

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***Keywords**: small mammals, abrasion, water transport, rounding.*

Bone abrasion is the principal effect that makes water transport recognizable in bone assemblages. Previous experiments were focused only on unaltered bones of rodents to see signs of abrasion. In this experiment, four types of bones showing different surface alterations were abraded: 1) Non-digested bones; 2) Weathered bones; 3) Digested bones and 4) Weathered plus digested bones. Each group contained two femora, two humeri and two incisors and they were introduced in a stone polishing tumbler until 360 hours, making observations after 24 hours, 72 hours and 192 hours. The sediment size used was gravels and clay+silt. Results obtained show that the most remarkable modification produced on bones abraded by clay and silts was a color change of the surface, preferentially on weathered bones. Bones immersed in gravels had more rapid rounding of the salient angles, especially for those that initially combined modifications produced by both digestion and weathering processes. This characteristic, which produces a loss of surface on bones, was evaluated using image analysis software to obtain a surface loss index, that allow us to quantify bone loss. It is remarkable that after 72 hours, cancellous tissues of some proximal femur and distal humerus were exposed for non-digested type bones and weathered bones. This trait mimics the corrosion produced by digestion process, making necessary to describe differences to distinguish between the two processes on long bones.

EARLY TAPHONOMIC ALTERATION IN RECENT FORAMINIFERA FROM A WESTERN MEDITERRANEAN COASTAL LAGOON (TORREBLANCA, EASTERN SPAIN).

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Keywords: *Foraminifera, taphonomy, coastal lagoon, Mediterranean.*

Evidences of several taphonomical processes were identified during a study of the recent foraminiferal assemblages from the coastal lagoon of Torreblanca (Western Mediterranean). The most abundant were mechanical breakage and $CaCO_3$ deposits on the foraminiferal test surface. Additional less common alterations, such as sedimentary and framboidal pyrite infillings, possible intracameral bioerosion, carbonate dissolution, gypsum crystalline growth and biogenic encrusting were also detected.

The quantitative analysis of mechanical breakage and $CaCO_3$ crust deposition (based on chamber loss and wall opacity evaluation) in *Ammonia tepida* (Cushman), one of the most abundant species in Torreblanca, reveals a relatively low incidence of these taphonomic processes, which results from very low energy conditions, together with the fact that probably most tests were of recent production.

In many coastal marshes, the decay of the abundant organic matter in peat deposits result in low pH conditions, carbonate dissolution, loss of calcareous tests and, subsequently, foraminiferal assemblages dominated by species with agglutinated tests. However, the geological setting in Torreblanca, mostly consisting of Mesozoic calcareous marls and limestones, determines the high alkalinity of the waters that feed the coastal lagoon and strongly favors the preservation of calcium carbonate and the predominance of calcareous species like *Trichohyalus aguayoi* (Bermúdez) or *A. tepida*.

The quantitative comparison between living (Rose Bengal stained) and dead assemblages yielded high similarity values, thus reflecting a weak degree of taphonomical alteration as a whole. This can be expected in low energy coastal lagoons, with almost no horizontal transport and limited sedimentary vertical mixing.

SUBDIVERSITY AND OVERDIVERSITY: OUR ABILITY TO RECONSTRUCT PALAEOECOSYSTEMS

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Keywords: *subdiversity, overdiversity, diversity estimates, species richness.*

As taxonomic identification is the most fundamental part of palaeontological research, the present work is attempting to re-examine the ability to discriminate palaeo-species. The limited nature of fossils has always been an inhibitor to a complete and accurate taxonomic identification. Therefore, a new method is presented that recalculates the diversity of palaeo-ecosystems.

Many mammalian taxa preserve dissimilar variability in their fossilized elements with respect to their external morphology (or in any other species-discriminative feature). Some taxa are characterized by high variability in their skeleton indicating higher species variability (overdiversity cases), while the majority of taxa is characterized by low skeletal variability indicating lower species variability (subdiversity cases). This fact leads to miscalculations of the final species number (S or species richness), which, therefore, needs to be recalculated.

This study defines the effect of such variability in fossil Neogene mammalian faunas, concerning five well-studied and frequently encountered taxa. Species richness is corrected through a simple equation and with an example of the Greek Turolian fauna of Ravin des Zouaves no. 5 site. The main purpose of this research is to improve the ability to determine species richness in mammalian faunas of the past, correcting the observable results in a simple and useful way. Therefore, it aims to establish a novel methodological framework that will provide a more reliable explanation of the palaeodiversity.

