

**XXI Encuentro  
de Jóvenes Investigadores (EJIP)  
6<sup>th</sup> International Meeting of Early-stage  
Researchers in Palaeontology (IMERP)**



**Abstracts  
Book**

**Lourinhã (Portugal)  
April 2023**



**Estraviz-López, D., Guillaume, A. R. D., Saleiro de Sousa Barros, A., Martino, R.,  
Ribeiro, C., Costa, F., López-Rojas, V., Russo, J., Rotatori, F. M., Pratas e Sousa, J.,  
Conti, S., Riccetto, M., Maréchal, A. (Eds.)**



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## PREFACE

For the first time in its 21 years of existence the EJIP (Encontro de Jovens Investigadores em Paleontologia) is coming to Lourinhã, the “Capital of the Dinosaurs” of Portugal. We think that this is the perfect setting for the meeting, as Lourinhã is a relatively small Iberian village with an extremely important palaeontological heritage (which is usually what towns holding EJIP have in common with each other). Lourinhã is not only the perfect setting just because of the palaeontological heritage itself, but also because of the extreme importance that this heritage has for the identity of the whole town; being it perpetually submerged on a “Dinofever” that has permeated on all levels of society. The local stores with palaeontological names, the streets of the town with dozens of figures of life-sized dinosaurs and the huge engagement of the population with both the Museum of Lourinhã and the Dinoparque of Lourinhã. Scientifically, the municipality has been a central piece for the study of the Jurassic faunas of Western Europe since decades ago and this has coalesced into around a dozen of PhD students doing variable parts of their PhDs with material housed on the municipality or directly coming from it.

This meeting is also the sixth edition for the “international brother” of EJIP, the IMERP (International Meeting of Early stage career Researchers in Palaeontology). It is also the second time that both congresses are held jointly since 2016, when the IMERP was born. We hope that this will revitalize the congress after the pandemic, as it has brought several international researchers together with their Iberian colleagues. Maybe it was because of the desire to come back to “in person” congresses, but the XXI EJIP-6<sup>th</sup> IMERP has been a great success of attendance, with 125 participants online or in person, 95 communications (64 oral presentations and 31 posters), four keynotes, four workshops, two roundtables and two fieldtrips. Also, 40 art pieces were submitted to the “V palaeoillustration contest of EJIP ” which in our opinion has been the most competitive edition to date.

Palaeontology is more alive than ever, including in Lourinhã, and the new generations of researchers who have gathered in this town prove it.

Lourinhã, April of 2023

Organizing committee of the XXI EJIP-6<sup>th</sup> IMERP

# KEYNOTES





## ACADEMIC ADVICE FOR YOUNG RESEARCHERS BASED ON PERSONAL EXPERIENCE WORKING WITH PERMIAN MICROFOSSILS FROM BALTIC COUNTRIES AND POLAND

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To study Permian fishes in a country without currently working specialists in the ichthyologist's field was an issue. Thus, I needed to find my answers abroad due to that situation. For taxonomical identification and comparative material related to my research, I visited the three biggest Natural History Museums in the world placed in London (United Kingdom), Washington DC (United States), and New York (United States). Also, the methodological part of my research was strongly developed during the Erasmus+ programs for students. At the University of Valencia (Valencia, Spain), I learned how to do 3D models using Avizo software (tomographic analysis) and to make ground/thin sections of microfossils (histological analysis). With these new skills, I successfully applied them to my dissertation. At the University of Opole (Opole, Poland), I improved my knowledge of local geology because two of my studied objects are in the western part of modern Poland territory. During an exchange semester at the Christian-Albrechts-Universität zu Kiel (Kiel, Germany), I listened to a course "How to write and publish the article" which improved drastically my publishing skills in scientific journals as a main author. Moreover, the different steps of this project were presented at more than 13 international and local conferences (symposiums, congresses, etc.). In the end, under the good supervision of my supervisor and adviser, I could successfully defend my PhD research related to Permian fishes from Baltic countries and Poland. My topic revealed new taxonomical data based on isolated ichthyofaunal material in the studied area with an implication of the palaeoenvironmental conditions in the easternmost part of the unique, semi-closed Zechstein Basin. As well, it increased the palaeogeographical distribution of *Helodus*, *Acrodus*, *Ganunselache*, and *Omanoselache* taxa. In addition, the *Helodus* taxon extended the existence of this genus up to the end of the Permian period.

**Keywords:** Conferences, Erasmus+, Supervision, Publishing articles, Museums, Collections.

**Acknowledgements:** I would like to thank professor Dr AS (supervisor of my bachelor's and master's studies), professor Dr SR (supervisor of PhD), and Dr MA (supervisor of 2<sup>nd</sup> master's study).



# PAST, PRESENT AND FUTURE(?) OF QUATERNARY LARGE UNGULATES: A CONSERVATION PALAEOBIOLOGY PERSPECTIVE

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Ungulates represent an important element of terrestrial ecosystems and are well-documented through Eurasia and Africa during the Neogene and the Quaternary. Some groups, such as cervids and bovids, are characterized by an extraordinary fossil and evolutionary record, with a high taxonomic diversity. Ungulates are often used to correlate continental deposits, to investigate dispersal patterns, and to detect palaeoenvironmental changes at different scale. Studies on body size variations of certain taxa have been claimed as proxy records of past climates, e.g., Bergmann's rule, and the occurrence of certain species has been used as undisputable chronological tool. However, taxonomy, phylogeny and chronology of ungulates are strongly debated, leading to controversial results and hypotheses. Among other ungulates, Hippopotamidae and Rhinocerotidae have been found throughout Eurasia and Africa, demonstrating how these large mammals were particularly flourishing in the past, both on continents and islands. Despite a century-long research history on these taxa, the phylogenetic relationships of various species remain uncertain. These relationships would highlight different implications for the evolutionary history of these groups and the rise of some adaptative traits within the considered lineages under determinate selective pressures. Further, a comprehensive view on morphological and morphometric characters of these taxa can constructively supports palaeobiogeographic and evolutionary hypotheses, underlining the importance of data and knowledge sharing among researchers. These aspects would lead to a better understanding over long-term effects of management and conservation actions on different rhinoceros' and hippopotamus' populations. Hippopotamidae and Rhinocerotidae are indeed currently represented by a few species listed as threatened and vulnerable by the IUCN Red List.

**Keywords:** Quaternary, Ungulates, Adaptation, Conservation palaeobiology.



# THE QUATERNARY RECORD OF BIRDS IN THE IBERIAN PENINSULA

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Aves is the most diverse tetrapod group nowadays, they appear through every ecosystem, and they can be observed in our cities and towns daily. Among the small vertebrate remains, bird fossils are common in the palaeontological record, especially in Quaternary sites. The analysis of the Pleistocene and Holocene bird fossil record in the Iberian Peninsula revealed their presence in around 250 sites, most of them related with caves and karstic systems. Also, it allowed the description of three new species: *Bonasa nini*, *Bubo ibericus* and *Aegypius prepyrenaicus*. Although it is a discipline with just a few researchers, the analysis of small bird fossil remains is full of possibilities. In this talk I will show you these possibilities by presenting three of my works concerning the small avian remains from the archaeo-palaeontological sites of Sierra de Atapuerca (Burgos, north of Spain), a human-evolution worldwide known site complex. In these works, focused in the Avifauna from Sima del Elefante, Gran Dolina (Early Pleistocene), and Galería (Middle Pleistocene), me and my co-authors have applied an array of different methodologies to analyse bones, eggs, and to perform palaeoenvironmental reconstructions. This diversity of results and techniques reflects the great potential that the avifauna has for systematic palaeontology and as a palaeoenvironmental proxy. We need more early-stage researchers to join the research in Quaternary birds!

**Keywords:** Avifauna, Atapuerca, Fossil bones, Fossil eggshells, Palaeoenvironmental reconstruction.

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# ENTOMOLOGICAL DIVERSITY AND ITS LIMITED POTENTIAL IN THE FOSSIL RECORD OF THE CARBONIFEROUS OF PORTUGAL

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Arthropods represent 80% of animal diversity, a phylum that has existed since the Cambrian Period. Three-quarters of all known modern arthropods are insects. Therefore, it is expected that insects would dominate the fossil record; however, they only represent about 1% of it. Their intrinsic characteristics, such as having exoskeletons composed of organic material, together with extrinsic factors, such as inhabiting almost exclusively terrestrial environments, significantly reduce their fossilization potential. Even so, the group had remarkable diversity and abundance during the Carboniferous Period. However, its fossil record in the Carboniferous of the Iberian Peninsula is very limited and fragmented. Therefore, we are far from being able to estimate its real diversity, considering its limited fossilization potential in intramontane basins. The Portuguese Carboniferous contains a richness and diversity of fossil macrofloras that are exceptionally well-preserved. However, there are still very few known palaeoentomological records. Only 15 species, most of them from the Phylloblattidae family (Dictyoptera), constitute a literature that is about 80 years old. This palaeoentomofauna, represented by so few records, reflects the difficulty in finding insect fossils in these intramontane environments. In these regions, the primary geological processes are erosion and the transport of sediments from fluvial systems. This means that most insect remains are easily destroyed before burial occurs. On the other hand, the poor quality of the supporting (siliciclastic) sediment and tectonic deformation also make preservation difficult. Over the last 12 years, new works have been carried out in the Douro and Buçaco intramontane basins, two of the main palaeobotanical 'hotspots' of the continental Carboniferous of Portugal. New taxa such as *Lusitaneura covensis* (Caloneurodea), *Stenodyctia lusitanica* (Palaeodictyoptera), *Poroblattina anadiensis* (Dictyoptera), and *Lusitadischia sai* (Archaeorthoptera) have been recently described in aforementioned localities.

**Keywords:** Preservation bias, Fragmented fossil record, Palaeoentomofauna, Intramontane basins, Continental Carboniferous of Iberian Massif.

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# ABSTRACTS





## BIOSTRATIGRAPHY WITH PLANKTIC FORAMINIFERA OF THE UPPER MAASTRICHTIAN FROM REBAÏA, ALGERIA

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The terminal Maastrichtian is receiving interest due to the role that the main eruptive phase of the Deccan volcanism (India) could have played in the mass extinction event of the Cretaceous–Paleogene boundary. To unravel the role of Deccan volcanism in the mass extinction event, it is important to have continuous and expanded outcrops to carry out micropalaeontological and palaeoclimatic studies. We present here the results of a biostratigraphic study with planktic foraminifera from the Upper Maastrichtian of Rebaïa section (36° 04' 39" N, 3° 10' 05" E), in Algeria. This section consists in 35 m of gray marls with centimetric intercalations of calcareous marls of the same color. The content of eight washed samples has been studied using a stereomicroscope. These were selected for their position in the stratigraphic column and for the abundance and preservation of foraminifera. Additional samples were reviewed to define the boundaries between foraminiferal zones accurately. As a result, diversified assemblages have been identified in Rebaïa, including 44 species belonging to the genera *Abathomphalus*, *Contusotruncana*, *Gansserina*, *Globigerinelloides*, *Globotruncana*, *Globotruncanella*, *Globotruncanita*, *Gublerina*, *Planohedbergella*, *Heterohelix*, *Laeviheterohelix*, *Planoglobulina*, *Plummerita*, *Pseudoguembelina*, *Pseudotextularia*, *Racemiguembelina*, and *Rugoglobigerina*. After analyzing their stratigraphic distributions, the last three standard Cretaceous foraminiferal biozones of Li and Keller (1998) have been recognized, spanning the last 10 m of the *Pseudoguembelina hariaensis* Zone, 10 m of the *Pseudoguembelina palpebra* Zone, and 15 m from the *Plummerita hantkeninoides* Zone. The great local thickness of this last foraminiferal biozone stands out, being the second largest of those described to date in the world and only surpassed at Aïn Settara (Tunisia). The high sedimentation rate of the late Maastrichtian at Rebaïa will allow the undertaking of future high-resolution quantitative studies with planktonic foraminifera and to study in detail the influence on plankton of the last global warming event of the Maastrichtian: the Late Maastrichtian Warming Event.

**Keywords:** Micropalaeontology, Biozones, Cretaceous, Western Tethys.

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## NEW DINOSAUR FOOTPRINTS IN SECTOR 3LVCb AT LA VIRGEN DEL CAMPO TRACKSITE (ENCISO, LA RIOJA, SPAIN)

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In this study, we focus the attention on the dinosaur footprints on the sector 3LVCb of La Virgen del Campo track site (Early Cretaceous), in Enciso, La Rioja. In this area two new trackways, composed of more than 20 footprints each and arranged in an almost perpendicular orientation were found. 3LVCb.1 is going from south to north and 3LVCb.2 from east to west. It is possible to observe that some of the ichnites of 3LVCb.2 directly deform 3LVCb.1 footprints, therefore, we can infer that the producer of 3LVCb.1 crossed first. These footprints show various characters usually present on theropod ichnites, like claw marks, low interdigital angles and V shaped heels. The tracks have an average length of 33 cm (3LVCb.1) and 21 cm (3LVCb.2) and can be attributed to small-medium theropods, respectively. Also, nowadays, there is no skeletal record of small theropods in La Rioja yet. While 3LVCb.1 shows some resemblance in shape with the rest of the footprint morphotypes present at the site, the main difference being the many metatarsal impressions recorded on this trackway, 3LVCb.2 presents some differences aside from size such as the interdigital angle being higher in this trackway than the average of the rest of La Virgen del Campo. 3LVCb.2 also shows some variation in the stride length reflecting different speeds while also changing course, tilting ca. 20° south. This finding is significant because it implies a new theropod footprint morphotype present at this site. Taking all of this into account, we can infer the following conclusions: we describe two new trackways that enlarge the ichnological record of the site with at least one new type of dinosaur that has not got any skeletal remains in La Rioja. Secondly, the range of behaviors present at the site is increased by the presence of one trackway that shows a dinosaur changing speed and direction.

**Keywords:** Ichnology, Tracks, Theropods, Cameros Basin.

**Acknowledgments:** Thanks to ATH, for giving us this opportunity to carry out this project and guide us at all times in the realization of the same. We would also like to thank PNL, RSP and MFV for dinosaur discussion during the summer course on the restoration of footprints, as it was the event that brought us together and allowed us to work together.



## MACROFOSSIL BONES FROM THE VERTEBRATE MICROFOSSIL ASSEMBLAGE OF THE BARREMIAN TRES PINOS SITE (LADRUÑÁN ANTICLINE, TERUEL PROVINCE, SPAIN)

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The Tres Pinos fossil site, near Ladruñán (Castellote, Teruel), is geologically located on the Ladruñán anticline, in the lower part of the Mirambel Formation (Barremian, Lower Cretaceous), in the northwestern area of the Morella sub-basin (Maestrazgo Basin). The site has been providing a great variety of fossils collected by surface picking along with microfossils coming from a small screen-washed sediment sample. That implies a first approach to the fossil assemblage (biased by the small sample size). The identified remains include microfossils of charophytes, invertebrates, and vertebrates (being osteichthyans and chondrichthyans best represented). However, larger bone remains were also found outcropping, such as an ungual phalanx and two vertebra centers. The taxonomic identification of these remains can provide valuable information on the faunal association identified in the Tres Pinos site, as well as the archosaur faunas in the Morella sub-basin. The specimen 3PG-08 is a small (30 mm of length) distal pedal phalanx, it is dorsoventrally flattened with a well preserved and rather flat ventral surface, lacking the distal end. The “claw” morphology of this phalanx is reminiscent of that of some small-sized ornithischians. Its triangular and not flattened shape on its major axis, among others, indicates that it belongs to a basal Ornithischia such as *Hypsilophodon*. The vertebrae (3G-14 and 3G-15) present immature features (*i.e.*, open neurocentral suture). The studied specimens share the amphicoelious character of caudal vertebral centra with some crocodylomorphs and dinosaurs, whereas, the presence of long and deep ventral grooves, with two well-developed keels at their limits, resembles a theropod (Spinosauridae) dinosaur morphology. In this regard, it is safe to attribute the vertebrae have been assigned to Archosauria indet. This is a first approximation to macrovertebrate fauna of Tres Pinos, although new remains or a more detailed study are necessary to establish a more precise classification.

**Keywords:** Lower Cretaceous, Mirambel Formation, Ornithischia, Immature, Archosauria.

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## ANATOMY AND SYSTEMATICS OF A HADROSAURID DINOSAUR FROM THE BASTURS EST LOCALITY (MAASTRICHTIAN OF THE EASTERN TREMP SYNCLINE, NE SPAIN)

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The Upper Cretaceous strata of the eastern Tremp Syncline have provided one of the richest and more diverse European vertebrate fossil records. One of the lesser-known localities is Basturs Est, which yielded vertebrate remains from the Conques Formation. Among these fossils, ten hadrosaurid bones are the subject of the present study, providing character data for placing this animal in proper phylogenetic context. Cranial elements consisted of a partial prefrontal and fragmentary maxilla and surangular. Postcranial bones included parts of the humerus, radius, metacarpals III and IV, tibia, fibula and a pedal phalanx II-1. As usually occurs in hadrosaurids, most phylogenetically informative characters came from the cranial elements. Specifically, the prefrontal of the Basturs Est hadrosaurid appeared to display a poorly developed medial flange. This is reminiscent of that of the basally-branching lambeosaurine *Jaxartosaurus aralensis*, from the Santonian of Kazakhstan, in contrast with the greater development of the prefrontal flange of all other known lambeosaurines from Parasaurolophini and Lambeosaurini. The phylogenetic position of Basturs Est hadrosaurid was analyzed in TNT via a heuristic search of 10,000 replicates using random additional sequences. Support was measured via bootstrap proportions, calculated in TNT, setting the analysis to 5,000 replicates using heuristic searches. The analysis resulted in 307 most parsimonious trees. The strict consensus tree showed the Basturs Est hadrosaurid positioned within Lambeosaurinae, forming a polytomy with several basally-branching Asian and western European lambeosaurines, all outside the speciose Parasaurolophini+Lambeosaurini clade. This study adds support to the presence of relatively basal forms of lambeosaurines in the early Maastrichtian of the Ibero-Armorican Island of the Late Cretaceous European Archipelago, representing lineages outside the better known North American and Asian parasaurolophin and lambeosaurin hadrosaurids.

**Keywords:** Basturs Est, Hadrosaurid, Lower Maastrichtian, Eastern Tremp Syncline, Systematics.

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## AND THE YEARS WENT BY: VARIATIONS IN THE DIVERSITY OF TERRESTRIAL VERTEBRATES THROUGH THE MIOCENE OF LISBON AND SETÚBAL'S PENINSULA, PORTUGAL

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Lisbon's Miocene vertebrate faunas have been studied since the 19<sup>th</sup> century. In this work, we review the bibliography on terrestrial vertebrate fossils from the Lower Tagus Cenozoic Basin (LTCB). We used the data from this bibliographic review to create generalised additive models (GAMs) in order to better understand the evolution through time of: (1) the number of species (NS); (2) the number of families (NF); (3) the number species per family (NSF) through the stages of the LTCB's Miocene. The NF was significantly higher in the Burdigalian and the Langhian than in the Aquitanian ( $p$ -value = 0.000242 and  $p$ -value = 0.001864, respectively). In contrast, the NF was lower in the Tortonian, albeit not significantly ( $p$ -value = 0.121426). The NS varies significantly throughout the Miocene ( $p$ -value < 0.05), following the variation patterns of the NF. The NSF did not change significantly through the Miocene ( $p$ -value > 0.05). These results show that both the NS and the NF increased significantly from the Aquitanian to the Burdigalian. These values remained high until the Tortonian, which presents similar values to the Aquitanian. Since the variation in the NS and NF is similar, and the NSF does not vary significantly, the increase in diversity during the Early–Middle Miocene might be due to the immigration of new lineages to the LTCB, something that is supported by previous works. The absence of terrestrial vertebrates during the Serravallian and the low diversity recorded during the Tortonian is probably due to the marine transgressive event that peaked during the Serravallian. Our work not only presents an updated compilation of Miocene fossils from the LTCB but is also the first study that analyses this type of data statistically, improving our understanding of how diversity varied through the Miocene in the regions of Lisbon and Setúbal's Peninsula.

**Keywords:** Lower Tagus Cenozoic Basin, Neogene, Bibliographic review, Palaeobiodiversity, Generalised additive models.

**Acknowledgments:** I would like to thank Professor MC and Professor CMS who supported this project not only providing bibliography but also with their invaluable advice.



## MACROEVOLUTIVE DYNAMICS OF CONULARIIDA (SCYPHOZOA), OR THE STRANGE CASE OF 340 MY GENERA

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Conulariida is a poorly studied extinct order of scyphozoan cnidarians and despite being a long-lived–uppermost Ediacaran to topmost Triassic–and widely distributed group. They were not very diverse, being represented by less than 45 genera, most of them short-lived. However, *Conularia* and *Paraconularia* survived during 300 My, a fact as remarkable as improbable considering the group's average extinction rate. In order to understand this high longevity, an updated database has been developed to estimate the generic diversity throughout the fossil record (635–201.3 My) and to calculate its extinction and origination rates. In order to analyze diversity changes two metrics were used: Boundary Crossers (BC) and Mean Standing Diversity (MSD). These calculated rates were used to perform the survivorship analyses. The study of rates obtained and the results of subsequent survivorship analyses, together with a detailed bibliographic research, point to the possibility that the group diversity would be lowered by the artificially high longevity of the two aforementioned genera. The bibliographic search has revealed that *Conularia* and *Paraconularia* have historically been used as catch-all taxa, and numerous species that were included initially in these two genera actually belong to other short-lived–or sometimes new–genera, so that the synonym occurrence is significantly high. Besides, the recently discovered *Paraconularia ediacara*, the first representative of the genus, lacks a mineralized periderm, one of the genus main apomorphies. All these facts point to the need to establish new diagnoses and/or redefine the diagnostic characters of the species ascribed to these genera in order to expose possible synonyms and masked taxa. If that were the case, then the group generic diversity would be higher than previously thought.

**Keywords:** Conulariids, Systematics, *Paraconularia*, *Conularia*.



## “HOUSE OF THE *IGUANODON*”–NEW PALAEOBIOLOGICAL PERSPECTIVES ON *IGUANODON* FROM THE DIGITALIZATION OF THE HISTORICAL COLLECTION IN BELGIUM

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In 1878, more than thirty, almost complete, skeletons of *Iguanodon* were found in a fossiliferous gallery of a coal mine in Bernissart (Belgium). Together with the English taxa studied by Owen and Leidy's *Hadrosaurus* from the US—all based on more or less complete specimens—the Bernissart iguanodonts provided a unique glimpse onto the anatomy and external appearance of dinosaurs in the early years of dinosaur palaeontology. Since then, these specimens have been exhibited in the Royal Belgian Institute of Natural Sciences in Brussels. The Bernissart iguanodontians are hypothesized to represent at least four different populations, and this offers a unique possibility to analyze intraspecific variations, behavioral interactions, palaeopathology, and biomechanics. However, these specimens suffer from severe pyrite decay, strongly limiting their accessibility for science and outreach. Here, we present the latest developments of the Belspo BRAIN-be 2.0 digitization project that aims to create a digital archive of the Bernissart individuals, currently encompassing two species, *Iguanodon bernissartensis* and *Mantellisaurus atherfieldensis*. Given the shiny and reflecting surface of the bones (provoked by the restoration resins and pyritization), we focused our methodology on structured-light surface scanners. The holotype of *I. bernissartensis*, the paratype of *M. atherfieldensis*, and at least ten other skeletons are now fully digitized in 3D and assembled in their most updated anatomical stance. The project shows that most of the individuals of *I. bernissartensis* possess similar body sizes, with greater variation of size and shape in the limbs. Some of the pathologies found in both species and the skull of *M. atherfieldensis* were analyzed via tomography, the latter showing discrepancies with previously published osteological descriptions. Future developments of the project will cover further palaeobiological aspects of the behavior of Early Cretaceous iguanodontians, such as the function of the spike-like pollex and the ranges of motion of tails and limbs.

**Keywords:** Dinosauria, Ornithopoda, Surface scanner, Morphometrics, Palaeopathology, Biomechanics.

**Acknowledgments:** Thanks to Belspo BRAIN-be 2.0 for funding the project. Thanks to the RBINS staff for logistical help with the moving, handling, and restoration of the specimens, as well as the Musée de l'Iguanodon (Bernissart) for providing access to the skeleton in exhibition. Thanks to Dr JM (Universiteit Antwerpen) and Dr AM (RBINS) for digitization aid.



## THE FOSSIL RECORD OF THE LATE JURASSIC OF ALPUENTE, VALENCIA THROUGH A PALAEOARTISTIC RECONSTRUCTION

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The fossil record of the Fm. Villar del Arzobispo (Kimmeridgian–Berriasian), in the Alpuente area, in the Serranos region (Valencia Province), stands out for its great abundance of dinosaurs. Here the main representative groups of the Upper Jurassic dinosaurs have been found, such as sauropods, stegosaurs, theropods, and ornithopods. Among them, the sauropod *Losillasaurus giganteus* and the stegosaur *Dacentrurus armatus* stand out. Also, the presence of at least two morphotypes of small and large ornithopods and theropods has been reported, where the theropods show some affinities to the allosaurids and megalosaurids of North America and Portugal. In addition, the presence of two very different types of crocodylians (bernissartids and thalattosuchians), albanerpetontid amphibians, turtles and fish not described yet is mentioned. The flora was equally diverse, with abundant ferns, bryophytes, and conifers. Until now, these new achievements have not been integrated into the same synthesis work that allows us to have a global idea of the ecosystem that develops in the area during the Upper Jurassic–Lower Cretaceous transition. In order to create a palaeoartistic reconstruction of the Alpuente ecosystem during this period, the fossil and geological record discovered so far has been analyzed. Then, the palaeoartistic reconstruction process was applied to illustrate the different groups of representative vertebrates and flora. Likewise, some of the main problems of the reconstruction of Mesozoic vertebrates have been addressed, such as the distribution of osteoderms in stegosaurs and crocodiles, the covering of teeth by oral tissue in theropods and sauropods or the choice of coloration patterns in extinct animals. As a result, novel palaeoartistic reconstructions of the representative taxa of the Alpuente area have been provided.

**Keywords:** Palaeoillustration, Scientific communication, Palaeoart, Scientific illustration.

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## THE USE OF MUSEUM COLLECTIONS IN TEACHING PALAEOLOGY: A CASE STUDY OF INSTITUTO SUPERIOR TÉCNICO IN LISBON

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The Instituto Superior Técnico (IST) (Lisbon, Portugal) and its professors have greatly contributed to the history of Palaeontology in Portuguese Academia. Between 1913 and 1948, in addition to being a professor of this subject, Ernest Fleury (1878-1958) was responsible for organising and developing the Portuguese collections of Geology, Stratigraphy, and Palaeontology at the Museu Décio Thadeu, located at the Mine Pavilion. The creation and development of this museum's collections, besides for scientific and utilitarian purposes, had a pedagogical objective, which is still achieved today as most of them are used to teach earth sciences. As a case study, we will analyse a shell collection that is currently under research and inventory as part of a master's thesis project. This collection is composed of modern and fossil records, for the purpose of comparison, and is organised by genera of molluscs, such as gastropod *Trochus* or *Turritella*, among numerous other genera. It is estimated that the collection includes approximately 8000 specimens representing five classes of molluscs (Bivalvia, Gastropoda, Cephalopoda, Polyplacophora, and Scaphopoda). Most of the fossil specimens were collected in Portugal and span several geological periods, from late Cambrian to Neogene, making it an important tool for teaching Portuguese Geology as well. The main goal of this work is to provide a brief history of Museu Décio Thadeu and its collections and to show how they were vital resources for the education of Portuguese Palaeontology students and how these can still be used for this purpose, as well as for the education of young generations about the richness of our maritime biodiversity and the importance of the preservation of sea life.

**Keywords:** Ernest Fleury, Décio Thadeu, Molluscs, Conchology, Malacology.



# THE EVOLUTIONARY TREND TOWARDS THE FULLY-MARINE LIFESTYLE OF THE MOSASAURS: THE CASE OF A 'PACHYOSTOTIC' SQUAMATE FROM THE BASAL LATE CRETACEOUS OF SPAIN

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The mosasaurs (Mosasauridae) were a clade of aquatic squamates ranging from the Turonian (earlier Late Cretaceous) to the Maastrichtian (lattermost Cretaceous), that probably originated in the Tethys region and that were distributed worldwide at the end of the Cretaceous. Although highly adapted to open-sea environments, mosasaurs radiated from a lineage including more basal forms, informally referred to as 'dolichosaurs' and 'aigialosaurs' (*i.e.*, non-mososaurid mosasaurians), that were adapted to shallow-marine and freshwater environments. A major radiation of shallow-marine mosasaurians that mainly inhabited the Mediterranean Tethys, occurred in the Cenomanian (earliest Late Cretaceous), during which an incipient adaptation of the clade to marine environments is evidenced by 'pachyostosis' (a non-pathological condition of bone hypertrophy). The 'pachyostosis' (or pachyostosis *s.l.*) may be represented as pachyostosis *s.s.* (increase in volume of the periosteal cortex), osteosclerosis (increase of the bone inner compactness) or pachyosteosclerosis (the combination of both conditions). 'Pachyostotic' mosasaurians were almost exclusively restrained to the Cenomanian, since more derived forms (*i.e.*, the members of Mosasauridae) were already adapted to a hydrodynamic lifestyle in open-sea environments and, therefore, their osseous characteristics were extremely modified. The gradual transition towards an open-marine lifestyle is reflected in the external bone morphology and microanatomy of some primitive mosasaurian taxa. In this context, a pachyosteoclerotic vertebra of a squamate has been identified in the Cenomanian site of Algora (Guadalajara, Central Spain). The specimen from Algora shows several characters that allow its identification as a non-mososaurid mosasaurian and, more specifically, as an undefined form closely related to *Carentonosaurus mineaui*, from the Cenomanian of France. The aim of this work is to discuss anatomical analysis of the vertebra from Algora including its degree of 'pachyostosis' within the evolutionary framework of the adaptations towards a fully marine lifestyle recognized for derived mosasaurians.

**Keywords:** Iberian Peninsula, Cenomanian, Mosasaurians, Pachyostosis, *Carentonosaurus*.



## SPINOSAURID TEETH FROM THE LOWER CRETACEOUS OF GALVE (MAESTRAZGO BASIN, TERUEL, SPAIN)

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In the Iberian Peninsula, the diversity of spinosaurids is represented by both clades Baryonychinae and Spinosaurinae, with the Barremian taxa *Baryonyx*, *Camarillasaurus*, *Vallibonavenatrix*, and *Iberospinus*. Despite this, fossils of Spinosauridae are considerably fragmentary, being represented mainly by bone fragments and teeth. In this work, we described and compared three isolated theropod teeth (SC-6-142, SC-8-2 and SC-8-103) from the San Cristóbal 6 (SC-6) and the San Cristóbal 8 (SC-8) sites in facies of the lower Barremian Camarillas Formation (Lower Cretaceous), in the municipality of Galve (province of Teruel, Spain). In addition, these teeth have been analysed according to their morphological and qualitative characteristics for their systematic classification, applying discriminant (DFA) and cladistic analyses. After their study, SC-8-103 has been assigned to Theropoda indet., and it possibly belonged to a spinosaurid. The rest of the teeth have been classified as Spinosauridae indet., one with baryonychine affinities (SC-6-142) and another one with spinosaurine affinities (SC-8-2). In particular, SC-6-142 resembles other baryonychine teeth from the Lower Cretaceous sediments of the province of Teruel, and differs from those assigned to *Baryonyx* sp. and *Iberospinus* in the lack of serration on the mesial carina and the presence of flutes on both labial and lingual surfaces. SC-6-142 and SC-8-2 represent two different, but coeval, morphotypes of spinosaurids which coexisted during a fluvial environment that evolved upward into a deltaic sedimentary system. As it is well known, this kind of system is propitious for these dinosaurs due to their partially piscivorous diet and aquatic habits. These teeth also increase the record of spinosaurids in the lower Barremian of the Iberian Peninsula and the United Kingdom, supporting a possible European origin of the clade and its later dispersion towards Africa and the rest of Gondwana.

**Keywords:** Lower Barremian, Camarillas Formation, Spinosauridae, Palaeoecology, Palaeobiogeography.

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## “WALKING IN THE SHADOWS” WITH *PELECANIMIMUS*: WERE EARLY-BRANCHED ORNITHOMIMOSAURS NOCTURNAL?

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Ornithomimosauria was a relatively widespread clade of distinctive theropod dinosaurs that lived from the Late Jurassic to the Late Cretaceous. Many species developed particular dietary specializations, such as *Pelecanimimus polyodon*, with more than 200 small teeth and a possible omnivorous diet. These dietary changes have been hypothesised to be potentially related to sensory habits such as visual capabilities. For example, recent studies have correlated the dimensions of the scleral ring and orbit with the type of vision and activity pattern. This revealed probable nightlife capabilities in some ornithomimosaur and other related taxa such as Alvarezsauroidea, unlike the vast majority of non-avian theropods. Ornithomimosaur such as *Ornithomimus* were shown to have had high probability of nocturnal vision capabilities, while others such as *Garudimimus* would have had cathemeral activity (day and night habits). In this study, we made a detailed reconstruction of the scleral ring of *Pelecanimimus* to evaluate its possible visual capacity and habits. The reconstruction of the structure is divided in two procedures: segmentation and reconstruction *per se*. The accurate segmentation of the different ossicles was made on a CT-scan of the right slab of the skull, which preserved both scleral rings. Later, each ossicle was exported as an independent 3D model, then realigned within the skull, with a manual rearticulation and retrodeformation of the whole ring. From these reconstructions, measurements were made over the scleral ring and orbit of *Pelecanimimus*, which were statistically correlated with visual capabilities and lifestyle of the species afterwards. Preliminary results show that *Pelecanimimus* could have had patterns more alike to other members of its clade rather than that of the rest of theropods.

**Keywords:** Theropod, Dinosauria, Visual capabilities, CT-Scan, Las Hoyas fossil site.

**Acknowledgments:** Special thanks to MUPA for giving us access to the material, and to FPDM for the CT-Scan of *Pelecanimimus*. XCP MSc is granted by a MEC scholarship.



## HOW TO DO GAMIFICATION IN TIMES OF PANDEMIC? VIRTUALIZING “EVOLUTIONARY” WITH COMMON TOOLS

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“Evolutionary” is a game that was developed in 2019 for the XIX Madrid Science and Innovation Week and aims to teach concepts of Palaeontology and Geology through gamification. The COVID-19 pandemic was a major impediment to develop this activity during 2020 and 2021. Therefore, a series of adaptations were made to carry out online and synchronous games with the general public during the last Science and Innovation Weeks. In developing these adaptations, we used tools that were available to the public and easy to use. PowerPoint allowed us to create new game modes based on the original live games using simple animations. For more complex interactions during the presentation, we use the PowerPoint developer tool, which involves simple programming to generate counters and text boxes. Online word searches and puzzles were included as competitive games through links sent live via the Google Meet platform, used to interact with participants. Some of the adapted games were skeleton digging, which was based on the Battleship game, or “Pictiopaleo”, for which we used the online whiteboard Google Jamboard for participants to draw. The dice were replaced by animated PowerPoint roulette wheels and buttons were added to the quiz questions according to the advantages gained by the players to improve the interaction. The advantages of the online version are that it requires less instructors and no equipment, just a computer, allowing accessibility from anywhere in the world. The problem is the interaction between players, which prevents the formation of teams. Besides that, the game could be successfully adapted, and the participants were able to engage with the game and keep their attention despite the circumstances. In the future, the goal is to develop a proper PC game version of “Evolutionary” in order to bring it to more people.

**Keywords:** Evolution, Didactic resources, Online format, Earth sciences, COVID-19, Scientific dissemination.

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## NEW OCCURRENCES OF DACENTRURINE STEGOSAURS FROM THE UPPER JURASSIC OF NORTH AMERICA (MORRISON FORMATION)

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Stegosauria is an iconic group of herbivorous dinosaurs that lived from the Middle Jurassic to Early Cretaceous, found in all continents but Antarctica, characterized by a double row of bony plates and spines on their backs. The subclade Dacentrurinae was first discovered in late 19<sup>th</sup> century from the United Kingdom, and later from France, Spain, Portugal and recently Morocco. Comparisons of the lost holotype material of the Upper Jurassic “*Alcovasaurus*” *longispinus* (Wyoming, USA) with a second relatively complete specimen of the coeval *Miragaia longicollum* from Portugal revealed that the former was a dacentrurine, closer to these than to *Stegosaurus*, thus recombined as *Miragaia longispinus*. This demonstrated that dacentrurines were also present in North America and opened the possibility of more occurrences being found. After first-hand analysis of a number of palaeontological stegosaur collections from the USA, the following specimens are believed to be dacentrurines (followed by diagnostic traits of Dacentrurinae or *Miragaia* observed): UMNH VP 5572, cervical plate triangular in shape, convex medially with a posterodorsal notch; AMNH 492 and WDC-DMQ-020, dorsal vertebrae with centrum wider than long and transverse processes projecting at about 30 degrees to the horizontal; YPM PU 14556 and UMNH VP 5732, medium sized caudal spines with sigmoid cross-sections and double edged; a spine from Mountain America Museum of Ancient Life (replicas DMNH 33431 and at FCT-NOVA) is exceptionally long with a wide and concave base. A skeletal set from possibly more than one individual, YPM 1388, includes cervical vertebrae with arguable dacentrurine similarities. These specimens are from the Late Jurassic Morrison Formation of Wyoming or Utah, being previously classified within Stegosauria or Ankylosauria. These findings further corroborate the theorized dinosaur faunal interchange between Europe and NA during the Late Jurassic and show that dacentrurine stegosaurs had a wider distribution and potentially larger diversity than previously thought.

**Keywords:** Wyoming, Utah, *Miragaia*, USA, Portugal.

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## DIVERSITY OF ARCHOSAURIFORM TEETH FROM A NEW LADINIAN (MIDDLE TRIASSIC) SITE IN POLAND

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A new Ladinian (Middle Triassic) vertebrate assemblage was discovered recently in Miedary, southern Poland. To date over 20 taxa of fish, amphibians and reptiles have been identified. Within the relatively abundant dental material belonging to Archosauriformes, eight morphotypes can be distinguished, representing several taxa. The bicarinate ziphodont teeth with labiolingually compressed crowns resemble those referred to the carnivorous pseudosuchian *Batrachotomus kupferzellensis* from the Middle Triassic (Ladinian) of southwestern Germany. A similar, yet more slender morphotype with much denser serration may represent the same or a closely related taxon. A recurved tooth with an oval cross-section and weak serration is similar to the teeth of phytosaurs, the group known mainly from the sediments of the Late Triassic. Several of the collected teeth have serration limited to the distal carina only, a condition quite rare among archosauromorphs. Some teeth also exhibit a condition of apically directed triangular denticles, potentially belonging to an herbivorous form. The collected sample suggests a relatively high diversity of archosauriforms from the Miedary site, which requires confirmation through other skeletal remains.

**Keywords:** Archosauriformes, Middle Triassic, Keuper.

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## NEW ALLODAPOSUCHID REMAINS FROM THE LATE CRETACEOUS OF CATALONIA (SPAIN) WITH A REMARKABLE RECORD OF OSTEODERMS

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The Late Cretaceous of Europe has shown to be crucial to our understanding of the origin and early radiation of Crocodylia, the group containing all extant crocodylians. Notably, most crocodyliform remains from the Late Cretaceous of Europe are found in Spain, France, and Romania, where the most common and controversial group is Allodaposuchidae, a family recently established solely based on cranial features. The discovery of a single individual mainly represented by teeth, and postcranial and dermal skeleton remains, from the fossil site of Fontllonga-6 (Àger Basin, NE Spain) in the lower red unit of the Tremp Formation (late Maastrichtian, Cretaceous) allows to discuss poorly documented postcranial morphology of allodaposuchids. The specimen represents the most complete crocodylian from the Maastrichtian of Spain, with more than 30% of the skeleton recovered, including more than 70 dorsal osteoderms, and is hereby described in detail and compared to other allodaposuchids. Taphonomic analyses reveal a disarticulated but probably autochthonous accumulation of bones. The individual shows massive and robust cervical, dorsal, lumbar, and caudal vertebrae. The recovered osteoderms have different morphology and size, from which a position in the dermal skeleton has been proposed. Besides, the vertebrae and osteoderm morphology resembles other unnamed eusuchian remains from the lower Maastrichtian of the Tremp Formation. The size of the vertebrae and the large ribcage suggest it had a bulky body. The massive pectoral girdle, with large areas of muscle attachment, support this interpretation and resembles that of *Allodaposuchus hulki*. The specimen can be considered a generalized predator based on tooth morphology and high tooth size disparity, and might have preyed on small-sized dinosaurs, turtles, amphibians, and fishes which have all been recovered from the same fossil site.

**Keywords:** Crocodylia, Allodaposuchidae, Taphonomy, Late Cretaceous, Osteoderms, Tremp Formation.

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## NEW TECHNOLOGIES AND COMMUNICATION STRATEGIES LINKED TO THE PALEONTOLOGICAL MUSEUM OF ELCHE (MUPE) (ALICANTE, SPAIN)

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Nowadays, social networks and new technologies lead the communication of scientific news. However, traditional museums, with their permanent exhibitions, are still the main reference in terms of general palaeontological dissemination and of the surrounding sites. The Palaeontological Museum of Elche (MUPE), since its foundation in 2004, has reached young and older audiences through lectures, guided tours and educational workshops. Proof that these initiatives continue to work is reflected in the figures: more than 17,000 people visited the museum's facilities during the past 2022. However, more and more institutions are advocating the digitization of their activities. The MUPE, far from shying away from this trend, has included these new communication strategies in its program. Thus, it combines classical forms of dissemination with the progressive modernization of its infrastructure. New technologies allow for museums to be more inclusive, offering an almost unlimited range of possibilities: the hearing impaired can now enjoy virtual guided tours without the need for subtitles, while people with visual impairments can recognize palaeontological heritage with their hands thanks to the 3D modeling. In addition, the new platforms have given the museum the possibility of including gamification within its educational projects. Thus, multi-choice tests have become competitions where the student's smartphone acts as a control, and the explanatory videos have become interactive environments where the students have to explore to access the information. Finally, social networks have also become a new way to capture the attention of the media. This, together with the rest of the new digital tools, allow MUPE to reach a larger audience and open new horizons of work.