BIOEROSION TRACES FROM A MARINE VERTEVBRATE BONEBED FROM THE LATE CRETACEOUS BEARPAW FORMATION (SASKATCHEWAN, CANADA)

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Keywords: *bioerosion, bonebed, ichnofossils, Late Cretaceous, marine.*

Macrovertebrate fossils preserved in a multitaxic bonebed, from the Late Cretaceous Bearpaw Formation of Saskatchewan, exhibit evidence of extensive bioerosion. The majority of the fossils from the bonebed are isolated bones that are referable to Plesiosauria, with elasmosaurids being more abundant than polycotylids. Two main bioerosion structures have been observed on the bone remains: (A) Some elements exhibit parallel-sided borings (approximately 1cm in diameter). When such borings are found on vertebrae, the foramina subcentralia were utilized by the tracemakers as an easy point of access. These ichnofossils were likely produced by bivalves. (B) The more common type of bioerosion at this site is the hollowing out of bones. This form of bioerosion is particularly prevalent among propodials, in which cases the cavities originate at the proximal and distal ends and extend into the interior of these bones. Hollowed out ribs and vertebrae are also observed. Although the morphology of these bioerosion structures do not conform with known ichnotaxa, possible tracemakers include the annelid worm *Osedax* or gastropods with a feeding behavior comparable to that of the modern deep-sea snail *Rubyspira*. While not all macrovertebrate fossils from this bonebed exhibit bioerosion, the abundance of such ichnofossils suggests that the bones were exposed at the sediment-water interface for an extended period of time before burial.

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The small mammals of the Neogene from Europe

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SMALL MAMMAL ASSEMBLAGES FROM THE EARLY MIOCENE MOKRÁ 1-3 SITES (MORAVIA, CZECH REPUBLIC)

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***Keywords**: Small mammals, Early Miocene (MN 4), Mokrá, Czech Republic.*

The karstic fissures of the Mokrá Quarry which is located about 12 km of the Brno city on the Mokrá Plateau in southern part of the Drahany Upland (Moravia, Czech Republic) contain the unique early Miocene (MN4) terrestrial vertebrate assemblages. In total three separate quarries occur in Mokrá but fossiliferous fissures with Neogene vertebrates have been reported only from the Western (1/2001 Turtle Joint, 2/2003 Reptile Joint) a Central (3/2005 Joint) quarries.

In total, 400 micromammal remains have been recovered from 1/2001. Preliminary studies have ascribed these remains to different genera belonging to Lagomorpha, Rodentia, Insectivora, and Chiroptera. The most abundant group in the examined taphocoenosis is Lagomorpha, represented by isolated 88 teeth tentatively referred to *Prolagus schnaitheimensis,* and *Prolagus* cf. *vasconiensis*. Regarding rodent remains, the presence of *Melissiodon dominans* is typical for the early Miocene (MN4) vertebrate assemblages, such those from the Dolnice and Ořechov, sites of the Czech Republic.

Preliminary studies of materials from other two joints (the 2/2003 and 3/2005) have revealed an abundant micromammal fossil fauna among of which remains of marsupials represent a special interest. Moreover, the differences in a relative abundance of small mammal taxa in every joint (e.g. the dominance of *Palaeosciurus* sp. in 2/2003) can be interpreted as different feeding behavior of raptors, probably representing different paleoecological conditions. This assumption is also supported by the presence of more aquatic amphibian forms in 2/2003, suggesting more humid conditions.

The fossil fauna of the Mokrá open-cast mine corresponds to a wide variety of different ecological environments: dry karst landscape with open steppe vegetation, swamps with stagnant to moderately flowing water, and lacustrine environment.

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FOSSIL FLYING SQUIRRELS TAKE OFF

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***Keywords**: Rodentia, Sciuridae, Miocene, postcranial anatomy, phylogeny.*