**Keywords:** Digitization, Dissemination, Museum, New technologies.



## PALAEONTOLOGICAL INTERVENTION AT ATALAYUELA 55 (VALLECAS, MADRID, SPAIN), A NEWLY DISCOVERED MIOCENE VERTEBRATE SITE

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Several fossil sites have been discovered in the Madrid Basin in recent years, thanks to urbanization works during the last years. In 2022 palaeontological remains were found during the palaeontological surveillance carried out on a building site located in the Vallecas district (Madrid, Spain), leading to the discovery of a new Miocene vertebrate site. In the present work, we provide a preliminary geological and palaeontological study of this new site, further providing some insights on its age and palaeoenvironment. The data presented here are preliminary, waiting to obtain the final results, to be able to make a correlation with other isochronological sites and to increase the knowledge about the ecosystems and faunas of the Aragonian of Madrid. The deposits consist of a succession of clays, sandy silts, and medium and coarse sands that have been interpreted as a sequence of fluvial/alluvial channels, floods, and mudflows, composed by successions of progradation/retrogradation events and subaerial exposure periods. Until now, more than 1,000 fossils have been recovered. A preliminary study allowed the taxonomic identification of 76.7% of the remains found in these deposits. Equids of the genus *Anchitherium* are the most abundant elements (21.3%), followed by the proboscideans *Gomphotherium* (15.7%), the rhinocerotid *Lartetotherium* (9.2%), and the cervid *Heteroprox* (8.8%). Rarer elements in the association include suid *Conohyus*, carnivores: hemicyonid *Hemicyon*, amphicyonid *Megamphicyon*, indeterminate mustelids and felids. As well as semiaquatic (Emydidae) and terrestrial turtles such as *Titanochelon*. The fossils appear disarticulated, partially fragmented, poorly preserved, covered by carbonate concretions, dissolved-replaced by carbonate or silica, transported, and accumulated as allochthonous remains by floods and mudflows after a period of exposure. The recovered rodent fauna includes: sciurids (*Heteroxerus grivensis*), cricetids (*Democricetodon larteti* and *Megacricetodon collongensis*), and lagomorphs (*Lagopsis verus*), which argue for a correlation to middle Aragonian zone E (Middle Miocene).

**Keywords:** Madrid, Fossil vertebrates, Fluvial-alluvial deposits, Biozone E, Aragonian, Middle Miocene.

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## METHODOLOGICAL PROPOSAL FOR THE STUDY OF BARREMIAN PLANT FOSSILS FROM THE EL CERROJÓN FOSSIL SITE (BUENACHE DE LA SIERRA, CUENCA, SPAIN)

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The palaeontological excavation campaigns carried out between 2017 and 2019 at the Barremian fossil site of El Cerrojón (La Huérguina Formation) have yielded many fossils of invertebrates and vertebrates, but also plant remains preserved as impressions and compressions. These include numerous specimens provisionally assigned to the genera *Podozamites* and *Zamites*. In both taxa, leaves (or leaf segments in the case of *Zamites*) are elongated and have an entire margin. For the correct taxonomic assignment of these specimens, it is necessary to observe the orientation of their stomata, which are only visible under SEM. The main objective of this study is to analyse the state of preservation of the sample to select those specimens that would provide best results under SEM observation. To minimize the human bias that could occur in this selection, a Taphonomic Alteration Index for Plants has been developed. For this purpose, six characters have been selected to differentiate the two genera while assessing the state of preservation of the specimen: presence/absence of peduncle, shape of the base, shape of the apex, consistency of the parenchymatic tissue, level of fragmentation, and venation. The sample consists of 75 specimens, of which 90.7% are disarticulated leaves (or leaf segments in the case of *Zamites*) and 9.3% correspond to branches with at least one articulated leaf. In 67% of cases, the leaves or leaf segments are complete, with apex and base. The application of this index has enabled us, following objective criteria, to establish three preservation categories (good, medium, and low), resulting in 53 specimens (62% of the sample) being categorised as “good”. Moreover, it has been possible to verify that there is no relationship between the taphonomic state of the specimens and the area of the fossil site from which they were recovered.

**Keywords:** *Podozamites*, SEM, Taphonomy, Upper Barremian, *Zamites*.

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## PRELIMINARY STUDY ON THE SYSTEMATICS AND PALAEOECOLOGY OF THE UPPER BARREMIAN (LOWER CRETACEOUS) OSTRACODS FROM VADILLOS-1 (CUENCA, SPAIN)

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The upper Barremian (Lower Cretaceous) palaeontological site of Vadillos-1 (province of Cuenca, central-eastern Spain) is located in the municipality of Beteta, near the village of Puente de Vadillos, belonging to Cañizares. The main lithologies present in the site are mudstones with gypsum and carbonate nodules, and interbedded sandy channels in "Weald" facies. Sampling conducted on the mudstones have yielded abundant microfossils, among which charophytes (used to assign the site to the *Asciadiella cruciata-Pseudoglobator paucibracteatus* biozone), crocodylomorph and fish teeth, eggshells, and ostracods are the most common. In 2022, new sediment sampling was done in Vadillos-1 with the main aim to obtain and study the ostracod fossils in detail. After the sediment was screen-washed, it was picked to separate these microfossils, which were then identified and photographed with a Scanning Electron Microscope (SEM). Several morphotypes of ostracods have been recognized, being most of them included in the variability of the genus *Cypridea*: *C. ex. gr. menevensis*, *C. aff. menevensis*, *C. aff. aragonensis*, *C. gr. alta* and *Cypridea* sp. 1, a possible new species of this group. Other specimens seem to belong to the genus *Vecticypris*, being recorded in the Iberian Peninsula for the first time in this work. *Cypridea* and *Vecticypris* are associated with fluvial-palustrine palaeoenvironments in the study area, and their representatives are tolerant to the occasional influence of brackish water produced by seasonal variations in water level and energy. With presence-absence data of ostracods and abundance data of other microfossils, a multivariate statistical analysis has been performed. This work has allowed to group the information to find a relationship between lithological characteristics and the presence of microfossils. Currently, different analyses are being carried out to understand the conditions of the lacustrine palaeoenvironment which was present during the late Barremian in the Hoces de Beteta area.

**Keywords:** Ostracoda, Cypridea, Weald, Palaeolimnology, Hoces de Beteta.

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## TECHNICAL STORAGE SPECIFICATIONS FOR THE CONSERVATION OF THE COLLECTION OF CRETACEOUS VERTEBRATE FOSSILS FROM POYOS (GUADALAJARA, SPAIN)

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Palaeontological collections constitute the evidence on which many of the hypotheses about the history of life on earth are built and, as such, have a heritage component. The main objective of its conservation is to ensure its availability for future research and for its use as a cultural resource for society. As part of conservation strategies, fossils require specific containers where they can be conserved and stored. These containers will be used for transfer, relocation, support during the study or deposit, so they have to be adapted to the morphological structure and state of conservation, guaranteeing their isolation from possible external agents of deterioration, but they must also be manageable and stackable, facilitating their handling and joint storage. Poyos (Guadalajara) is a Cretaceous continental vertebrate fossil site located on the banks of the Buendía reservoir. This means that the fossils are subjected to hydration and dehydration stress associated with the capacity cycles of the reservoir and that specimens generally have high humidity levels that suddenly drop after extraction. In fact, one of the most important instability risks for the Poyos material is the contraction and expansion of the clayey matrix associated with the specimens, even after having been intervened in the laboratory. To minimize humidity fluctuations that can cause alterations in the fossil, it is necessary to use specific storage supports. These structures must also protect the fossils from the effects of direct physical forces and damage caused by transport and handling. It will be shown how extruded polystyrene foam has been used to wrap the fossils with polypropylene fabric in the contact areas and fitted to a standard polyethylene box to prevent the loss of topography associated with the pieces, to protect the foam material and to facilitate storage.

**Keywords:** Fossils, Preservation, Support, Foam, Management.

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## DO NOT HIDE THE DATA FROM THE RESTORER. THE IMPORTANCE OF THE INFORMATION THAT ACCOMPANIES THE EXTRACTION BLOCKS OF PALAEOLOGICAL REMAINS

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In the process of extracting palaeontological remains, it is often decided to extract the fossil together with part of the rock structure that encompasses it. These structures are generally stabilised with the incorporation of external frameworks of a different nature that depend on the type, size, and structure of the block to be extracted. However, the final coating of these extraction blocks may hide details of particular interest during the preparation process. The absence of data on the internal structure of the block, the arrangement of the fossil elements, their state of conservation, or how, with what and where the block has been given consistency in the field makes the preparation process difficult, increases the need for exploratory tests (as radiological examinations) and greatly increases the risk of deterioration during the restoration process. Comprehensive data collection directed specifically to the restoration process is not only beneficial for the conservation of the fossil, but also a way of ensuring the protection of palaeontological information. A documentation routine is proposed that must accompany the creation of extraction blocks consisting of: (1) intensive photographic documentation of the process of excavation and construction of protections; (2) carrying out a mapping of the distribution of the set with all the complete pieces and the fragments that have been extracted individually; (3) indicate the interventions carried out, materials used and specification of handling, placement and opening; (4) elaborating exhaustive maps of the deteriorations, indicating the areas of fracture and the most resistant areas to grasp when handling the piece. On many occasions, the required documentation is similar to that usually taken in the excavation process, but, given that individualization of the specimens is not produced in the construction of blocks and that, generally, the different elements are hidden by an external framework, this documentation is especially necessary for the restoration process.

**Keywords:** Conservation, Palaeontology, Restoration, Documentation, *In situ* work, Excavation.

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## ANALYSIS OF GREGARIOUS BEHAVIOR IN THEROPOD DINOSAURS AT THE PEÑAPORTILLO TRACKSITE (MUNILLA, LA RIOJA, SPAIN)

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Several nearly parallel non-avian theropod trackways at Peñaportillo site in Munilla, La Rioja, have been studied to determine if these tracks suggest gregarious behavior among these dinosaurs. This tracksite is formed by limestones and marls of the Lower Cretaceous (Hauterivian) deposited ca. 125 My. It is a deltaic environment with a marshy submedium, which can be interpreted as a passageway used by dinosaurs to move from one place to another. One of the tools used to analyze the tracks is a photogrammetric model, that has made it possible to analyze the dinosaur footprints with a high level of detail and identify patterns in the distribution of 5 theropod dinosaur trackways present at the site. It has been observed that the trackways are arranged in similar directions, suggesting that these animals may have moved together. In addition, the photogrammetric model has made it possible to measure the depth and distance between the tracks with great precision. Based on this, we can deduce that the true tracks of dinosaurs of different sizes have similarities in depth and distance, suggesting that these animals moved at similar speeds and with similar postures. Also, it has also allowed us to study the geometric characteristics of the trackways to determine the direction of travel of these theropod dinosaurs. Previous studies have shown that tracks that are oriented in the same direction, have similar depth and preservation, and indicate similar speed usually suggest that the animals that produced the footprints were walking together. Hence, based on the data collected in this study, it can be inferred that the group of five dinosaurs that left these trackways at Peñaportillo could display a gregarious behavior.

**Keywords:** Photogrammetry, Tracks, Lower Cretaceous, Gregariousness, Non-avian theropod.

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## 'PALEOADVENTURE': TEACHING PALAEOLOGY TO THE FUTURE GENERATIONS

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Scientific outreach is important for society for several reasons, including the deontological imperative of the transmission of knowledge by the scientific community to the rest of the public, increasing research funding, and improving research conditions. Furthermore, when scientific outreach is explicitly aimed at children, apart from generating interest, it can even create vocations in the generations that will work in science in the future. 'Paleoadventure', an initiative carried out by a group of students from the Master's Degree in Advanced Palaeontology at the Complutense University of Madrid within the framework of 'Madrid Science and Innovation Week' activities, was born with this purpose in mind. It consisted of a series of different games created for children of primary school age with the purpose of disseminating concepts of palaeontology, geology and evolution with a ludic and educational approach. For this study, an overview is given of the process of creating the activity and the design of the different stands, the problems faced before and during its development and the conclusions reached at the end of the activity. It is also synthesized how the different games adapt the scientific content for the understanding of children, and what elements stand out in them at an informative level, as well as what modifications would be convenient to apply for its recreation in future editions of 'Science Week'.

**Keywords:** Children Outreach, Educational games, Palaeobiology, Geology, Evolution.

**Acknowledgments:** Our sincere thanks to the Faculty of Geological Sciences (Complutense University of Madrid), and especially to the area of Palaeontology for the assignment of the spaces to develop this experience. This work has been carried out as part of the activities of the project "Geodivulgar: Geología y Sociedad" (Educational Innovation Project of the Complutense University) during the call INNOVA-DOCENCIA 50 / 2022-23. This study has been financed by the madri+d Foundation.



## WHAT DO FOSSIL AND PALAEOLOGY MEAN ACCORDING TO CHILDREN? A PROSPECTIVE STUDY DONE WITH FOURTH GRADE ELEMENTARY SCHOOL STUDENTS

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Palaeontology is a very attractive science, especially for children. In order to make a more precise and adapted scientific dissemination as well as formal education in the classrooms, it is of special interest to assess the presence of palaeontology in the education. Palaeontology as a discipline is not generally present in elementary education curricula, but through concepts such as evolution and adaptations to the environment, it can be introduced in classrooms. It is important to seek the prior knowledge of elementary students of common terms such as “fossil” or “palaeontology”, since these are very familiar and challenging concepts for them. A survey was carefully designed in order to detect how 4<sup>th</sup> grade elementary students would define these concepts. The results show that, although more than a half of the 47 students who participated did not know how to define both terms, the remaining students gave answers that were mostly correct or very close. In their definition of fossil, the children used “animal remains”, “ancient bone” and “ancient life remains”, associating the notion with bones and animals, but excluding invertebrates, vegetation or vestiges of activity in their definitions. They usually used terms to define long time periods but very few used units such as millions of years. In the definition of palaeontology—with only 44.7% of answers compared with the 68.1% in the previous question—they used “science”, “study of fossils” and “extinct animals” as the most common terms. Very few students considered palaeontology as a job, but more of them considered it an adventure or discovery of fossils. In addition, they used to refer to professionals as “sirs”, so a gender bias can be deduced in professionals dedicated to palaeontology. It can be preliminarily concluded that in this educational stage, knowledge about these two terms is highly polarized, with a greater tendency towards unawareness.

**Keywords:** Education, Elementary School, Fossil, Palaeontology, Scientific divulgation.

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## PALAEOENVIRONMENTAL RECONSTRUCTION OF THE PLIO- PLEISTOCENE FOSSIL SITE OF EL RINCÓN-1 (ALBACETE, SPAIN)

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New information on the palaeontology, sedimentology and taphonomy of El Rincón-1 site (Motilleja, Albacete) was obtained thanks to the new excavations carried out during 2018–2022, after more than 30 y since the last excavation, which took place in 1986 by a team led by Professor M. T. Alberdi (MNCN-CSIC). This fossil site has provided one of the richest samples of fossil mammals from the middle Villafranchian (ca. 2.6–2.5 My, MN 16b, Plio-Pleistocene transition) of the Iberian Peninsula. For the interpretation of the geology of the site, a detailed stratigraphic column was made, distinguishing 6 levels that were analysed by X-ray diffraction in order to characterize their mineralogical composition. Besides this, a taxonomic revision of the new fossils was carried out, as well as a taphonomic study; this latter analysed a total of 437 fossils recovered during the campaigns of 2018 and 2019, considering their preferred orientation, grouping patterns, and XYZ coordinates, as well as a SEM analysis to study the bacterial activity of the fossils. From all these data, several palaeoenvironmental inferences can be made for El Rincón-1. Employing the occurrence of the taxa in the mammalian community, with a high percentage of cursorial taxa such as the bovid *Gazella*, the felid *Acinonyx* and the equid *Equus*, and less abundant browsers and mixed-feeders, such as the cervid *Eucladoceros* and the rhinoceros *Stephanorhinus*, it can be inferred the presence of a relatively low-structured environment, with open areas with more vegetated patches. Besides, the taphonomical and geological analyses suggest that El Rincón-1 was formed within a transitional environmental context between a lake and a fluvial system with shallow waters and low energy, where bones were exposed to high humidity conditions and re-orientation during the biostratigraphic phase due to slight fluctuations of the water column in a shallow lake shore.

**Keywords:** Palaeontology, Geology, Taphonomy, Pliocene, Pleistocene, Castilla-La Mancha.

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## NEW SAUROPOD TRACK CASTS FROM THE LOWER CRETACEOUS OF THE PEÑAGOLOSA SUB-BASIN (EASTERN IBERIA, SPAIN)

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In the Peñagolosa sub-basin, southwestern sector of the Maestrazgo Basin (province of Teruel, Spain), some Lower Cretaceous lithostratigraphic units have yielded a large number of tracks and tracksites in recent years. They are commonly registered in the lower Barremian Camarillas Formation (notably in its lower and upper parts). The ichnological record of this unit is represented by large-sized ornithopod (the most frequent), medium and large-sized theropod, and scarce thyreophoran and sauropod tracks. Here, we analyzed unusual and well-preserved manus and pes sauropod tracks found *ex-situ* in the CT-74 site in facies of the Camarillas Formation, in the municipality of El Castellar (province of Teruel, Spain). These tracks are preserved as thick natural casts in reddish, medium-grained sandstones and exhibit some well-defined anatomical details, which is unusual in the sauropod ichnological record from the Barremian of Iberia. The manus is wider (23 cm) than long (20 cm) and horseshoe-shaped (TLm/TWm ratio = 0.86). The proximal surface has a convex arc. The anterior digits (II, III and IV) would be situated in an anterior position although they are slightly impressed. Digits I and V are posteriorly located. Digit I shows clear evidence of a medium-sized pollex mark. The pes is subtriangular, longer (34 cm) than wide (30 cm). The anterior region is wider than the posterior and presents four digits anteriorly directed. Digit V is a small callosity situated laterally. This track also exhibits a slightly lateral notch, and a subtriangular and rounded heel. Some of these morphological features allow us to refer these casts to Sauropoda indet. Regarding the potential trackmakers, the horseshoe shape of the manus and the size of the pollex are features typically attributed to titanosauriforms, which is consistent with the osteological record in this unit.

**Keywords:** Maestrazgo Basin, Camarillas Formation, early Barremian, Saurischia, Palaeodiversity.

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## LAMNIDAE DECLINE AND CARCHARINIFORMES RISE IN TERTIARY ECOLOGICAL SHIFT: THE REMMERT DAAMS COLLECTION AND THE COLLECTOR'S BIAS

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Sharks (clade Selachimorpha) are one of the most well-known animal groups for the general audiences as shown by collecting shark teeth being a popular hobby in countries such as Belgium or the US. Unfortunately, the knowledge of their evolutionary history is hampered as a result of their cartilaginous skeletons, which hardly fossilizes. As a result, only their vertebral discs and teeth are a common find in the fossil record. Among the six extant modern shark order Lamniformes (mackerel sharks) and Carcharhiniformes (ground sharks) make up the bulk of the fossil teeth found. When these two shark clades are compared, Carcharhiniformes stand out as the most thriving and diverse extant shark group, comprising over two hundred and seventy species. On the other hand, however, Lamniformes are a barely diversified group, having suffered a severe decline in diversity over the last twenty million years that has reduced the clade to a meager fifteen extant species of medium and large-sized sharks. The causes of such decline are not well known and a variety of explanations, such as colder oceans or interspecific competition have been proposed has the motor driving the decline of lamniforms and the rise of carcharhiniforms. This ecological shift, however, is not well represented in the Remmert Daams collection, a shark teeth collection assembled in Belgium that comprises two thousand three hundred and eighty pieces with ages that range between the Ypressian (lower Eocene) and the Langhian (middle Miocene). In the following submission the causes for this ecological shift between lamnids and carcharhinids will be studied, and a comparison between the Remmert Daams collection and studies from Belgian and global sites will be carried out. Lastly, explanations for this anomaly, such as “collector’s bias” for big, complete, and striking teeth, ecological factors or taphomical factors will be proposed.

**Keywords:** Shark teeth, Eocene, Miocene, Belgium, Diversity.

**Actknowledgements:** Special thanks to EBS, who is in possession of the Remmert Daams collection and kindly lent it for the purpose of its study, and to SK, Belgian collector who helped with some of the identifications.



## AN APPROACH TO THE STUDY OF THE FAUNAL ASSEMBLAGE OF THE EL CASTELLAR FORMATION (UPPER HAUTERIVIAN–LOWER BARREMIAN) IN THE PEÑAGOLOSA SUB-BASIN (TERUEL, SPAIN)

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Fossil surface collecting is useful to determine the palaeobiodiversity, or at least part of it, in a lithostratigraphic unit of a particular geological area. Palaeoecological studies can be conducted with the combination of both the preceding analyses and the inclusion of geological data. Here, we have analyzed a sample composed of remains of different animal groups, mainly vertebrates, collected on the surface in several sites of the El Castellar Formation (upper Hauterivian–lower Barremian) located in the surrounding El Castellar village (Peñagolosa sub-basin, Teruel province, Spain). This unit is lithologically constituted by two stages: a lower one with purplish and grey claystone containing evaporites and intercalated sandstones, and an upper one composed of gray marlstones intercalated with limestones. After a preliminary study, the faunal composition is represented by different groups of bony fishes (Ginglymodi indet., indeterminate albuliforms, *Scheenstia* and pycnodontiforms), testudines (partial plates of Cryptodira and Pleurodira indet.), isolated teeth corresponding to indeterminate crocodylomorphs and saurischian and ornithischian dinosaurs, coprolites, gastropods, and bivalves. These new data on the faunal assemblage of the Castellar Formation complement the previous discoveries of postcranial remains of indeterminate theropods, medium and large-sized styracosternans, and huge neosauropods. Fossils assigned to fishes within the order Albuliformes have been associated with brackish water conditions in tropical coastal areas, which is compatible with the interpretation by other authors about the depositional system of El Castellar Formation.

**Keywords:** Surface collection, Early Cretaceous, Palaeobiodiversity, Palaeocommunity, Tropical coastal.

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## REVENGE OF THE INVERTEBRATES: NEW ICHNOLOGICAL RECORDS FROM THE FAMOUS MONTI PISANI VERTEBRATE ICHNOSITE (MIDDLE TRIASSIC, CENTRAL ITALY)

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The Middle Triassic (Ladinian) ichnofauna from the Quarziti del Monte Serra Formation (Monti Pisani massif, northern Apennines) has been studied for over a century, but such studies have focused almost entirely on vertebrate tracks. In fact, few authors have ever examined invertebrate traces in their research on the Monti Pisani ichnosite, and they did so often only marginally and sometimes erroneously. In the present work, beside some additions to the study of the vertebrate ichnoassemblage through three-dimensional methods (such as photogrammetry and structured light scanning), some invertebrate traces are investigated and analyzed. The invertebrate ichnotaxa that are preliminary identified herein include *Asteriacites*, *Diplocraterion*, *Planolites* and *Gyrochorte* (from the lagoonal Scisti Verdi member), *Archaeonassa*, *Diplopodichnus*, *Helminthopsis*, *Kouphichnium*, *Monomorphichnus*, *Rugalichnus* and cf. *Skolithos* (from the Quarziti Bianco Rosa and Quarziti Viola Zonate members, which testify to a coastal sandflat/delta and coastal ponds, respectively). Some of these traces can be primarily related to a lagoonal or coastal-marine depositional setting, while some appear to fall within continental ichnofaunal ichnoassociations, namely, the *Mermia* and *Scoyenia* ichnofacies. Previous palaeoenvironmental reconstructions of the Quarziti del Monte Serra Formation as deposited in a suite of paralic settings with both marine and continental influences is thus corroborated.

**Keywords:** Ichnofossils, Ichnofacies, Triassic, Apennines.

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## THE FIRST PUTATIVE PLACODERM EGG CAPSULE FROM THE UPPERMOST FAMENNIAN (LATEST DEVONIAN) OF POLAND

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Oviparity among early and lower vertebrates is under intensive discussion due to being well known among extant chondrichthyans, and the recent discoveries of internal fertilization and life-birth evidences in placoderm fishes, together with egg-capsules in the Devonian that could be assigned to different groups of vertebrates. Recent studies of Polish material that includes evidence of an egg-capsule of a fish with placoderm affinities complement similar evidence recently reported in the Devonian of Cleveland, USA. The specimen analysed was identified as an egg-capsule based on its morphology and similarity to the one already described and fits within one of the morphotypes: *Vetacapsula*. Also, the age context is of particular interest: the specimen is very well dated at the boundary of two mid-Paleozoic era periods: Devonian and Carboniferous. This moment is characterized by one of the biggest mass-extinction expressed by Hangenberg event at the Devonian–Carboniferous boundary. Besides almost 100 years of detail studies of Devonian vertebrates in the Holy Cross Mountains and hundreds of specimens revealed, no egg-capsule has been previously identified. We hypothesize that this may be due to a taphonomic bias, as the carbonate deposits which dominate the outcrops hinder the preservation of delicate structures, and only hard skeletal parts, such as dermal bones, scales and teeth are usually preserved. The exceptional environmental conditions during the anoxic event at the Devonian–Carboniferous boundary are recorded in deep sea sediments favoured the protection of such a delicate specimen. This interval, exposed in the Kowala Quarry, already well recognized due to its geochemical and stratigraphical relevance, should be now the target of detailed surveys and studies focused on soft tissue fossils. These studies will allow for a better understanding of the uppermost Devonian ecosystems and its palaeobiocenosis.

**Keywords:** Placodermi, Reproduction, Oviparity, Egg case, Famennian, Holy Cross Mountains.



## FIRST DINOSAUR TRACKS FROM LA PUEBLA DE VALVERDE (TERUEL, SPAIN)

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The late Jurassic deposits (Villar del Arzobispo Formation) have yielded countless sites with dinosaur fossil remains (tracks and bones) in the Peñagolosa sub-basin (western Maestrazgo Basin, Teruel Province). Key localities such as El Castellar municipality and surroundings have yielded abundant and diverse dinosaur tracks in this formation. They mainly include large to giant theropod, small ornithopod, large sauropod and stegosaur tracks. Here we present new dinosaur tracks found in La Puebla de Valverde municipality (LPV). Five specimens have been found. Geologically the footprints are found in an outcrop with facies that are mainly siliciclastic, consisting of mudstone interbedded with reddish and yellowish sandstone. The outcrop is included in the Villar del Arzobispo Fm. The tracks have been found isolated *in situ* and *ex situ* (fallen blocks) and are predominantly contained in different sandstone bedding layers. They are preserved either as casts and true tracks. The most distinctive fact about the study area is the diversity of track morphologies. The majority of the tracks are recognizable as small and medium tridactyl ichnites but they have poor morphological quality preservation excepting one. Some of the tracks show extramorphological features such as high interdigital angles, missing digits, and collapsed walls due to substrate conditions during the production. This preservation complicates the taxonomic assignment considering the difficulties of identifying small/medium theropod and ornithopod tracks during this age. However, the best-preserved footprint is a tridactyl natural cast of medium size, slightly longer than wide, with low mesaxony and preserving claw marks. These features suggest it is a theropod footprint morphologically different to the previously identified ichnotaxa in the sub-basin. Further research will clarify not only the ichnotaxonomic assignments and the variations in the morphology depending on the substrate conditions.

**Keywords:** Ichnites, Theropod, Preservation, Maestrazgo Basin, Peñagolosa Sub-basin, Villar del Arzobispo Formation.

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## DIFFERENT APPROACHES TO FORAMINIFERAL BIOSTRATIGRAPHY—CASE STUDIES FROM THE CRETACEOUS OF CENTRAL EUROPE

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Undoubtedly, foraminifera are one of the most useful microfossil groups for Cretaceous biostratigraphy. Foraminiferal biostratigraphy comprises at least two different approaches: (1) classical biostratigraphy utilizing vertical ranges of selected species; and (2) event stratigraphy including relatively short-lived foraminiferal event (characteristic foraminiferal community assemblages, different to those normally observed). As an example, we present two case studies of biostratigraphy based on Cretaceous foraminifera from the Central Europe, where these two approaches have been applied. The Upper Cretaceous case study is about a 13 m thick succession of chalk exposed in Belgorod (SW Russia). The co-occurrence of stratigraphically important benthic foraminiferal species *Gavelinella annae* and *Globorotalites michelinianus* and the first appearance datum (FAD) of *Globorotalites emdyensis* have been recorded within the section. It indicates the middle Campanian, the boundary between the two foraminiferal zones *G. annae* and *G. emdyensis*. On the other hand, large numbers of deep-dwelling planktic forms (*Globotruncana* and *Contusotruncana*), which are unique for the Campanian and Maastrichtian of the Russian Platform might be correlated with the global sea-level highstand (transgressive peak No. 2 of Hancock, 1993) observed in north-western Europe, the USA and New Zealand. The second case study deals with foraminiferal assemblage from a clays outcrop in the Owadów-Brzezinki quarry in central Poland. Based on long ranges of dominant species (*Verneuilinoides neocomiensis*, *Haplophragmoides concavus*, *Bulbobaculites inconstans*), the classic foraminiferal study allows to date them to the Early Cretaceous, but not more precisely. However, the lack of calcareous foraminifera makes this assemblage unique and allow the correlation with the upper part (abundance zone of boreal ammonites *Dichotomites*) of the Wąwał succession, a classical section of the Lower Cretaceous strata of the Polish Basin. Such assemblage composed of entirely agglutinated forms occurred only at very short interval and has been dated by ammonite biostratigraphy to the late Valanginian.

**Keywords:** Micropalaeontology, Foraminifera, Biostratigraphy, Event stratigraphy, Cretaceous.

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## SHELL ANOMALIES ON SPANISH SPECIMENS OF THE EOCENE *NEOCHELYS* (PLEURODIRA, PODOCNEMIDIDAE) FROM THE DUERO BASIN

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The Spanish Duero Basin (the largest Cenozoic continental basin in the Iberian Peninsula) stands out for the find of abundant and diverse remains of fossil vertebrates, especially reptiles and mammals. Material attributable to turtles is very common in the Eocene sedimentary successions of this basin, with four turtle lineages identified there (*i.e.*, Podocnemididae, corresponding to Pleurodira, and three lineages of Cryptodira: Testudinidae, Carettochelyidae, and Trionychidae). Podocnemididae, restricted to the freshwater genus *Neochelys*, is, by far, the most abundant turtle lineage there, present in various Eocene levels, from the Lutetian to the Priabonian. In this context, anomalous shell remains of about 10 *Neochelys* had been previously identified. However, these palaeopathological conditions lacked accurate analysis, detailed descriptions and differential diagnoses not having been published for almost any of them, which led to highly speculative hypotheses. More than 200 anomalous shell remains of *Neochelys*, most of them corresponding to unpublished specimens, are recognized by us. They correspond to both articulate and isolated plates. In this context, we perform a detailed study of the anomalies present on the fossil remains of the most representative turtle lineage in the Eocene levels of the Duero Basin: that of the podocnemidid *Neochelys*. The detailed external evaluation of the anomalies, combined with the use of computed axial tomography for some specimens, allowed us to refute several previously reported hypotheses of those being a product of putative predation by crocodiles, proposing distinct causal agents. The incorporation of an interpretation of new anomalous shell remains provides a more global vision about some agents (*i.e.*, bacteria, fungi, parasites, among others) to which turtles were subjected to in that region, as well as the effects that these had on the more representative turtle taxon of the Duero Basin.

**Keywords:** Testudines, Iberian Peninsula, Cenozoic, Anomalous conditions.



## PRELIMINARY MORPHOLOGICAL CHARACTERIZATION OF THE APPENDICULAR SKELETON OF THE TURTLE *ALGORACHELUS PEREGRINA* (PLEURODIRA, BOTHREMYDIDAE) FROM ITS TYPE LOCALITY (CENOMANIAN OF ALGORA, CENTRAL SPAIN)

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The fossil record of turtles is very abundant and diverse, especially from the Late Jurassic to the present. Given the peculiar body plan of this lineage, the find of plates or even more or less complete shells, is very common in many vertebrate palaeontological sites. Given the interest of the analysis of the shell remains to perform precise systematic attributions, and of the much less abundant skulls, other skeletal remains have received relatively scarce attention. This is the case of the appendicular elements, ignored or barely analysed for many extinct representatives for which, however, some of these bones were found. The palaeontological locality of Algora (Guadalajara, central Spain) represents the highest concentration of vertebrate remains for the European Cenomanian record. The analysis of this fauna is providing many new data on knowledge about the vertebrate faunas of the base of the Upper Cretaceous, which notably differ from those of the Lower Cretaceous. Thus, the oldest European representatives of several lineages represented in the uppermost Cretaceous of this continent are recognized there. In this sense, Algora is the type locality of the oldest bothremydid turtle (Pleurodira, Podocnemidoidea) identified in Europe: *Algorachelus peregrina*. The lineage of *Algorachelus* represents the oldest dispersal event of Pleurodira from Gondwana to Laurasia so far identified. *Algorachelus peregrina* is the most abundant taxon in Algora, hundreds of remains having been found. Among them, abundant appendicular elements regarding any other pleurodire described in Europe are included. They are generally found as isolated bones. Nevertheless, there is not an exhaustive study about the appendicular elements of *Algorachelus* yet. The objective proposed here is the preliminary analysis about its appendicular elements to understand the palaeobiology of this turtle, which has been proposed as a littoral form, most pleurodires (including all those that are part of current biodiversity) being freshwater taxa.

**Keywords:** Iberian record, Guadalajara, Late Cretaceous, Podocnemidoidea, Girdles, Legs.



## COMPARISON OF PALAEOECOLOGICAL ESTIMATIONS ACROSS MARINE BENTHIC INVERTEBRATE FOSSIL SAMPLES COLLECTED BY DIFFERENT SAMPLING METHODS

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Palaeoecological estimations are dependent on a good sampling design to avoid potential biases. The two major sampling techniques for collecting marine invertebrate fossils are surface sampling (collecting weathered-out fossils from the ground) and bulk sampling (taking sediment samples which are subsequently processed in the laboratory). We wanted to know if there are differences in diversity and palaeoecological results when using either surface or bulk samples. Fossil marine benthic invertebrate assemblages from the Late Triassic Cassian Formation (North Italy, Dolomites) were used because the sediments are mostly unlithified and allow therefore both sampling strategies. The results show that rarefaction curves are very similar across surface and corresponding bulk samples. In contrast, diversity indices (Shannon and Simpson) and rank-abundance distributions are different between bulk and surface samples in all studied Cassian assemblages. Diversity is always higher in the bulk samples and the community structure differs between bulk and corresponding surface samples. In addition, the three most abundant species in each assemblage differ to a high degree between both sampling types. The described differences can be attributed to the so-called mesh-size effect. When surface sampling is conducted, the ground is scanned by the eye and every fossil, which is found, is collected. Since the naked eye can find only fossils until a minimum size of about 3 mm, the eye resolution acts as a mesh-size of ca. 3 mm. All fossils smaller in size are lost. In comparison, bulk samples are washed and then sieved in the laboratory. Therefore, every desired mesh-size can be used for sieving. We used 0.5 mm as smallest mesh-size. Species and specimens < 3 mm are retained in the bulk samples, explaining the higher diversity and different taxonomic structure in comparison to the corresponding surface samples.

**Keywords:** Diversity, Palaeoecology, Marine invertebrates, Mesh-size effect, Sampling method.



## NEW CONTRIBUTIONS TO THE KNOWLEDGE OF THE LATEST MAASTRICHTIAN VERTEBRATE FAUNA FROM THE TREMP FORMATION (COLLADA BLASI OUTCROP, SOUTH PYRENEAN BASIN)

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The sedimentological and palaeontological analyses of a 200 m thick succession of the Maastrichtian part of the Tremp Formation at Collada Blasi area (Arén, Huesca province, NE Spain) have allowed to characterize a rich assemblage of vertebrate fossils, preserved in the continental-transitional palaeoenvironments, developed prior to the K–Pg boundary in this area of the South-Pyrenean Basin. The lower part of the studied succession (17 m thick) corresponds to the “Grey Garumnian”. It encompasses grey mudstones and marly and sandy limestones accumulated in a lagoon associated to a barrier-island system, and intercalated flood delta/washover sandstones. The overlying succession (190 m thick) corresponds to the “Lower Red Garumnian”, which includes brown, red and multi-color mudstones interpreted as coastal plain-distal alluvial muds, and intercalated sandstones and microconglomerates (fluvial channels/deltas) as well as grey mudstones and limestones (pond deposits). The vertebrate record at Collada Blasi area is wide and is mostly composed by dinosaur remains, mainly hadrosaurs, including *Arenysaurus ardevoli*, *Blasisaurus canudoi* and other undescribed taxa. At Collada Blasi outcrop at least, two hadrosaurid ornithopods have been found: one of small size (probably due to insular dwarfism) in lagoonal grey mudstones and the other one recorded in sandy limestones and in coastal plain brown mudstones, assigned to lambeosaurine, based on some of its remains (three caudal and one dorsal vertebrae and a fragment of a dentary). There are also crocodylomorphs (osteoderms) and chelonians (plate fragments) found in lagoonal sandy limestones and brown mudstones, respectively. Besides, some eggshell fragments have been identified in grey mudstones at Blasi 5 site, with two ootaxa belonging to theropod dinosaurs: *Pseudogeckoolithus* sp. and *Prismatoolithus* sp., plus some eggshells referable to Krokolithidae. Moreover, some dinosaur tracks are preserved as positive hyporeliefs at the base of fluvial sandstones/microconglomerates. Based on their morphology, these have been identified as *Hadrosauropodus*, an ichnotaxon related to hadrosaurid dinosaurs.

**Keywords:** Upper Cretaceous, Garumnian facies, Huesca province, Hadrosaurs, Ootaxa, *Hadrosauropodus*.



## REVISION OF ISOLATED THEROPOD TEETH FROM THE LATE MAASTRICHTIAN (LATE CRETACEOUS) OF THE WESTERN TREMP SYNCLINE (SOUTH PYRENEAN BASIN)

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The South Pyrenean Basin is one of the most important areas of Ibero-Armorica for the study of the late Maastrichtian dinosaur and penecontemporaneous vertebrate faunas, just prior to the Cretaceous–Paleogene extinction event. Hadrosauroid remains are especially abundant in the Arén Fm. and lower Tremp Fm. of the Tremp Syncline in the Southern Pyrenees (NE Spain). In addition, these units also yielded ankylosaurs, ornithopods, sauropods and theropods, and other fossil remains assigned to fishes, amphibians, squamates, testudines, crocodylomorphs and pterosaurs. This work updates the isolated theropod teeth record from the Western Tremp Syncline (Huesca). The teeth come from the late Maastrichtian (C30n–C29r) sites of 172-i/04/e, Amor 3, Blasi 1, 2b and 3, Larra 4, and Veracruz 1. The performed systematic and morphometric analyses, with a database that includes 1159 teeth and 65 taxa, allowed to differentiate seven tooth morphotypes: Abelisauridae indet. 1 and 2, Dromaeosauridae indet., Paraves indet. 1 and 2, cf. *Paronychodon* sp. and cf. *Richardoestesia* sp. This study has led to the reassignment of several teeth and an increase of the theropod palaeobiodiversity of the Western Tremp Syncline, with a new medium-sized abelisaurid and plenty of small coelurosaurians. The tooth morphotypes of the Arén and Tremp formations are already present in older Campanian strata, supporting that, overall, theropods were not negatively affected by the intra-Maastrichtian faunal turnover observed in other dinosaur clades. Nevertheless, some differences in pre- and post-turnover theropod faunas are observed. For instance, none of the abelisaurid teeth can be attributed to *Arcovenator*, suggesting the presence of a different abelisaurid in this basin. Furthermore, in contrast to the latest Campanian Iberian sites (e.g., Laño), only one cf. *Richardoestesia* sp. morphotype has been identified, and the more elongated and closer to conodont paravian teeth are more abundant in the Maastrichtian deposits of the Western Tremp Syncline. Nonetheless, sampling bias and sample-size factors cannot be ruled out.

**Keywords:** Abelisauridae, Coelurosauria, Europe, Maastrichtian, Pyrenees, Theropoda.

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## NEW THEROPOD TEETH FROM LATE JURASSIC OF THE LOURINHÃ FORMATION, PORTUGAL: EMPHASIS ON SMALL-SIZED TEETH

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Identifying theropod dinosaurs has always been challenging when their teeth are the only available remains to be preserved. Unlike mammals, theropod teeth lack apparent diagnostic characteristics, but with the help of numerous studies on their morphology and microstructures, it is now possible to identify them to the family or even species level if enough diagnostic features are present. Using recent techniques and up-to-date datasets, this study explored the phylogenetic affinity of five theropod teeth from the Kimmeridgian–Tithonian Lourinhã Formation of central Portugal (ML 728, 738, 746, 748 and 2793), based on a cladistic analysis run on TNT, performed on a dentition-based matrix of 146 characters scored in 115 theropod taxa, and a discriminant function analysis (DFA) using fifteen crown-based measurements with PAST. This study reveals that the DFAs show no consistent placement of the specimens at the family or genus level using Jackknifed Reclassification Rates. This method appears less reliable for small (< 2 cm) theropod teeth. Cladistic analysis results, however, indicate that one tooth likely belongs to a megalosaurid (ML 2793, one MPT), whereas the others are from coelurosaurs: two from a dromaeosaurid (ML 746, two MPTs; and 748, one MPT), one tyrannosauroid (ML 738, one MPT) and one from an indeterminate coelurosaur (ML 728, one MPT). The studied specimens could not be classified further than the family-level, particularly ML 738, with a globulous shape and a constriction at the base crown. This peculiar morphology approaches that of a straight folioid tooth and may pertain to a juvenile tyrannosauroid. Other specimens displayed several morphological traits observed in theropod teeth from the Portuguese Guimarota Mine, whose deposits are also from the Late Jurassic. This study allows us to re-identify some Guimarota specimens as belonging to Tyrannosauroida and invites reconsidering the presence of the putative dromaeosaurid *Richardoestesia* in the Late Jurassic of Portugal.