Gliding has evolved independently several times in mammalian evolution. However, flying squirrels are the only group of gliding mammals to have achieved a significant diversity and wide geographical distribution, occurring in Eurasia and North America. Yet their evolutionary history is insufficiently known, to the point that estimates on their time of origin as derived from paleontological and molecular data blatantly disagree. Whereas for most mammal clades molecular-based estimates yield older dates, for flying squirrels fossil evidence exceptionally suggests much older dates (ca. 36 Ma) than most molecular phylogenies (23±2.1 Ma). This discrepancy might derive from the identification of extinct flying squirrels exclusively based on dental features, which, contrary to certain postcranial characters, are not unique to them but also occur in different tree squirrel groups (Ratufinae, Callosciurinae, Protoxerini and Sciurini). Here we describe the first partial skeleton of a fossil flying squirrel, attributed to *Miopetaurista neogrivensis* and dated back to 11.6 Ma. The wrist bones unambiguously show that it displayed the gliding adaptations of extant pteromyins and indicate that it belongs to the large-sized flying squirrel clade (subtribe Pteromyina). In addition, its elongated and slender limb bones with reduced muscle attachments (thus enhancing joint extension), as well as the elongated lumbar vertebrae are indicative of gliding behavior. This new fossil evidence allows for a recalibration of the divergence date between tree and flying squirrels. Our phylogenetic analyses combining morphological and molecular data generally support older dates than previous molecular estimates, being congruent with the inclusion of some of the earliest fossils into this clade. However, the most likely estimates for this event lay between 31–25 Ma. Furthermore, *Miopetaurista* is found to be the sister taxon to extant *Petaurista*, showing that flying squirrels have undergone little evolutionary change for almost 12 million years.

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LOWER MIOCENE TALPIDS AND DIMYLIDS FROM THE RIBESALBES-ALCORA BASIN (CASTELLÓ, SPAIN)

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***Keywords**:Talpidae, Dimylidae, Lower Miocene, Ribesalbes-Alcora Basin, Palaeoecology, Biostratigraphy.*

The Miocene record of talpids and dimylids (Eulipotyphla, Mammalia) in south-western Europe is very scarce. In the present work, we study for the first time the talpids and we complete the description of the dimylids from the Ribesalbes-Alcora Basin (eastern Iberian Peninsula, Spain). In a recent study a new species of the genus *Plesiodimylus* was described on the basis of the fossils recovered in one locality from this area. The mammal fossil record of this basin is distributed in forty-five sites located in seven sections along the Campisano ravine of the Araia/Mas de Antolino outcrop. The presence of the rodents *Megacricetodon*, *Democricetodon* and *Ligerimys* allows us to assign an early Aragonian age (MN4, early Miocene) to these localities, which can be correlated with local biozone C of the Calatayud-Montalbán Basin (Spain). The talpids recovered in the Ribesalbes-Alcora Basin comprise the most common *Desmanodon daamsi* and *Desmanella fejfari*, for which the last known occurrence is recorded here. The study of dimylids confirms the presence of the recently described *Plesiodimylus ilercavonicus* in other two localities of the basin, which expands the biostratigraphic record of the genus and species. In addition, the presence of an indeterminate species of the genus *Chainodus* has been recognized, representing the youngest record of this genus in the Iberian Peninsula.

BAT ASSEMBLAGE FROM THE LOWER MIOCENE OF THE RIBESALBES-ALCORA BASIN (SPAIN)

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Keywords: *Chiroptera, lower Miocene, Ribesalbes-Alcora Basin, Iberian Peninsula.*

Bat assemblages from Spanish fluvio-lacustrine deposits have been rarely described in detail. We present here the results obtained of a study of the assemblages from several lower Miocene levels in the Ribesalbes-Alcora Basin, which have yielded remains of ten chiropteran taxa. Fossil mammals have been found in this basin in seven sections where forty-five different sites have been located; the material described here comes from fossiliferous deposits found in the Campisano ravine of the Araia/Mas d'Antolino outcrop. The faunal assemblages of the levels where bats occur indicate an early Aragonian age (MN4, early Miocene) which has been inferred from the presence of rodent taxa such as *Megacricetodon*, *Democricetodon* and *Ligerimys*. This rodent assemblage has allowed us more precisely place these sites to the local biozone C of the Calatayud-Montalbán Basin (Spain). The most outstanding feature of the chiropteran taxa recorded in the basin is the high proportion of free-tailed bats, represented by *Hydromops helveticus*, *Rhizomops* cf. *brasiliensis*, *Cuvierimops* sp., *Chaerephon* sp. and *Tadarida* sp. Vespertiolinids such as *Myotis* cf. *intermedius* and *Miostrellus* aff. *petersbuchensis* are also present, together with several undetermined species ascribed to the genera *Submyotodon*, *Plecotus* and *Rhinolophus*. The material from the Ribesalbes-Alcora Basin has revealed the highest bat species richness described to date for Neogene assemblages in the Iberian Peninsula until now.