**Keywords:** Lourinhã Formation, Theropoda, Teeth, Jurassic.



## FIRST OCCURRENCE OF A FROG-LIKE BATRACHIAN (AMPHIBIA) IN THE LATE TRIASSIC FLEMING FJORD GROUP, CENTRAL EAST GREENLAND

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Over seven Danish-US team palaeontological field expeditions occurred in the Jameson Land Basin in East Greenland between 1989 and 2001. Their objective was to recover vertebrate fossils to understand the evolution of the vertebrate fauna of the region and its dynamics with their palaeoenvironments through geological times. The Triassic basin was located at 41°N on the northern rim of Pangea and bordered in the North by the Boreal Sea. During Late Triassic, the region consisted of ephemeral to perennial lake systems in a temperate, dry to humid climate crossed by rivers. This study focused on the microvertebrate remains recovered by Danish-US and later expeditions between 2012 and 2016. The specimens have been photographed and listed in a catalogue. 867 specimens of 993 could be identified, representing all the main groups of vertebrates (Chondrichthyes, Actinopterygii, Amphibia, Reptilia). Among them, one of the youngest and northernmost Batrachia of the Late Triassic has been represented by a right ilium. Fossils of Triassic batrachians are scarce and found only in a few outcrops, with only three described taxa: the two salientians *Triadobatrachus* and *Czatkobatrachus*, and the caudate *Triassurus*. After thorough comparison with several clades (lizards, temnospondyls, salamanders and frogs), we consider the specimen as a lissamphibian sharing features with salientians and anurans: a squarish acetabular region, a deeply concave acetabular surface, a laterally projecting acetabular rim, and a flat mesial surface. In association with this ilium, many remains of the above-mentioned clades of vertebrates have been identified. Among them, taxa never described nor reported in Greenland have been identified, such as *Lissodus*, *Rhomphaiodon*, *Gyrolepis* and Nothosauridae. Those taxa highly documented in Europe and Asia, confirm a relationship between the faunas of Greenland and Eurasia during the Late Triassic.

**Keywords:** Late Triassic, Chondrichthyes, Actinopterygii, Amphibia, Reptilia, Fleming Fjord Group.

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## HOW DID THE ORIGIN OF HERBIVORY IN TETRAPODS EXPAND TERRESTRIAL FOOD WEBS?

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The Carboniferous was a key period in Earth's history, as tetrapods became increasingly important components in terrestrial ecosystems. This included the development of new functional and evolutionary innovations, of which herbivory was one of the most important because of its effects on other trophic levels, such as the control on diversity and evolution of the flora, impacts on the nutrient cycle and on higher trophic levels. Herbivory emerged as tetrapods, particularly amniotes, diversified on land creating new terrestrial faunas with more complex food webs. One of the oldest terrestrial tetrapod faunas is Linton, Utah. This site dates from the Moscovian (315–307 My), which makes it a perfect place to explore trophic diversity patterns in early ecosystems, the evolution of fully terrestrial herbivorous amniotes and the trophic relationships between them and the other taxa present at the site. Using data on morphofunctional dental variation and body size, dietary specializations and tetrapod ratios at the site will be evaluated. Then we will build trophic networks that will allow us to find out the functioning of the Linton tetrapod community and compare it with the structure of modern ecosystems (in which a large number of herbivores support a relatively low number of carnivores) and explore the impact that the first herbivores had on this ecosystem.

**Keywords:** Herbivory, Carboniferous, Ecosystems, Trophic relationships.

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## MICROENDOLITHS IN TESTS OF FORAMINIFERA FROM THE WESTERN CARPATHIANS UNDER DISOXYC CONDITIONS

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Microbial endoliths occur in a wide range of marine hardgrounds, from the intertidal and wave spray zones to abyssal depths. They may also occur in tests of planktonic and benthic foraminifera, and their traces may provide clues as to palaeobathymetry, oxygenation and environmental stress. The investigated material ranges from the Rupelian to the Serravallian from four localities from the Central Paratethys area surrounding the Western Carpathians, in the Czech Republic, Slovakia (DNV), and Hungary (Rozalia). The technique we used consists of embedding and casting the tests in epoxy resin in a vacuum chamber unit and, subsequently, dissolving them. The obtained positive casts of the borings keep the external morphologies of the traces allowing their identification. A total of 10 ichnospecies and 4 at level of affinity were identified. The inferred ichnocoenosis indicates deep euphotic to aphotic zones. DNV presented the highest diversity, with 4 forms identified and, along with LKŠ, LOM-1 presented also high levels of infestation, whereas Rozalia lacked microborer activity. Rozalia is also the only sample where associated biofilms and framboidal pyrite could be found with the highest concentration of elemental iron, sulfur, and phosphorus. Raman spectroscopy from these structures revealed the presence of organic molecules similar to pigments. The obtained BFO index shows a predominance of indicators for suboxic to disoxic conditions. Mikulov was the only locality showing oxic indicators whereas Rozalia presents only disoxic ones. This condition in Rozalia may be a result of the origin of these sediments as a part of the deposition of Tard Clay Formation, largely known for oil deposits and deep disoxic bottoms. Anoxic bottom conditions necessary to preserve organic matter that will originate oil may be incompatible with microendolith communities other than sulphur-reducing bacteria, as they may be too stressful even for endolithic heterotrophs.

**Keywords:** Microendoliths, Microbial biofilms, Sulphur content, Palaeobathymetry, Bioerosion, Palaeoecology.



## THE PALYNOLOGICAL RECORD OF THE TAGHANIC EVENT IN SOUTH-CENTRAL POLAND

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Eight Devonian sections located in south-central Poland have been investigated for palynology. These deposits originated in different palaeoenvironmental conditions that involved three various basins with different geological setting (Kielce Region of the Holy Cross Mountains, the Łysogóry and the Lublin Basins). The palynostratigraphic analysis allowed establishing the age from Givetian (Ex2 subzone of Ex Miospore Zone) to Frasnian (Aur Miospore Zone). This means that investigated interval could coincide with the Taghanic Event. The most prominent feature of the palynological Taghanic interval was a noticeable decrease in miospores taxonomic diversity. Here, the well-preserved material seemed to follow this pattern but only to some extent. The decrease of taxonomic diversity is noticeable however not significant. Palynofacies analysis revealed the complexity of the palaeoenvironmental situation with the few transgressive-regressive impulses that affected the relatively shallow marine shelf with the high terrestrial material input. However, it is difficult to indicate with certainty that miospore taxonomic decrease and environmental changes are directly connected. This means that palynological record of the Taghanic Event requires further investigations.

**Keywords:** Palynomorphs, Miospores, Devonian, Palynostratigraphy, Palynofacies.

**Acknowledgments:** I would like to thank SCC for taxonomic recognition of chitinozoans, that has significantly improved my work.



## TRILOBITES OF THE GENUS *ENCRINURUS* FROM BALTOSCANDIAN ERRATIC BOULDERS COLLECTED AT ORŁOWO CLIFF (NORTH-EAST POLAND)

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This presentation aims to discuss specimens of the trilobite genus *Encrinurus* Emmerich, 1844 recovered to date from erratic boulders of Baltoscandia and to compare these with literature data. The specimens were collected during field trips in the area below Orłowo Cliff in Gdynia (Poland) during 2017-2022. On the beach near the cliff there are a lot of erratics, which were transported here by the ice sheet from Scandinavia and several Baltic countries during the Pleistocene Ice Age. Twelve pygidia, four fragments of cephalons, and single thoracic segments were found in Palaeozoic limestones, which probably belong to two species of the genus *Encrinurus*. Because recognition of *Encrinurus* species is based mainly on cephalon characteristics, it is not always possible to assign a specimen to a particular species. Both lithology and the presence of co-occurring fossils suggests that all *Encrinurus* specimens are of Silurian age, mostly likely of Wenlock and/or Ludlow age. In addition, some morphological features of exoskeleton of *Encrinurus* permit broad-based interpretations regarding the lifestyle of these trilobites. It is possible that they were able to swim; spines and tubercles provided protection from predators.

**Keywords:** Arthropods, Fossils, Erratics, Trilobites, Orłowo Cliff.



## VEGETATION CHANGES IN THE VICINITY OF THE LAKE AMALVAS (LITHUANIA) DURING THE LATE-GLACIAL-HOLOCENE TRANSITION, ACCORDING TO POLLEN DATA

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Pollen as a source of palaeoecological information is extremely important and informative. When analysing the taxonomic composition of pollen in the sediments of the Late Glacial and the Holocene, it is possible to reconstruct the natural dynamics of vegetation, signs of human activity, environmental changes. The transition from the Late Glacial to the Holocene was extremely prominent in terms of palaeoecology. The late Glacial is characterized by a cold and dry climate, a low water level, soil formation and overgrowth of lakes proceeded very slowly, intensive erosion and an open landscape prevailed. The early Holocene was characterized by a drier, warmer climate with cold winters and cool summers. However, there is still a lack of high-resolution information on how this event affected the environment in different parts of the world. In a detailed pollen analysis of the sediments of Lake Amalvas in Lithuania, the first few samples spanning the Late Glacial–early Holocene boundary were analysed. Concentration of pollen increased significantly at the onset of the Holocene, in particular the pollen of trees and shrubs, whereas herbaceous plant pollen content remained similar. The study site at the end of the Younger Dryas was particularly dominated by herb vegetation. Only single trees could grow in the area. At that time the biome was most similar to a tundra because frozen ground was common in Younger Dryas. As the temperature risen, the open or sparsely overgrown areas became covered with trees (mainly birches and pines). Birch usually quickly occupies open areas, creating favourable conditions for the immigration of other trees, so this explains the large number of new plants such as elm, aspen, ash, etc. that appeared in the study area. The biome has changed from tundra to a forest tundra. The sudden appearance and disappearance of juniper may be due to the rapid expansion of the forest due to warmer and sunnier climate.

**Keywords:** Pollen analysis, Palaeovegetation, Late Glacial, Holocene, Lithuania, Younger Dryas.



## A SKULL FIT FOR A CROWN: ONTOGENIC SHAPE VARIATION OF *EUSTHENOPTERON FOORDI* CRANIAL ROOF

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The study of the first appearance of tetrapods during the Devonian period (416–359 My) requires the discovery of transitional forms of fossil fish that bear morphological similarities with the primitive tetrapods. Since the 20<sup>th</sup> century, *Eusthenopteron foordi* has served as a model for comparison between tetrapodomorph fish and elpistostegalians. Due to its abundance in the Escuminac Formation of Parc national de Miguasha and the remarkable work done by numerous researchers, the anatomy of *E. foordi* is one of the best known in the entire fossil record. Although few studies have been performed on the skeletal ontogeny of *E. foordi*, there is a lack of information regarding the ontogenic shape variation of the cranial roof since the number of immature specimens is limited; the early ontogenetic stages being less ossified, their fossilization is rarer. The main goal of this research is to study shape variation of the cranial roof in *E. foordi* during different stages of ontogeny. Using 2D geometric morphometrics, the morphometric variation in 30 specimens at different stages of development will be analyzed. The landmarks will be placed at the intersection of the parietals, postparietals, extrascapulars, tabulars and supratemporals. A maximum of 15 markers will be used in total. Subsequently, a principal component analysis (PCA) will be performed, allowing the variation between specimens to be assessed. This will allow the construction of a morphospace that will be used to interpret the cranial morphometric variation as well as the variation related to ontogeny. The new information on the ontogenic shape variation of the cranial roof will be greatly useful in studying the role of cranial pedomorphosis in the origin and evolution of tetrapods.

**Keywords:** 2D Geometric Morphometrics, Tetrapodomorpha, Devonian, Principal component analysis.

**Acknowledgments:** I would like to sincerely thank my research director, RC, as well as the PNM for their trust and support.



## A VIRTUAL CRANIAL ENDOCAST OF THE MIOCENE PRIMATE *MIOEUOTICUS SHIPMANI* (LORISIDAE, STREPSIRRHINI) FROM KENYA

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*Mioeuticus shipmani* is an extinct primate of the family Lorisidae, the group that includes modern lorises and pottos. This species comes from the early Miocene of Kenya and has been argued to belong to the lorisid stem. *Mioeuticus shipmani* is known only from its holotype (KNM-RU 2052), represented by a relatively complete partial cranium. Here we present a virtual cranial endocast, which allows for comparison with other endocasts from extant and extinct lorisoids (*i.e.*, lorises + galagos). Despite the comparatively smaller absolute size, the cranial endocast is very similar in appearance to its present-day relatives (*e.g.*, relative size of the olfactory bulbs, presence of small petrosal lobules, level of neocorticalization), suggesting very conservative trends in the evolution of Lorisidae at least as far back as the Miocene. Despite the great similarity to living lorisoids, there are endocranial differences between *Mioeuticus shipmani* and extant lorisoids, such as a lesser expansion of the occipital lobe, a smaller cerebellum than in galagids, a more exposed cerebellum compared to modern lorises, widely spread olfactory bulbs compared to modern lorisoids, and a markedly convex pituitary gland. The study of this specimen will undoubtedly help us illuminate critical aspects of the brain evolution in Lorisidae and fill an important gap in their evolutionary history.

**Keywords:** Brain evolution, Palaeontology, Virtual endocast, Strepsirrhini, Primates.

**Acknowledgments:** I would like to thank FKM of the National Museums of Kenya and MN of Kyoto University for access to the original datasets, and MTS and MML of the University of Toronto Scarborough, for data sharing and guidance. This study is supported by a National Science Center (Cracow, Poland) grant no. 2022/45/B/NZ8/03585 to SLT.



## **DIPLOCYNODON RATELII (CROCODYLIA: DIPLOCYNODONTIDAE) FROM THE MIDDLE MIOCENE (MN5) SITE OF ELS CASOTS: NEW FOSSIL REMAINS AND PALAEOBIOLOGICAL INFERENCES**

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Els Casots (Subirats, Catalonia) is one of the richest vertebrate sites of the Vallès-Penedès Basin and is considered a key reference site at the European level for the beginning of the middle Miocene (early Aragonian subzone Cb, MN5). Among the herpetofauna, fossil remains of crocodylians are very abundant, but until now only partial skulls and isolated elements such as osteoderms and teeth belonging to the species *Diplocynodon ratelii* had been recovered. The specimen IPS127899 recovered during the 2021 excavation campaign represents the first ever almost complete skeleton found in anatomical connection. Multiple skull and postcranial features confirm its assignment to *Diplocynodon ratelii*, such as: (1) the distinct dorsoventral step on the frontal; (2) the shape of the frontoparietal suture; as well as (3) keeled dorsal osteoderms associated with bipartite ventral osteoderms. According to skull measurements, IPS127899 had a total length of 1.38 m long, about the size of smallest extant crocodylians, and probably fed on fishes, amphibians, mollusks, and insects as well as small reptiles and mammals. Associated geological and palaeontological data show that at els Casots it inhabited a shallow, seasonally-fluctuating, eutrophic freshwater lake situated very close to the coastline. To provide a first insight into the palaeobiology of the species, we have further analyzed the bone histology of an isolated femur of *Diplocynodon ratelii* found in previous campaigns. The main bone tissue found in the thin-sections (parallel-fibered bone) suggests similar growth rates for this extinct crocodylian and extant alligators. Future histological studies focused on the analysis of vascular canals and growth marks will yield more detailed information about the growth pace of *Diplocynodon ratelii*.

**Keywords:** *Diplocynodon ratelii*, Els Casots, Aragonian, Vallès-Penedès Basin, Bone histology, Growth.

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## NEW DENTAL REMAINS ASCRIBED TO *GOMPHOTHERIUM* FROM THE MIDDLE MIOCENE OF QUINTA DA FARINHEIRA (LOWER TAGUS BASIN, LISBON, PORTUGAL)

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Gomphotheriidae is an extinct family of proboscideans that first appeared during the Early Miocene in Africa. They were characterized by the presence of an upper and lower pair of tusks and bunodont cheek teeth, being a cosmopolitan family recorded in a high variety of habitats. During the Miocene, they were widespread in North America, Central America, Africa, and Eurasia, reaching South America probably during the Late Miocene and completely disappeared in the Pleistocene–Holocene transition. One of the greatest representatives of Gomphotheriidae is *Gomphotherium*, a proboscidean with several species and a global distribution during the Miocene. Here we describe Gomphotheriidae dental remains from the Middle Miocene (MN5, 13.7–16.0 My) of the classical sites of Quinta da Farinheira and Charneca (Chelas Valley and Lumiar, Lower Tagus Basin, Lisbon, Portugal). The specimens are thirteen isolated cheek teeth of adult individuals, housed at the Department of Earth Sciences of FCT-NOVA, which were collected decades ago, being never described. The new material shows dental features of *Gomphotherium* sp., a ubiquitous taxon of the European faunas during that time. Most of the material exhibits 3 distinct lophs and the presence of the anterior and posterior cingula. The dental remains are mostly well preserved and have different stages of wear, including the pretrites and posttrites, which allowed the identification of the tooth position. The amount of loph(s) and the size contributed to the identification of the molars (m1, m2 or m3) and they have a simple trefoil wear pattern, with rare accessory cusps. Based on the dental morphology of the cheek teeth, the herein studied remains from Quinta da Farinheira can be tentatively attributed to *Gomphotherium angustidens*, a Gomphothere widely known from the Lisbon region.

**Keywords:** Gomphotheriidae, Proboscidea, Dentition, Morphology.

**Acknowledgments:** For this study, we would like to thank the Department of Earth Sciences (FCT-NOVA) for providing the teeth for the study and we appreciate all of Professor MTA guidance on the proboscideans of the region.



## INVERTEBRATE SCLERITES FROM CAMBRIAN LIMESTONES OF THE CANTABRIAN MOUNTAINS

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The content in microfossils from one sample of limestone from the upper member of the Láncara Formation, close to Las Salas (León), and another sample from the lower part of the Oville Formation, close to Sotres (Asturias), was herein studied. The microfossils are preserved as calcium phosphate, calcium carbonate and glauconite and dissolution with buffered formic acid technique was applied in order to avoid the damaging of the fossil remains. Both samples correspond to the middle Cambrian (interval between the Mediterranean Leonian and Caesaraugustian stages, equivalent to the time between the Global Stage 4 and the Drumian). Sclerites, preserved in phosphate of palaeoscoleids, are abundant in both samples. The palaeoscoleids belong to an extinct Cambrian group of vermiform metazoan with possible affinities with the priapulids, covered with a cuticle of phosphatic sclerites. These button-like sclerites, with tubercular ornamentation and very small size, constituted the external skeleton. The specimens correspond to the parataxon *Hadimopanella oezgueli* Gedik. The second sample shows a greater diversity and abundant invertebrate remains, echinoderm plates, brachiopods, hyolitids and mollusks. Among them, the rays and sclerites of the chancelloriids have been studied. The chancelloriids are a group of extinct Cambrian animals whose phylogenetic position is uncertain. The remains of its tissues allow to interpret a sack-shaped body covered by a flexible integument formed by sclerites. These sclerites are usually composed by a series of hollow rays which in life have been filled with organic matter. The occurrence of the genus *Chancelloria* Walcott, as well as probable rays of the genus *Archias-terella* Szudy, are firstly recognized in the Oville Formation of the Cantabrian Mountains.

**Keywords:** Palaeoscoleids, Chancelloriids, Cambrian, Láncara Formation, Oville Formation.

**Acknowledgments:** Thanks to the Department of Geology of the University of Oviedo by the financial support of the sessions in the programme of TFG's.



## PALAEOHISTOLOGY OF ORNITHOPOD DINOSAURS FROM THE BARREMIAN OF LADRUÑÁN (TERUEL PROVINCE, SPAIN)

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Several remains of iguanodontid ornithopods have been reported from two fossil sites (Camino de La Algecira and Pepe) from the Mirambel Formation (Barremian, Lower Cretaceous). The sites are located in the Ladruñán anticline (Maestrazgo basin, Teruel province, Spain). The sampled bones are a neural spine of a dorsal vertebra, four fragments of vertebrae, two ribs and two ossified tendons belonging to several individuals. These are curated at Museo de Ciencias Naturales of the University of Zaragoza. By means of the palaeohistological study of the different types of bone tissue and their relative structures, ontogenetic stages have been proposed for the different specimens. We identified three samples of somatically mature individuals and a somatically immature one at the Camino de La Algecira fossil site (MNI = 2). On the other hand, we found three samples of somatically immature specimens and one somatically mature in the case of the Pepe fossil site (MNI = 2). These results indicate that the populations recorded in both sites could be ontogenetically diverse. Furthermore, some of the diagenetic processes and their influence on the preservation or alteration of mineralized tissues have been reconstructed. In this sense some phases of mineral generation have been observed, apart from the primary apatite of the bone tissue. We can distinguish: (1) an initial phase of micritic and sparitic carbonate filling; (2) a second in which pyrite-type sulfides crystallize and oxides replacing some sections of the carbonate filling; and (3) gypsum formation processes which only affected the samples from Camino de La Algecira.

**Keywords:** Bone histology, Ornithopoda, Ontogeny, Early Cretaceous, Maestrazgo basin.



## FIVE YEARS OF DINO PARQUE LOURINHÃ PREPARATION LABORATORY, 2018–2023

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In the five years since its opening in 2018, Dino Parque Lourinhã includes a fossil preparation laboratory. Besides the usual preparation work, the laboratory also plays an important role in scientific outreach communication, since all the work can be seen through large windows while staff and volunteers work. The fossils under the care of the laboratory do not belong to Dino Parque, most belong to the Museu da Lourinhã. Despite the large number of local materials, there are fossils from other Portuguese museums, such as the Museu Décio Thadeu in Lisbon, and from other countries like Germany, Angola, and the USA, all lent for study, preparation, or exhibitions. An educational component is also present in the lab, with not only the opportunity to see palaeontologists at work, but also with the possibility of participating as volunteers starting at 16 years of age, with a total of 44 volunteers, from 12 countries, having already passed through the lab. For many of them, it was their first contact with palaeontology and the first time learning more about fossils and preparation. The Dino Parque's laboratory also received several students doing their master's thesis, in either preparation, palaeontology (mostly from Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa) or palaeontological illustration (Universidade de Aveiro). Since 2018, a wide variety of fossils have gone through the laboratory, including some with international relevance like the holotype of *Plesiopharos moelensis* (ML2302), the oldest and most complete plesiosaur from Portugal and Spain, studied at Dino Parque; and Paimogo nest, one of the most important fossils of Portugal with presence of eggs (ML 565) and embryos attributed to *Lourinhanosaurus antunesis*. Other fossils, still being studied, may be of equal importance, providing insights of the Portuguese Jurassic ecosystem, as another nest from Caniçal (ML 2281), a crocodylomorph skull (ML 2776) from a possible new goniopholidid species, several sauropod bones, and vertebrate microfossils picked under a binocular lens.

**Keywords:** Laboratory, Dino Parque, Palaeontology, Education.

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## MORPHOLOGICAL DIVERSITY OF CHILEATE BRACHIOPODS FROM THE DRUMIAN MEMBER OF THE LÁNCARA FORMATION (NORTH SPAIN)

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The Láncara Formation, Cambrian in age, is a mixed carbonate-siliciclastic unit from the Cantabrian Zone of Northern Spain. The specimens reported here were sampled from its Drumian (Miaolingian) upper member. This member is particularly interesting due to its rich and diverse faunal assemblage, consisting of encrinitic packstones, overlain by an alternating succession of bioclastic wackestones-packstones and shales punctuated by storm events. The variegated limestone/shale couplets (*griotte* facies) record a variety of organisms such as echinoderms, trilobites, chancellorids, hyoliths and brachiopods. The focus of this work lies within a particular group of matutellid brachiopods, which show a noticeably morphological variability, with three distinct morphotypes. Morphotype 1 is the smallest, and exhibits a subquadrate outline, a longer and straighter posterior margin and a less pronounced fold and sulcus. Morphotype 2 is intermediate in size and shape between Morphotype 1 and 3. Morphotype 3 is the largest one, with a subcircular outline, a short and slightly sloped posterior margin, elongated “ears” and a very pronounced fold and sulcus. This diversity of morphotypes was controlled by an increase in plasticity within the population, the product of living in an environment subjected to both spatial (due to the presence of tectonically induced horst and half-grabens with differing environmental factors) and temporal (long-term process of deepening and drowning of the platform alongside short-term cycles of deepening-shallowing) variations. The interaction of numerous factors led to the appearance of an incipient polyphenism within the brachiopod population, which increased its intraspecific variation and possibly led to evolutionary divergence of the more extreme morphs. Our results point to an ecophenotypical origin for the morphological plasticity of Cambrian chileate brachiopods.

**Keywords:** Echophenotypical plasticity, Polyphenism, Matutellids, Cambrian, West Gondwana.

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## PALAEOBOTANICAL RECONSTRUCTION AND DATING OF ONE OF THE MOST MODERN LATE MAASTRICHTIAN DINOSAUR SITES (VERACRUZ 1, NE SPAIN): PALYNOLOGICAL INSIGHTS

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Continental deposits containing the K–Pg. boundary in Europe are scarce. Some of the best examples locate in the SW of Europe, particularly at the South-Central Pyrenees. One of the latest Maastrichtian tetrapod fossil assemblages, including dinosaurs, has been recorded in the lower units (“Grey Garumnian” and “Lower Red Garumnian”) of the Tremp Formation, outcropping in north-western-most sector of the Tremp syncline (South Pyrenean Basin). The Veracruz1 site (VE 1) locates in a grey mudstone package at the uppermost part of the “Grey Garumnian” representing a muddy pond developed in the perilagoonal area of a barrier-lagoon system. In this work, we present a palaeopalynological and palaeoecological interpretation of the VE 1 site near Beranuy village. The collected sample has a rich and well-preserved palynological assemblage with 41 fossil-taxa identified. This assemblage is dominated by angiosperm pollen grains mainly represented by the post-Normapolles group. Continental character is justified by freshwater/brackish algae and marine influence by dinoflagellate cysts, which is coherent with the sedimentological interpretation of the site close to the barrier-lagoon system. Late Maastrichtian age can be deduced for the VE 1 site based on the presence of the selected taxa: *Subtriporopollenites microconstans*, *Camarozonosporites insignis*, *Lusatiporis dettmanae*, *Trudopollis granulosus*, *Rugulitriporites pflugii* and *Bacumorphomonocolpites* sp. This age assignment is coherent with previous dating obtained by combination of magnetostratigraphic and biostratigraphic studies of the lower part of the Tremp Fm. in the Beranuy-Serraduy area within the magnetochron C29r (late Maastrichtian). The palaeoecological interpretation of the area based on the palynological assemblage of VE 1 shows a coastal forest of Jugladaceae/Myricaceae trees and shrubs with a flowering understory of Liliaceae herbs. Regarding the palaeogeography, the assemblage is consistent within the Normapolles Province but Gondwanan influence was also observed (e.g., *Bacumorphomonocolpites* sp.).

**Keywords:** Tremp Formation, Palaeopalynology, late Maastrichtian, South-Central Pyrenees.

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## VERTEBRATE MICROFOSSILS STORAGE—THE SYSTEM OF MUSEU DA LOURINHÃ

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Working with vertebrate microfossils presents its challenges. Their small size, most often millimetric, their fragility, their instability, and the usual presence of highly diagnostic delicate structures require the development of specific preparation, conservation, and curation techniques for this type of fossil. Difficult to find, easy to lose or damage, and problematical to restore, these fossils require extreme care in their handling and study. The recent expansion of the vertebrate micropalaeontology collection at the Museu da Lourinhã compelled its preparators to adopt a strategy for storing and accessing thousands of new specimens. The constraints for this project were: (1) packaging thousands of fossils in materials that are stable, economical, easy to acquire and manipulate, and compatible with the use of imaging techniques and others analyses; (2) assuring the fossils were stored in safe conditions; (3) optimization of the time spent in conditioning and studying the specimens; (4) optimization of the space occupied in museum storage facilities; (5) sustainability in the choice and use of materials; (6) and minimizing specimen handling. Taking this criterion into consideration, the fossils were stored in polyethylene foams of different densities in 0.5 ml Eppendorf PCR clear polyethylene tubes. In this work, we present a review of the techniques and materials most used in the conservation and curation of microfossils. An instrument was specifically developed to optimize time and packaging materials, based on previous techniques, with the aim to elaborate a storage and access strategies adapted for the collection in question, and could be followed and reproduced by any preparator or curator. This is a massive improvement for the Museu da Lourinhã collections, which did not have an adapted storage for microvertebrates, and for the Portuguese palaeoheritage, of which Lourinhã constitutes one of its major centres.

**Keywords:** Microvertebrates, Collection, Conservation, Access.

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## UNMELTING AN ICE AGE EXPO: USING NON-SCIENTIFIC FOSSILS FOR ASSEMBLING AN EXHIBITION

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The museum collections, including exhibitions and storages, are the final natural destination for fossils collected by the researchers. Generally, scientific novelties and beautiful fossils go to exhibitions, and the others fossils to the storage shelves, sometimes under specific storage conditions, hidden from public spaces. This is especially true if we talk about vertebrate fossils. If the fossils do not have background information, like collection data, place, or geology, are they particularly doomed never to see the spotlight of an exhibition glass? A 130 fossil collection, labelled as Ice Age mammal bones, without more data than country, was used as a complementary exhibition to the inauguration of new Ice Age models at Dino Parque Lourinhã in March 2023. The fossils were borrowed by Dinosaurier-Park Münchehagen and were shown in a 21 m<sup>2</sup> temporary exhibition, side by side with Dinosaurs of Lourinhã permanent exhibition. This work reveals the exercise of assembling a palaeontological exhibition, using a fossil set with low-scientific information, showing the several steps, some tips, and procedures, to be used as guidelines for non-experienced young palaeontologists when called to assist with a palaeontological exhibition. What to have in mind when drawing palaeontological exhibition showcases, lights, texts and font sizes, shelf heights, and so on. Also, this work reports the fossils used in the exhibition as a record for the future.

**Keywords:** Museology, Exhibition, Ice Age, Mammal fossils, Dino Parque Lourinhã.



## IT'S DINNER TIME: GREAT WHITE SHARK (*CARCHARODON CARCHARIAS*) BITE MARKS ON RIGHT WHALE REMAINS FROM THE ITALIAN PLIOCENE

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Modern marine waters are inhabited by more than 500 shark species. Among them, the great white shark (*Carcharodon carcharias*) occupies the topmost position of most marine food pyramid, representing the apex predator of the present-day global ocean. Even if *Carcharodon carcharias* is well-known as a formidable active predator of marine mammals (pinnipeds and odontocetes), it also constitutes an example of scavenger. In fact, several anecdotal and scientific documentation exists for white sharks feeding on floating whale carrions, which are rich in blubber, and as such, highly energetic food. Given the latest Miocene origin of *C. carcharias*, the Plio–Pleistocene marine deposits preserve occasional evidence for the feeding activity of white sharks in the form of bite marks on bones and teeth embedded into (or closely associated with) marine mammal bones. Here, we report on a new example of white shark–cetacean trophic interaction evidence from Pliocene shelf sediments of the Argille Azzurre Formation exposed at Monterotondo Marittimo (Tuscany, Italy). The fossil specimen described herein consists of a well-preserved cetacean scapula whose lateral surface is densely incised by serrated shark bite marks up to several centimeters long. Based on osteoanatomical considerations, the scapula can be referred to as a likely diminutive extinct member of Balaenidae (right and bowhead whales, which are no longer part of the poorly diverse Mediterranean fauna), about 8 m long. In addition, during the recovery operations, a shark tooth fragment was found embedded into the scapular. Considering the fragmentary nature of the studied specimen, whether the observed bite marks represent scavenging or active predation could not be assessed. What is remarkable here is the kind of trophic interaction that it witnesses, which includes a member of a baleen whale morphotype that is no longer present in the modern Mediterranean Sea, not even in the rest of the global ocean.

**Keywords:** Elasmobranchii, Cetacea, Taphonomy, Tuscany.



## A REAPPRAISAL OF *DIPLOCYNODON MUELLERI* (KÄLIN, 1936) FROM THE EARLY OLIGOCENE SITE OF EL TALLADELL (EBRO BASIN, IBERIAN PENINSULA)

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*Diplocynodon* was a medium to large-sized genus of basal alligatoroid (surpassing 2 m long) that inhabited the lake environments of Western and Central Europe, achieving a notable degree of speciation between the late Palaeocene and the middle Miocene. As a result of the rapid global climatic cooling that occurred during the Eocene–Oligocene transition (ca. 34 My), all the crocodylian fauna was negatively affected, leaving *Diplocynodon* as the only surviving European genus. As for the Paleogene Iberian Peninsula record, two different species have been recorded: *Diplocynodon tormis* from the middle Eocene of the Duero Basin; and *D. muelleri* from the early Oligocene of the Ebro Basin. The early Oligocene Lagerstätten site of El Talladell (Lleida, Spain) is of particular interest due to its abundance and preservation of specimens in anatomic connection, and it is the reptile type-locality for *D. muelleri* and *Cuvierichelys iberica*. Even though *D. muelleri* was established long ago, at the beginning of the last century, this species has received scant attention, and the only thorough description of the material was provided in 2006. More recently, some authors have questioned the alleged morphological differences between *D. muelleri* and *D. tormis*, suggesting the latter as a junior subjective synonym of *D. muelleri*. To shed light on the aforementioned question, a detailed review of both published (skulls and postcranial remains) –including the type specimens– and unpublished remains (mainly skulls) of *Diplocynodon* from El Talladell was conducted. Further, several craniomandibular features frequently used to distinguish *D. muelleri* from *D. tormis* were re-evaluated in terms of intraspecific and ontogenetic variability. Although more detailed comparisons with other *Diplocynodon* taxa from additional European localities are required, our preliminary results suggest that both *D. muelleri* and *D. tormis* are valid species.

**Keywords:** Cranial anatomy, Diplocynodontidae, *Diplocynodon tormis*, Basal alligatoroid, Lleida Province, Lagerstätten site.

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## FIRST EVIDENCE OF FISH HUNTING TRACES IN THE CRETACEOUS OF SPAIN

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Fish traces are uncommon on the fossil record, mainly representing swimming, resting, courtship and feeding behaviors. This last group, commonly referred to the ichnogenus *Osculichnus* has been only previously described in five localities: in the Lower Devonian of Poland, in the Upper Devonian of China, in the Upper Jurassic of Spain, in the Lower Cretaceous of Mexico and in the Eocene–Oligocene of Turkey. La Virgen del Campo site (Enciso, La Rioja) is located in the north-east of the Cameros Basin. La Virgen del Campo site belongs to the Enciso Group (Aptian), which is found between Urbión Group (Valanginian–Aptian) and Oliván Group (Aptian–Albian). The palaeoenvironment inferred from previous studies for La Virgen del Campo site is a siliciclastic-carbonaceous lacustrine system with cyclic evidence of subaerial exposure. This site is well-known for its abundant dinosaur tracks, where invertebrate traces are also frequent such as *Arenicolites* or *Archaeonassa*. The traces interpreted as *Osculichnus* cf. from this site, consist of multiple epichnial concave bilobate traces with lenticular outline morphology. These traces are shallow in depth with a longitudinal fine ridge at the bottom. This ridge divides the trace into two curve and asymmetrical lobes. They are often found near multiple traces morphologically similar to *Arenicolites*. *Osculichnus* has been interpreted as a fish hunting trace. The fish penetrated the sediment layer to hunt endobenthonic bivalves and other invertebrates. The fact that these traces are associated with other bioturbation structures might indicate a predation attempt on minor organisms. This type of trace is quite important not only because this is the first evidence of *Osculichnus* in the Lower Cretaceous of Spain but its usefulness for inferring behavior traits and understanding the complex ecosystem that this site represents.

**Keywords:** Ichnofossil, Fish, *Osculichnus*, Palaeoenvironment.

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## TESTUDINIDAE: A FOSSIL RECORD AND STUDY IN THE COUNTRY OF MEXICO

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Turtles (clade Testudines) can inhabit almost every continent on the planet except Antarctica and 357 extant species are known today. The country of Mexico counts with a huge diversity in both modern turtles and evidence of extinct ones. The fossil record of these reptiles in Mexico is very extensive from the Jurassic to the Pleistocene, and it is especially abundant in Paleogene and Neogene in various localities of southern and southeastern Mexico. Despite the apparent abundance, there have been few studies of these reptiles in the country. Fossil testudines can help in diverse palaeontological studies. In the north of Mexico, for example, the iconological record of these reptiles help to a better understanding of the palaeoecology and palaeohabitat of the study area. In the southern area of Mexico, the study of turtles is more prominent with diverse fossil evidence both osteological and iconological. There have been studies to update the fossil record of Testudines of Mexico, and every year it is progressing, including comparisons with the fossil records of Central America, Nicaragua, Honduras, Costa Rica, Cuba, Panama and more. Recent studies and investigation do suggest that in some places of southern Mexico the fossil record may get updated like in the case of Oaxaca that it has been found the possible genera of *Gopherus* and *Kinosternon* both found in Santiago Chazumba. These results indicate that the new study may help to get a better understanding of the palaeohabitat of the Pleistocene in Mexico.

**Keywords:** Testudines, Central America, Paleogene, Neogene, Palaeoecology.



## PRELIMINARY STUDY OF TWO EXQUISITELY PRESERVED CAVE BEAR CUBS FROM THE LATE PLEISTOCENE OF “TECCHIA PREISTORICA” (TUSCANY, ITALY)

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The “Tecchia Preistorica” (Equi Terme, Massa–Carrara Province) is a cave of great palaeontological and archaeological relevance that opens in the northern sector of the Apuan Alps (Tuscany, Italy). Abundant faunal remains have been collected from this cave, being mostly represented by late Pleistocene (MIS3) mammals. In 2014, two extremely small skeletons of cave bear (*Ursus spelaeus*) were collected from a single stratigraphic horizon at the Tecchia Preistorica. Both specimens (hereinafter, Cub 1 and Cub 2) exhibit an excellent state of preservation. Cub 1 includes the skull, which preserves an undeformed three-dimensional morphology and is still connected to the cervical vertebrae. The cervical and thoracic vertebrae and the partially ossified ribs are fully articulated. The 23-mm-long scapulae, a 33-mm-long humerus and a tibia are also preserved. Cub 2 features the thoracic cage and part of the vertebral column. Preserved parts of the forelimbs consist of both the 31-mm-long humeri, ulnae and radii, plus a 25-mm-long scapula. Many anatomical traits of Cub 1 and Cub 2 reveal a very young age at death, including vertebrae that are not fully ossified and the missing epiphyses of the long bones. Cub 1 is edentulous, and its skull displays open fontanelles and unfused cranial sutures. By comparing the measurements of the scapulae and long bones of both cubs to the values reported in literature for early juvenile individuals of cave bear from other sites of central Europe, an age at death of less than a week was estimated. Cub 1 and Cub 2 did likely belong to the same litter. These cave bear cubs may have died from malnutrition a few days after their birth, similar to what happens to many modern bear cubs due to the critical nutritional conditions that the mothers often experience during hibernation.

**Keywords:** Apuan Alps, MIS3, *Ursus spelaeus*, Taphonomy, Ontogeny, Hibernation.



# RECONSTRUCTION OF THE BRAIN ENDOCAST AND INNER EAR STRUCTURE IN THE DJADOCHTATHERIID MULTITUBERCULATE *TOMBAATAR* (MAMMALIA) AND INDIVIDUAL VARIATION IN THE GENUS

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The multituberculates (Mammalia: Altheria) are one of the long-lived groups of the Mesozoic mammals. We have still rather limited understanding of the anatomical variability of intracranial structures and their phylogenetic implications. Here we present a new material of the djadochtatheriid multituberculates from the Late Cretaceous of Mongolia, consisting of two incomplete skulls of the young individuals. The systematic affinity of this material is unclear. The skull structure and dentition are very similar to those of *Tombaatar*, but our specimens show features unknown in the type material, such as the I3 location in the premaxilla only. The specimens were scanned at the NanoFun lab (Institute of Paleobiology, PAS), with a voxel size of 35  $\mu\text{m}$ . Dragonfly and 3D Slicer were used to process the CT data and generate virtual endocasts of the brain and inner ear. The brain endocast of the older individual is almost complete without paraflocculi preserved, while in the younger, only the olfactory bulbs and a small part of the cerebral hemispheres are preserved. Compared with known fossilized endocasts of *Chulsanbaatar* and *Kryptobaatar*, the ratio of brain endocast length to skull length in the older individual equals 51.6, similar to 53.5 in *Kryptobaatar*, and is smaller than in *Chulsanbaatar* (55.8 and 58.6). The brain endocast of both new individuals is similar in shape to that of *Kryptobaatar*, although the ratio of olfactory bulb length to skull length in the older individual equals 13.3 compared to 18 in *Kryptobaatar*. The bony labyrinth structure of the new material differs from that of cf. *Tombaatar* (IMM 99BMIV/4) in shape and orientation of the semicircular canals, which may indicate an apomorphic feature in the new specimen, and potentially different agility. The features of the bony labyrinth may point to the different taxonomic affiliation and phylogenetic position of the new material described here.

**Keywords:** Mammalia, Multituberculata, Brain endocast, Bony labyrinth, Micro-CT scan, Cretaceous.

**Acknowledgments:** Thanks are due to K. Janiszewska (IPAL PAS) for CT-scanning.



## PALAEODIETARY STUDY OF SKELETAL MATERIAL OF THE PYGMY HIPPO *PHANOURIOS MINOR* FROM AYIA NAPA (CYPRUS) BASED ON CARBON ISOTOPE ANALYSIS

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Dwarf elephants, pygmy hippos and some small mammal species are some of the vertebrates that lived in Cyprus during the terminal Pleistocene, 11 to 13 Ky before present. Here, we reconstruct the palaeodiet of the pygmy hippopotamus *Phanourios minor*, excavated from the fossiliferous site in Ayia Napa, based on carbon isotope analysis from fossil skeletal material (bones and teeth). *Phanourios minor* is considered to be the smallest hippopotamus of all known insular hippopotamuses. Palaeodietary studies are mainly based on stable isotope analysis of bone collagen and secondarily of bioapatite of bone and teeth. In the samples of *P. minor*, the collagen was not preserved, thus, we performed the analysis on bone and tooth bioapatite. Our carbon isotope results, following the appropriate corrections, showed that *P. minor* was a terrestrial species that was largely a browser and preferred C3 plants, that thrive in cold and wet environments, but also in hot dry ones, where C4 plants also thrive. The isotopic value range of the Cypriot pygmy hippo is very narrow compared to that of the extant common hippo (*Hippopotamus amphibius*), suggesting a more specific dietary range for this species, possibly as a result of limited availability of plant species. Several possible parameters that may have affected the isotopic composition of apatite were investigated, including age, sex, tooth type and diagenesis. The range of carbon values for C3 plants is -19.2‰ to -28.7‰. The average value calculated in our results is in the range of values that isotopically belong to the C3 plants.