MELISSIODON (MAMMALIA, RODENTIA) FROM THE EARLY MIOCENE OF THE VALLÈS-PENEDES BASIN (CATALONIA)

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Keywords: *early Miocene, Rodentia,* Melissiodon*, Iberian Peninsula.*

Melissiodon is a long-lived genus endemic of Europe, ranging from the early Oligocene to the end of the early Miocene, and includes nine species, most of them based on scarce material. This genus has a unique molar morphology which consists of a complicated net of pointed cusps joined by multiple thin and high ridges. This peculiar morphology gives the genus its name, which means "honeycomb-tooth". The assumed diet, suggested by some authors, of this species is insectivorous. Previous studies indicate that there were two different species, *Melissiodon dominans* and *Melissiodon arambourgi*. However, recent studies indicate that most of the specimens found in the Vallès-Penedès Basin are referred to *Melissiodon dominans*. And the other endemic species of this basin, *Melissiodon arambourgi,* was synonymized to *M. dominans* after revision, due to its similar morphology. The last occurrence of *Melissiodon* in the Vallès-Penedès Basin is in the Sant Mamet site, located just a few meters below middle Miocene marine deposits, and represents one of the youngest records of this long-ranging genus. *Melissiodon dominans* is also found in other Iberian basins such as Calatayud-Montalbán Basin (Aragón, Spain), but it is generally rare, requiring a sample size of hundreds of specimens to recover just one or two molars of this genus. However, in the Vallès-Penedès, as well as in other areas of Western Europe, it appears to have been more common in comparison with Calatayud-Montalbán Basin. Catalonia presented a more humid and forested environment during the early Miocene, compared to other areas of Spain, this suggests a higher abundance of invertebrate prey which would have favored insectivorous taxa such as *Melissiodon*. In this work, we review the material of this genus found in the Vallès-Penedès Basin.

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THIN SECTION ANALYSIS OF COPROLITES FROM MIDDLE/UPPER PERMIAN OF THE PARANÁ BASIN, BRAZIL

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***Keywords**: Permian, Paraná Basin, coprolites.*

Coprolites (fossil feces) can provide important paleoecological information on extinct vertebrates, thanks to the rests of non-digested food items which can be found as inclusions in the coprolite matrix, providing information about the trophic chain and the paleoecology. The Rio do Rasto Formation comprehends a lithostratigraphic unit of the Middle/Upper Permian of the Paraná Basin, where are found fossils of vertebrates, invertebrates, plants and coprolites. For further information about the inclusions found in the coprolites, we have made thin sections from seven coprolites from de São Jerônimo da Serra Site, Rio do Rasto Formation, southern Brazil. The studied specimens are morphologically classified as spiral bromalites (coprolites or possibly cololites), in literature attributed to fishes. In thin sections, it was possible to determine that the matrix of the coprolites is composed mainly of amorphous apatite and, in less quantity, of micrite and opaque minerals. In the matrix there are present also bone fragments and fish scales. The fish scales vary from 0,5 to 4 mm in length and some of them have a structure probably related to the peg-and-socket of the Palaeonisciformes fish. The bone fragments are mostly of the length of 1 to 3 mm. In the thin section of the specimen UFPR 0287 PV we have found a mandible of the length of 3 mm, composed of 5 partially preserved teeth. This study allows to understand the trophic relationships in the ecosystem in the studied interval, whereas the producers of the studied coprolites were fish with carnivorous habits.

THE STUDY OF DINOSAUR TRACKWAYS USING GEOMETRIC MORPHOMETRICS

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***Keywords**: bipedal dinosaurs, geometric morphometrics, paleoichnology, shape, trackways.*

The study of dinosaur trackways encompasses a standardized protocol for measuring, among other parameters, step, stride and digit lengths, footprint rotation, the trackway's midline and the trackways gauge. All these measurements aid to characterize the shape of the tracks for descriptive and comparative purposes, and to infer aspects of the trackmaker such as its locomotion capabilities. Geometric Morphometrics (GM) is an advanced multidimensional tool for shape analysis only used for the comparison of isolated tracks and never for the study of dinosaur trackways. Using 2D GM, we analysed the differences between 75 randomly selected trackways of bipedal dinosaurs from literature, finding that the method easily summarizes with appealing graphics all the trackway differences at once. Moreover, the utility of GM is that it can also aid discovery by testing the covariation between shape and other variables. Here, the multivariate statistics showed that the differences between trackways were not associable to taxonomical groupings, whilst they correlate with the speeds estimated for the studied trackways. Although this suggests that trackway differences have an anatomical and biomechanical meaning, such variation represents only 15% of total difference, suggesting that differences between the tracks are due to taphonomy and other indeterminate sources.


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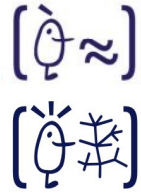


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