**Keywords:** Stable isotopes, Hippopotamidae, Palaeodiet, late Pleistocene, Tooth enamel, Bioapatite.



## MORPHOLOGICAL RESPONSE ACCOMPANYING SIZE REDUCTION OF BELEMNITES DURING AN EARLY JURASSIC HYPERTHERMAL EVENT MODULATED BY LIFE HISTORY

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One of the most common responses of marine ectotherms to current and past global warming is an increased developmental rate and a decrease in adult body size. However, the changes in morphology that emerge from changes in early ontogenetic growth are not frequently studied in palaeontology, even though they can indicate details of an organism's ecological response to environmental crises, such as changes in resource acquisition or function. The Pliensbachian–Toarcian (Pli–Toa) environmental crisis (ca. 183 My) is the first pulse of the Early Toarcian Ocean Anoxic Event, and is driven by rapid warming and acidification of oceanic waters, triggered by volcanic activity of the Karoo-Ferrar Large Igneous Province. We use 3D geometric morphometrics to study morphological changes of 144 belemnites (extinct coleoids) from five consecutive subzones across the Pli–Toa crisis in Peniche, Portugal. Our results show that two belemnite species (*Catateuthis longiforma* and *Passaloteuthis bisulcata*), which decrease in body size also significantly increase in robustness during the Pli–Toa crisis. While adults drive the change in *C. longiforma*, the increasing robustness of *P. bisulcata* is driven by juveniles, indicating varying ecological tolerances among the species and ontogenetic stages. The morphological change in the juveniles of *P. bisulcata* is significantly correlated with seawater pH, eluding to similarities with stress-induced hypercalcification of extant cuttlefish in response to climate-related stressors, such as acidification and starvation. These results stress the importance of taking life history into account, when studying impacts of environmental stressors on fossil marine organisms, to facilitate the comparability to extant organisms.

**Keywords:** Climate change, Cephalopods, Toarcian Ocean Anoxic Event, Body size, Morphology, Ontogeny.

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## DIET AND HABITAT OF *AMPELOMERYX GINSBURGI* (*ARTIODACTYLA PALAEOMERYCIDAE*,) OF THE MIDDLE MIOCENE SITE OF ELS CASOTS (VALLÈS-PENEDÈS BASIN, CATALONIA)

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Palaeomerycids are a group of three-horned giraffomorph ruminants that inhabited Eurasia from the late Early to the early Late Miocene and radiated approximately during the Early–Middle Miocene transition. Among them, *Ampelomeryx ginsburgi* is abundantly represented at the Middle Miocene (15.9 My) site of els Casots in the Vallès-Penedès Basin (Catalonia, Spain). Palaeomerycids had brachyodont dentition and have generally been associated with dense humid or even boggy forested environments where they could have fed on soft vegetation. Sedimentological, palaeobotanical and faunal data indicate that els Casots represents an ancient freshwater palustrine area. We can test the hypothesis of palaeomerycids as consumers of soft plant material using isotopic analysis. The stable isotope composition of teeth of ancient mammals provides valuable palaeobiological and palaeoenvironmental information. Carbon (C) and oxygen (O) isotopes are incorporated during the animal's lifetime and derive from dietary intake and drinking water, respectively. We analyzed <sup>13</sup>C and <sup>18</sup>O stable isotopes from dental enamel of 10 m3s of *A. ginsburgi*. Samples consisted of 10 mg of enamel powder and were analyzed using an isotope ratio mass spectrometer. After correcting raw enamel data using VPDB standards for carbon and SMOW for oxygen, considering metabolic isotopic fractionation and ancient atmospheric composition, δ<sup>13</sup>C data were used to infer δ<sup>13</sup>C of consumed vegetation. Raw δ<sup>18</sup>O values were corrected and used to infer mean annual temperature. Corrected δ<sup>13</sup>C values indicate a diet that included exclusively C3 plants, likely leaves of trees growing near the lake shore or in closed nearby forests. The relatively high δ<sup>18</sup>O values may indicate relatively cold temperatures (ca. 6° to 19°). This contradicts other lines of evidence that indicate that els Casots coincided with a particularly warm period, the Miocene Climatic Optimum. Alternatively, *Ampelomeryx* would have ingested water from a <sup>18</sup>O-enriched source, most likely <sup>18</sup>O-enriched leaves defining the upper canopy which would account for these high values.

**Keywords:** Carbon and oxygen stable isotopes, Palaeomerycidae, Palaeodiet, Palaeoenvironment, Middle Miocene, Iberian Peninsula.

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## NEW SMALL VERTEBRATE FINDS FROM THE LEVEL QS-3 FROM QUIBAS-SIMA SITE (EARLY PLEISTOCENE, MURCIA, SPAIN) AND THE ORIGIN OF THEIR ACCUMULATION

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The site of Quibas (Murcia, Spain) is a karstic complex of cavities filled by sediments of Early Pleistocene age. The main structures of this palaeontological complex are a gallery called Quibas-Cueva and a vertical shaft known as Quibas-Sima. The Quibas-Sima sequence contains seven different detritic units, namely from bottom to the top, QS-1 to QS-7. The upper unit QS-7 does not present fossil remains and QS 5 and QS 6 have only delivered fossils of gastropods, while all the underlying units are also rich in vertebrate remains. The lower units of the section (QS-1) show a reversed magnetic polarity ascribed to the pre-Jaramillo Matuyama (1.2–1.07 My), whereas the intermediate units (QS-2 to Q- 5) bear a normal polarity directly linked to the Jaramillo subchron (1.07–0.99 My). Finally, the upper units record post Jaramillo reversed polarity (0.99–0.78 My). The Quibas sequence, therefore, immediately post-dates the oldest hominin record in the Early Pleistocene of Europe, represented at the sites of Barranco León, Fuente Nueva 3 (both in the Guadix-Baza Basin) and Sima del Elefante (Atapuerca karstic complex). This work presents an updated view of the taphonomy and taxonomy of the fossil assemblage from the QS-3 unit. The diversity of the fossil assemblage of this level is mostly represented by herpetofauna (amphibians, squamate reptiles and chelonians) and small mammals (insectivores, chiropterans, rodents and lagomorphs). Regarding the taphonomy, different processes are observed; the most representative one is corrosion that affects the other ones, even so it is possible to recognize other processes like digestion marks and some color changes in the bones remains. Some of these alterations are indicative of an accumulation caused by scatological processes, most likely carried out by avian and non-avian predators, and a light hydrodynamic influence.

**Keywords:** Jaramillo, Taphonomy, Small mammals, Biharian, Predator.

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## RE-EVALUATION OF GERMAN *STENOPTERYGIUS* IN ITALIAN MUSEUMS: UPDATED IDENTIFICATION AND MORPHOFUNCTIONAL INFERENCES

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Fossil remains of the genus *Stenopterygius* (Ichthyopterygia, Parvipelvia) are mostly found in Lower Jurassic strata of the Württemberg area, Germany. Several complete and articulated specimens of *Stenopterygius* have been recovered from the famous locality of Holzmaden (Württemberg) and sold to museums throughout Europe since the early 19<sup>th</sup> century. Many *Stenopterygius* skeletons arrived to Italian palaeontological collections, however, most of them have never been properly studied. Because of their presence in many museums worldwide, *Stenopterygius* fossils represent an ideal statistical sample for investigating the inter- and intraspecific morphological variability of this genus. Here, we report on 19 ichthyosaur skeletons from five Italian museums (Museo Geologico Giovanni Capellini, Museo Geologico Paleontologico dell'Università di Padova, Museo di Paleontologia di Napoli, Museo di Storia Naturale di Milano, Museo di Storia Naturale dell'Università di Pisa) identified as *Stenopterygius* using modern taxonomic schemes. Updated species-level identifications of these fossils were attempted by relying on the linear morphometric analyses previously proposed by other authors. Out of 19 studied specimens, eight were assigned to *Stenopterygius quadriscissus*, three to *S. triscissus*, with all other specimens being referred to *Stenopterygius* cf. *quadriscissus*, *Stenopterygius* cf. *triscissus* or *Stenopterygius* sp. Including these 19 specimens in morphometric analyses improved the precision of these methodologies by increasing the statistical sample size. The studied specimens were documented by high-resolution photographs and 3D models. Two skeletons kept at the Museo di Storia Naturale dell'Università di Pisa (MSNUP) were CT-scanned, revealing interesting anatomical elements, such as the hyoid bones and ischiopubis, which would have been otherwise hidden beneath the embedding limestone. CT-scans resulted in the reconstruction of the tridimensional rostral morphology of one of the MSNUP specimens, allowing some morphofunctional inferences on the feeding behavior of *Stenopterygius*. The rostra of some long-snouted odontocetes and istiophoriforms may represent good functional analogues of those of parvipelvic ichthyosaurs.

**Keywords:** Ichthyosaurs, Early Jurassic, Toarcian, Holzmaden, CT-scans, Morphometrics.

**Acknowledgments:** We would like to thank the curator of MSNUP vertebrate palaeontology section, CS, for providing access to the specimens reported in this work. We thank VG and CP for their help in measuring, taking pictures of the fossils and their precious comments on the geology of Holzmaden.



## THE PALAEOLOGICAL DAYS OF CAÑIZARES (CUENCA, SPAIN): NATURAL HERITAGE AND RURAL DEVELOPMENT AT CRETACEOUS SITES OF THE IBERIAN PENINSULA

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The palaeontological sites of Hoces de Beteta (upper Barremian, Lower Cretaceous) include three outcrops, Vadillos-1, Vadillos-2 and El Tobar, located in the Cuenca Range (central-eastern Spain). They correspond to lutites and sandstones with interbedded limestones in “Weald” facies. Up to date, they have provided fossils of charophytes and plants; invertebrates, such as bivalves, gastropods and ostracods; and vertebrates, like fishes, amphibians, turtles, crocodylomorphs and dinosaurs. This rich biota inhabited the late Barremian continental and transitional environments, related to lacustrine margins and alluvial flood plains. Due to the scientific value and didactic potential for Geoeducation and Geotourism, since 2017 the “Palaeontological Days” have been carried out in the region by the Paleolbérica Group of the University of Alcalá, and other co-worker teams, with the support of local Town Councils. These outreach sessions consist of didactic activities, mainly for the pupils of rural schools of the area, along with scientific conferences about the Geological context of the region for the general public. This year, the emphasis will be focused on the importance of the Natural Heritage of the locality and its surroundings, promoting sustainable Geotourism actions as a means to prompt the socioeconomic development of rural areas. Therefore, considering Out-of-school techniques which authors are designing and putting into practice at different Cretaceous palaeontological sites of the Iberian Peninsula, Geotouristic itineraries will take place outdoors at different urban and natural spaces of the locality of Cañizares. During these routes, participants will immerse in meaningful learning experiences travelling through the History of Earth and Life. Furthermore, some of the scientific conferences will attend these fascinating Geological and Palaeontological aspects, highlighting their value as didactic resources for formal educational contexts and as an asset, which could allow the preparation of a specific project for the design and creation of an Interpretation Centre in this locality.

**Keywords:** Didactics, Fossils, Palaeontology, Geoeducation, Geotourism, Outreach.

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## ONE OF THE LAST RECORD OF PARAVIAN THEROPODS OF THE IBERO-ARMORICAN ISLAND: THE UNGUAL PHALANX FROM LARRA 4 SITE (VALLE DE LIERP, NE HUESCA)

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The Upper Cretaceous record of paravian theropods of Iberia and southern France is scarce and fragmentary, mainly represented by isolated teeth and bones. Fossils referable to indeterminate dromaeosaurids (including *Pyroraptor* and *Variraptor*), troodontids (including *Tamarro*), and large ornithomorph and ornithurine birds (including *Gargantuavis*) have been recovered from the Campanian–Maastrichtian continental deposits of the former Ibero-Armorican island. Here we describe a paravian unguual phalanx (specimen MPZ 2019/196), recovered from Larra 4 site (Valle de Lierp, Huesca, Spain) in the uppermost Maastrichtian (chron C29r) continental deposits of the Tremp Formation, in the Southern Pyrenees. MPZ 2019/196 is an incomplete left unguual phalanx that lacks part of its dorsal margin and the distalmost tip. It is strongly curved, lateromedially compressed, and is sickle-shaped, pointing to a paravian affinity. Its blood grooves are simple and slightly asymmetrical, with the medial one shifted ventrally relative to the lateral one. The cross-section of MPZ 2019/196 is dorsoventrally elongated, with flattened lateral and medial margins. The dorsal surface is strongly tapered, whereas the ventral one is broad and flat. The articular surface is not preserved, causing that the presence of a proximodorsal lip and the projection of the flexor tubercle cannot be assessed. This state of the articular facet hinders the identification of the unguual as manual or pedal, however the flat shape of the ventral margin suggest that the phalanx is from the forelimb, by lacking the typical blade-like shape of pedals II. Previously, MPZ 2019/196 was described as a pedal unguual phalanx II of an indeterminate dromaeosaurid. The re-evaluation provided here supports its classification within Paraves, but the lack of a well-marked asymmetry and the absence of accessory blood grooves excludes its inclusion within Eudromaeosauria, belonging the phalanx potentially to an early-branched dromaeosaurid, a troodontid, or an avialan.

**Keywords:** Southern Pyrenees, Tremp Formation, late Maastrichtian, Paraves, Blood grooves.

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## THE PUFFERFISH STRIKES BACK: FORECASTING THE FUTURE OF A MEDITERRANEAN BIOINVASION THROUGH VERTEBRATE PALAEOLOGY

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The main goal of the Paris Climate Accords is to keep the rise in mean global temperature well below a maximum of 2°C above pre-industrial levels, recognizing that this would substantially temper the effects of global warming. As regards the Mediterranean Basin, mean temperatures have increased 1.4°C since the late XIX century (*i.e.*, distinctly more than the global average of +1.1°C), and they are projected to increase by an additional 1.5°C by 2050 in case of no decarbonization. During the Pliocene, temperatures were 2–3°C higher than today, which means that the Mediterranean Pliocene palaeoenvironments may provide a much realistic example of what the Mediterranean Sea might become in a not-so-far future (would we fail the main goal of the Paris Agreement). In this perspective, vertebrate palaeontology can help in understanding the patterns of biodiversity that could characterize the future Mediterranean fauna. Pufferfishes (Tetraodontiformes: Tetraodontidae) are instructive in this respect. Until the XIX century, a single pufferfish species, *Lagocephalus lagocephalus*, was known to inhabit the Mediterranean for sure, being rarely reported from the waters off Sicily. Nowadays, as many as six more pufferfish species are spreading across the Mediterranean, representing some of the more striking examples of “lessepsian immigrants” that have entered the eastern portion of the basin through the Suez Canal. These include the poisonous pufferfish *Lagocephalus sceleratus*, which currently represents 4% of the weight of total artisan catches in the Eastern Mediterranean. Pliocene fossils of Tetraodontidae, mostly consisting of premaxillae and dentaries, are fairly common in the Mediterranean area as north as in Tuscany and Emilia-Romagna (Adriatic palaeo-area), taking their place besides thermophilic relics of the Tethys ocean and other warm-water, currently extra-Mediterranean taxa (*e.g.*, the tiger shark, *Galeocerdo cuvier*) that may be on the cusp of re-entering the basin. The whole Mediterranean could therefore become a sea of pufferfishes.

**Keywords:** Pufferfish, Vertebrate Palaeontology, Tetraodontidae, Mediterranean, Bioinvasion.



## VERTEBRAS FOR VERTEBRATE DRAWING EXERCISE

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While palaeontological illustration skills and live reconstitutions of extinct species become an iconographic exercise among young palaeontologists, bone illustration does not step up. Making scientifically accurate skeletal drawings is an important tool in science communication, because it improves the interpretation of anatomical descriptions and simplifies the information. This exercise encourages dialogue between palaeontologist (experienced in fossils) and illustrator (experienced in drawing techniques), reconciling the needs of palaeontology with intrinsic competences of illustration, while both can learn about the fossil itself. To explore this idea, the drawing of four different vertebrae (dolphin, human thoracic, fossil Bovidae and mammoth spinous process) was proposed as the beginning exercise for an anatomical illustration lesson. The choice of vertebrae as drawing models allows an upgrowing complexity approach, given by anatomy, symmetry, size, or completeness. In this case, the illustrator (less trained in fossil/bone drawings) acquires, during each task, knowledge about procedures and conventions of osteological illustration applied to palaeontology, as well as the correct use of several tools and techniques, such as: correct positioning of each vertebra, the choice of different views, transfer to graph paper (in real or reduced scale), analogical techniques (graphite, black ink), highlighting bone edges and fading cracks/fractures, preparing drawings for scanning and digital post-production to obtain the best and most reliable possible result for a publishable version. This exercise is easily applicable to other bones and fossils, as long as an increasing degree of morphological complexity is accomplished. With this study, the illustrator (less trained in bone drawings) acquires knowledge about osteological illustration applied to palaeontology, as well as skills to draw complex fossils. In a subsequent work, a skull drawing, a much more complex illustration, the main author was able to proceed with the work in a much more confident way using the correct techniques with minor difficulties.

**Keywords:** Fossils, Vertebrae, Palaeontological illustration, Osteological drawing.

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## SEDIMENTARY FACIES AND VERTEBRATE FOSSILS FROM THE LOWER CRETACEOUS GOLMAYO FORMATION, CAMEROS BASIN (SORIA PROVINCE, SPAIN)

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The Golmayo Formation is a synrift succession of fluvial to lacustrine deposits (red clays with intercalations of sandstones and lacustrine limestones) located in the southern margin of the Mesozoic Cameros Basin (Soria province, N Spain). This unit is relevant for its vertebrate fossil content, which includes holotype specimens of some dinosaurs such as *Magnamanus soriaensis* and *Soriatitan golmayensis*. The considerations about its age and its depositional sequence have been debated due to the problems of direct correlation with other sectors of the Cameros basin. Currently, biostratigraphic data based on charophytes indicate the Golmayo Formation as late Hauterivian–lower Barremian in age. However, the stratigraphic distribution and palaeoenvironmental significance of potentially fossiliferous sedimentary deposits of the Golmayo Formation are poorly understood. The aim of this work is to evaluate the most favourable sedimentary facies within the Golmayo Formation to bear dinosaur fossils by providing new fieldwork data. Most vertebrate remains from the Golmayo Formation previously known come from the Zorralbo I fossil site. This locality has provided remarkable specimens including sauropods (*Soriatitan*), ornithopods (*Magnamanus*) and ankylosaurs (*Polacanthus* sp.), but no other significant fossils have been described in the unit. The fossiliferous character of the Golmayo Formation has been reinforced with the discovery of new vertebrate fossil-bearing beds, highlighting the new fossil site of Peñuquillo. This fossil site consists of grey laminated siltstones that has yielded abundant vertebrate fossil remains, including undetermined dinosaur bones, turtle plates, crocodylomorph teeth and osteoderms as well as coprolites. Microfossil content also includes osteichthyan, lissamphibian, lizard, and archosaur remains. The depositional environment related to this bone accumulation is a poorly drained floodplain within a braided fluvial system. The facies association identified in the new locality is similar to the one at Zorralbo deposits.

**Keywords:** Mesozoic Iberian Rift System, Depositional environments, Alluvial sediments, Microfossil Bonebed, Fossil vertebrates, Dinosaurs.

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## MANAGEMENT AND CONSERVATION OF THE PALAEOLOGICAL REMAINS OF THE TRIASSIC LOCALITY OF PALANCA DE NOVES, LLEIDA, SPAIN

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The conservation and management of fossils are the essential procedures that have been carried out, from the time when a fossil is extracted from a site to its being studied, exhibited, or integrated into a museum or collection. The actions carried out to promote good management and conservation begin with a study of the palaeontological materials obtained at the site, in order to determine what kind of packaging should be made, and which are the most appropriate materials to use to ensure its conservation (both in the interim and long term). It should also be borne in mind that good management begins by checking that no fossils are missing from a site and that good labeling practices are followed, to facilitate their identification. In this work, all the management and conservation practices performed on 102 fossils extracted in two excavation campaigns at the Triassic site of Palanca de Noves have been described. For management and conservation, the current protocol at the Institut Català de Paleontologia Miquel Crusafont (ICP) has been followed. The fossil materials of the site are mostly ichnites and plants in sandstones and clays (remains of different sizes that allow for the use of different packaging techniques). For each fossil or ichnite, the most appropriate material was chosen to make the packaging, and all information has been recorded in Museum Plus software, to facilitate its search and accessibility for future research. The main materials used for the packaging are Jiffy Foam®, Ethafoam®, Plastazote® and other less specific brands. In the case of the Ethafoam® and Plastazote®, we conducted compression tests to study the strength of force-elongation and stress-strain factors of each material for comparison.

**Keywords:** Conservation, Palaeontology, Management, Packaging, Palanca de Noves, Triassic.



## A GIANTS TALE: HISTORY AND PALAEOBIOLOGY OF THE SAUROPOD DINOSAURS OF THE NATURAL SCIENCES MUSEUM OF VALENCIA (SPAIN)

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The Iberian Peninsula is undoubtedly a great enclave for the study of dinosaurs. The Mesozoic geological outcrops exposed in the Iberian region have provided a great deal of faunal information. The region of Los Serranos is one of these enclaves for the study of Mesozoic fossil vertebrates. Located in the inner zone of the province of Valencia, and very close to the province of Teruel, it represents one of the best places to study the biodiversity of dinosaurs and other associated faunas from the Tithonian to the Berriasian in the Iberian Peninsula. This is due to the fact that, in this location, materials from the Villar del Arzobispo, El Collado and Utrillas formations emerge, which document the transition between the Jurassic and Cretaceous periods. Sauropods are particularly well known. The Museum of Natural Sciences of Valencia houses some of these fossil remains found in the Levantine territories. For many years, some of the fossil remains recovered from the Villar del Arzobispo Formation of Los Serranos have been deposited at the museum. Remains include those of the sauropod *Losillasaurus giganteus* and some fragmentary remains of other dinosaurs from the same ecosystem. In recent years, with the description of the Turiasauria clade, the remains of *Losillasaurus* and the sauropods found in these Tithonian-Berriasian transitional deposits have once again gained importance. For this reason, we present an updated historical synthesis of the sauropod dinosaurs found in Los Serranos, specially those held at the museum collections. Also, a deeper analysis of some *Losillasaurus giganteus* material is being carried out, together with other previously undescribed sauropod material from the museum.

**Keywords:** Vertebrate, Archosaurs, Mesozoic, *Losillasaurus*, Jurassic, Cretaceous.



## RODENTS, REPTILES AND AMPHIBIANS AS A METHOD OF PALAEOENVIRONMENTAL RECONSTRUCTION OF THE OLDEST SITES WITH HOMININ PRESENCE IN THE IBERIAN PENINSULA

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The Iberian Peninsula is known to be one of the best places to study human evolution in Europe. Sites in the north of the Peninsula as those in the Sierra de Atapuerca, or some located in the Mediterranean area such as Guadix-Baza basin, Barranc de la Boella, Estació Vallparadís and Alto de las Picarazas help us to understand the presence of the first hominid populations of Europe during the Early Pleistocene, and their interaction with the environment and the faunas that inhabited them. In recent years, micropalaeontology has gained strength, and knowledge of the microfauna in Quaternary environments has increased. During the Early Pleistocene, the structure of the small vertebrate faunas of these archaeo-palaeontological contexts it is changing, being able to observe transitions and changes in terms of hominid evolution. These changes have often been interpreted as successions of cold and warm climates that produce variations in the populations of these small vertebrate faunas throughout the Calabrian until the Calabrian–Chibaninan transition. This poster works as a review of the Early Pleistocene small vertebrate faunas in the previously mentioned sites, analysing the evolutionary trends of the most representative taxa of the micromammals as *Allophaiomys* and *Mimomys*, as well as the variations in the presence of herpetofauna. For this, the methodologies of the “optimum habitat method” and the “weighting habitat method” have been followed with the aim of presenting these faunas from the basic biostratigraphic classifications. Based on this data, we aim to make a palaeoclimatic and palaeoenvironmental approximation during the Early Pleistocene up to the Early–Middle Pleistocene boundary, in addition of putting these small vertebrate faunas in context with the associated megafauna and with the first hominid populations in the Iberian Peninsula.

**Keywords:** Vertebrate, Micromammals, Herpetofauna, Early Pleistocene, Quaternary, Palaeoenvironment.



## LATE VISEAN (EARLY CARBONIFEROUS) AMMONOIDS FROM THE CULM GROUP OF THE NERVA MINING DISTRICT: PRELIMINARY STUDY

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This work studies the ammonoids found at selected points in the mining region of Nerva, in the province of Huelva. The sites are located in the Culm Group (CG) of the South-Portuguese Zone (SPZ; Variscan Massif), which includes all the post-volcanic sedimentary rocks of the Iberian Pyritic Belt, divided into three units: the "Basal Slate Series", the "Turbiditic Formation" (or Culm facies s.s.) and the "Shallow Sandy Platform Unit". The selected fossil sites are located in the "Basal Slate Series", a volcanodetritic and shale sequence that preserves fossils of *Archaeocalamites* sp., *Posidonia becheri* and various taxa of ammonoids like *Goniatites crenistria*, *G. spirifer* and *G. sphaericus* that have suggested a late Visean age. In the first site, ammonoids occur within a succession of shales, while in the second, they are found in siderolithic concretions within greywacke layers. A bulk sample of 70 specimens from the selected areas have been studied, among which there are impressions, and internal and external moulds. This work aims to improve the palaeontological knowledge of this region and, if possible, to establish a correlation of the Huelva ammonoid record and that of the Mértola Formation in the Portuguese sector of the SPZ. Detailed ammonoid biostratigraphy of CG would help to unravel the complex, imbricated architecture of the SPZ. A better palaeontological knowledge of the Culm Group based on ammonoids could result in an improved biostratigraphic framework of the Culm Group in the Iberian Pyrite Belt, which may have potential for determining the depth of the underlying Vulcano-Sedimentary Complex (which contains massive sulphide deposits). Furthermore, their specific classification may improve the regional and international correlation of the late Visean rocks of southwestern Iberia with those of other Late Visean contexts worldwide.

**Keywords:** Visean, Goniatitida, South-Portuguese Zone, Iberian Pyritic Belt.

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## MORPHOLOGICAL DESCRIPTION AND TAXONOMIC CLASSIFICATION OF ELASMOBRANCH FOSSIL TEETH FROM THE UPPER CRETACEOUS “LAS ENCINAS” FORMATION OF COAHUILA

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Sharks appeared about 400 My. One of the characteristics of these predators is that their teeth are replaced constantly; increasing the possibility of fossilization; the objective of this work is to describe and interpret the collected material of fossil shark teeth, from a field study carried out in “Las Encinas” Formation, in the “Arroyo San Juan de Amargos” locality, to the Northwest of Saltillo (México). A lithological column was made on the clayey limestone strata from the Upper Cretaceous (Maastrichtian). The samples were collected from strata number 10 and 11 of the stratigraphic column. Thirty-eight rock samples were obtained and analyzed by direct observation and microscopical analysis, determining that all the teeth found have triangular-shaped crown, with secondary cusplets. Only 76% of the samples present the root of the tooth with a pronounced concavity towards its base or a forked root that divides into four lobelets. The size of the teeth varies from 5–6 mm wide and 5–25 mm in total height. All of the studied samples have the original enameloid constituted by Fluorapatite:  $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$  according to the X-Ray Diffraction analysis. It is concluded that almost all of the fossil teeth belong to the families Serratolamnidae and Cretoxyrhinidae (Order Lamniformes); and only two samples probably belong to the Sclerorhynchidae family (Batoidea). According to the morphological interpretation of their teeth, these sharks probably had a size and weight of about 1.5 m long and 18–30 kg respectively. Based on the associated fauna found on the column like ammonites, pelecypods, and gastropods, these elasmobranchs likely lived in a nearshore marine platform in a shallow environment.

**Keywords:** Teeth, Sclerorhynchidae, Fluorapatite, Cusp, Lamniformes.



## FIRST FINDINGS OF THE TRIASSIC CALCAREOUS NANNOPLANKTON ASSEMBLAGES OF THE SOUTHERN ALPS (SLOVENIA)

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Upper Triassic calcareous nannoplankton assemblages from two sections located in the southern borders of the Southern Alps in Slovenia, were investigated in this work. Studied sections were originally situated within the Julian carbonate platform on the northwestern margins of Neotethys (Carnian–Rhaetian), close to a larger intra-shelf depression called the Slovenian Basin. The unicellular haptophyte algae, also called coccolithophores, are a good palaeoenvironmental proxy and respond very quickly to the environmental pressures by changes in its diversity pattern and size. The late Triassic, the end-Triassic extinction was driven by the global environmental changes, which disturbed the global oceanic biogeochemical cycles. Nannosized particles derived from the calcareous organisms are found in the Triassic sedimentary rocks from the Alpine and Subalpine regions in the Northwestern Slovenia. The Norian and Rhaetian beds in Slovenia, lie with a conformity on Carnian rocks and they show continuous upwards transition into different settings of the Lower Jurassic. The studied sections were deposited in sections: (1) Vrh Bače (Carnian); and (2) Povdnar (Norian–Rhaetian). Extraction of coccoliths from the carbonate rocks is challenging due to the intense diagenesis and therefore a new modified preparatory method was developed. The aim of this research was to investigate the calcareous nannoplankton close to the end-Triassic mass extinction event in two different depositional environments. In addition to 23 standard smear slides, nannofossils were investigated on a total of 5 thin sections polished to an average thickness of 7 µm. The preliminary results show the occurrence of *Prinsiosphaera triassica* and more rarely the genus *Eoconusphaera*, in the marlstones at Povdnar section. *Schizosphaerella punctulata* (and *Prinsiosphaera triassica*) were identified in the thin sections from marly limestones at Vrh Bače resembling identified assemblages already found in the Western Southern Alps, Italy.

**Keywords:** Carnian, Norian–Rhaetian, Calcareous nannoplankton, Tethys, Slovenia.



## COMPARING OSTRACOD FAUNAL DYNAMICS DURING THE MULDE AND LAU OCEANIC EVENTS (SILURIAN) IN THE BALTIC PALAEOBASIN

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Ostracods are bivalved crustaceans and an essential component of benthic communities through the most of the Phanerozoic, starting from the Ordovician and up until the recent times. Their rich taxonomy (over 65,000 recent and fossil species), a high abundance in deposits, and their small sizes make ostracods a significant proxy and model system for various palaeoecological and evolutionary analyses. Their ability to survive in a variety of habitats, and under a variety of conditions makes ostracod research even more valuable and necessary, as their distributional patterns can give insights into changes in widely differing environments. Ostracods have undergone significant taxic changes through geological time. Substantial environmental rearrangements driven and enabled shifts in the ecological niches of Ostracoda. Mulde/lundgreni (Wenlock) and Lau (Ludlow) bioevents were some of the most important geobiological events which affected biota in the dynamic Silurian period. At that time, it had a major effect on the conodont and other important faunal groups. Regardless of the significance of these events, their impact on Silurian ostracods is barely known. Gėluva-118 (97 samples) and Bebirva-110 (77 samples) core sections (South Baltic, Lithuania) were investigated, with later processing of samples and extraction of ostracod shells. Additionally, their taxonomic identification was accomplished. Mulde/lundgreni and Lau events coincided with a global sea level fall that immediately was followed by an excursion in geochemical isotopes. In the data we can see a reorganization of the major groups during the Lau event: species that occurred before the events were replaced by others with substantial losses. During the Mulde/lundgreni event, not a single species of ostracods went extinct and the increase in local species richness was observed soon afterwards, despite the fact the event led to a significant restructuring of ostracod communities.

**Keywords:** Ostracoda, Extinction event, Positive carbon isotope excursion, Diversity.



## THE ENGAGEMENT OF AN INSTAGRAM AMATEUR SCIENTIFIC DISSEMINATION ACCOUNT ON GEOSCIENCES, A CASE STUDY

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This study analyses the engagement reached by an Instagram amateur account focussed on geosciences dissemination, depending on the format and the topic of the publications. The engagement principles of the social network predict that the publications with the best results are those about experiences or lifestyle. In addition, Instagram's algorithm tends to benefit specific formats such as reels. The aim here is determining if the general principles of engagement also work for scientific dissemination accounts. For that, the content of @geogeologos has been analysed between April 24<sup>th</sup> of 2022 and December 31<sup>st</sup> of 2022. The account is managed by undergraduate students at the University of Zaragoza (the authors of this study). Three topic categories were distinguished (experiences, entertainment and knowledge translation) and three format categories (stories, publications and reels). To analyse the data, Facebook's Meta Business Suite tool was used, which shows the engagement of each post. The results reveal that publications with the greatest impact are knowledge translation reels. According to our data, the average number of reels' engagement was 793.13 people, compared to 669.42 for publications and 194.83 for stories. As for the topic, the data show that knowledge translation publications are the ones with the highest engagement, with an average of 725 people. Followed by those of experiences, with a rate of 721. And finally, with significantly lower values, those of entertainment with 490.8. Therefore, the results of our study agree with the initial hypothesis regarding the format that achieves the highest engagement. Unexpectedly, knowledge translation is the topic that prevails over experiences or lifestyle. Further analysis on professional accounts will be able to confirm if this trend is also true when working with a larger number of followers.

**Keywords:** Marketing, Social media, Knowledge translation, Geology, Palaeontology.



## TRILOBITES FROM THE CASTILLEJO FORMATION (DOBROTIVIAN, MIDDLE ORDOVICIAN) OF THE EASTERN IBERIAN CHAINS: COMPOSITION OF ASSEMBLAGES AND NEW RECORDS

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Upper Ordovician (upper Katian) trilobites from the Aragonese Branch of the Iberian Range were studied in 1990 and 1992, while older trilobite record was briefly described or illustrated in 2008 for the Lower Ordovician, in 1993 for the Middle Ordovician, and in 2018 and 2019 for Middle–Upper Ordovician rocks. With the aim of increasing the knowledge on the Middle Ordovician trilobites of the Iberian Chains, where only 4 species have been described so far, we have studied 11 fossiliferous localities in the areas of Alpartir, Aladrén, Luesma and Fombuena (Zaragoza province) and Poyo del Cid (south of Calamocha, Teruel province). Most of them belong to the Alpartir member of the Castillejo Formation and correspond to argillaceous shales ranging from upper Oretanian (Middle–Upper Darriwilian) to lower Dobrotivian (Upper Darriwilian). In the overlying Sierra Member, three localities were studied in the sandy facies of the sandstone-dominated alternations, mostly belonging to the upper Dobrotivian (uppermost Darriwilian). A total of 21 trilobite species of the genus *Ectillaenus*, *Uralichas*, *Neseuretus*, *Colpocoryphe*, *Salterocoryphe*, *Prionocheilus*, *Eohomalonotus*, *Phacopidina*, *Klouceki*, *Crozonaspis*, *Morgatia*, *Eodalmanitina*, *Zeliszella*, *Eccoptochile*, *Placoparia*, *Nobiliasaphus*, *Isabelinia*, “*Panderia*” y *Parabarrandia* were identified, highlighting the first record of the species *Uralichas hispanicus*, *Parabarrandia crassa* and “*Panderia*” *beaumonti* in the Aragonese Branch of the Iberian Cordillera. The Alpartir member main assemblage is characterized by an asaphid-dominated biofacies, related with soft sediment from offshore environments, which is assigned to the *Placoparia tournemini* Biozone, correlable with many areas of SW Europe. The few records of the Sierra member are assignable to the *Crozonaspis incerta* Biozone, in a biofacies composed of a mixture of trilobites with a preference for sandy bottoms, together with other trilobites typical of muddy bottoms from neritic environments and a relative absence of homalonotids.

**Keywords:** Trilobita, Darriwilian, Iberian Range, Aragonese branch, Correlation.

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## A PALAEOENVIRONMENTAL AND PALAEOICHOLOGICAL ANALYSIS OF LAS PEÑAS AMARILLAS SECTION (CRETACEOUS, ENCISO, LA RIOJA)

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The Cameros Basin (northern Spain) is the region that contains the largest number of dinosaur footprints within the Iberian Peninsula, and one with the highest ichnite concentration worldwide. Hundreds of sites discovered in the region have been studied and published in numerous scientific papers, but many other identified localities remain undescribed and awaiting an adequate study to reveal the information they contain. One of these long ignored sites is located in the municipality of Enciso (La Rioja, northern Spain), and has been known for several years as Las Peñas Amarillas. The site consists of 3 fallen metric blocks from a massive limestone level with a yellowish color on the surface and tabular geometry strata, and it contains 26 footprints and 7 poorly defined marks, corresponding to theropod and ornithopod dinosaurs. In this work, a stratigraphical and palaeontological study of Las Peñas Amarillas section is carried out, including the logging of the stratigraphic section and sampling of the different lithologies for microfacies analysis. The footprints were identified, photographed, represented on a scale model, labeled and measured. From the results obtained, the palaeoenvironment of the site has been established as the eulittoral fringe of a shallow carbonate lake, characterized by an important contribution of terrigenous materials from the avulsion belt of a large adjoining alluvial plain. The succession of facies in the column has been identified as a shallowing upward section. Most footprints were identified as produced by ornithopod dinosaurs, and the presence of the ichnogenus *Hadrosaurichnoides* on one of the outcrops is proposed. A walking or trotting speed has been calculated for the trackways and evidences of gregarious behavior have been identified.

**Keywords:** Ichnite, Cretaceous, La Rioja, Theropod, Ornithopod.

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## A LARGE ORNITHOPOD AS POTENTIAL TRACKMAKER OF SOME LARGE TRACKS IN THE UPPER JURASSIC OF IBERIA

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During the Late Jurassic, Iberia dinosaur assemblages were dominated by huge sauropods, stegosaurs and theropods. Nevertheless, the ichnological record had revealed that large ornithopods were also present, though ornithopod skeletons compatible in size had not been described until now. In the present work, we provide new data about on the ornithopod specimen from Barrihonda-El Humero fossil site (Riodeva, Teruel, Spain) in deposits of the Villar del Arzobispo Formation (Kimmeridgian–Tithonian; Upper Jurassic). Barrihonda-El Humero is the type locality of the giant eusauropod *Turiasaurus riodevensis* and the pleurosternid turtle *Riodevemys inumbragigas*. Furthermore, specimens of the stegosaur *Dacentrurus armatus*, as well as theropod remains, have also been found. This specimen consists in a dentary tooth, an ungual pollex of the manus, and an almost complete left hindlimb. The Barrihonda-El Humero specimen is remarkably large and probably achieved at least 6–7 m in length, being comparable to Early Cretaceous medium-sized styracosternans, such as *Mantellisaurus atherfieldensis*. An estimation of its approximate footprint length (L) using Thulborn's formula ( $h = 5.9L$ ) indicates that the tracks produced by this specimen were probably between 29 and 31 cm. Large ornithopod tracks ranging between 25 and 33 cm have been uncovered in several Upper Jurassic lithostratigraphic units in Spain and Portugal. Therefore, Barrihonda-El Humero ornithopod raises as one probable candidate to be the trackmaker of these large tracks in the Iberian Peninsula.

**Keywords:** Dinosauria, Ornithopoda, Villar del Arzobispo Formation, Late Jurassic, Teruel.

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## AN ABERRANT, DOUBLE-LAYERED, FUSIOOLITHID TITANOSAUR EGG SHELL FROM THE POYOS FOSSIL SITE (LATE CAMPANIAN–EARLY MAASTRICHTIAN, GUADALAJARA, SPAIN)

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Multi-layered eggs have been observed to occasionally occur in extant amniotes as a consequence of a stress period during its formation. The multi-layered condition has previously been described in several megaloolithid eggshells from the end-Cretaceous of Europe (South Pyrenees and Southern France), an oofamily typically associated with titanosaur sauropods. Now, an anomalous eggshell presenting two superimposed shell layers from the Campanian–Maastrichtian Poyos fossil site (Villalba de la Sierra Fm.) has been identified and prepared at thin section. While its inner layer is well-developed and shows a normal structure, the external layer presents an aberrant morphology and ornamentation. The eggshell thickness, shell unit morphology and dimensions of the inner layer match those of *Fusioolithus baghensis*, an ootaxon also associated with titanosaurs. The external profile of this layer is clearly demarcated by a dark layer, possibly indicating the presence of an additional membrane. Over this dark layer, only a few possible extra organic cores have been observed, located over internodal spaces of the subjacent layer. Instead, most of the shell units of the superimposed layer seem to epitaxially grow from the nodes of the subjacent layer and extend the shape of their shell units, even presenting near complete optical continuity under polarising light. All the shell units of the superimposed layer are considerably wider and end on a non-coalesced node with similar height but around twice as wide as the subjacent node from which they grow. This produces a compactituberculated ornamentation with large nodes and no internodal spaces, contrasting with other ornamentations identified at Poyos and misleadingly resembling that of a distinct ootaxon.

**Keywords:** Sauropoda, Dinosauria, Upper Cretaceous, Fossil eggs, Palaeopathology.

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## PALAEOBIOLOGY OF THE GENUS *ISOXYS* (ARTHROPODA) FROM ITS RECORD IN CAMBRIAN KONSERVAT-LAGERSTÄTTEN

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*Isoxys* is a bivalved arthropod genus from the Cambrian period. This genus is known for its exceptionally well-preserved deposits (Konservat Lagerstätten) from all around the world: Canada, China, Russia, Greenland, Australia, the USA, and Spain. As we can deduce from the disparate locations, it was a cosmopolitan genus, which used to live in low latitudes. The fact that most of the fossil record is in exceptionally well-preserved sites means that soft tissue elements and organs are preserved (which otherwise wouldn't be) such as the intestine or the eyes, making the study of its palaeobiology more complete. The most outstanding feature of *Isoxys* is that it had a carapace with two spines, one in the anterior area and one in the posterior area, and an ornamentation pattern. Both the spines and the ornamentation are very important diagnostic characters. Besides these features, there are more elements that can be found in modern arthropods as different types of appendages adapted to functions such as hunting and feeding, spherical eyes (a trait that indicates that it lived in well-lit waters), antennae, and even venomous glands. Furthermore, it has been confirmed that several species of the genus presented sexual dimorphism, which can be seen in the slight differences in the size of specimens. Some of the most important species are found in Burgess Shale, Canada (*Isoxys acutangulus* and *Isoxys longissimus*), in Emu Bay Shale (*Isoxys communis* and *Isoxys glassneri*), in Sirius Passet, Greenland (*Isoxys volucris*) or in Chengjiang, China (*Isoxys auritus*, *Isoxys paradoxus* and *Isoxys curvirostratus*). It is also worth to mention the only species of the genus found in Spain, *Isoxys carbonelli* from the Pedroche Formation.

**Keywords:** *Isoxys*, Morphology, Bivalved arthropod, early Paleozoic.



## SUBSPECIES IN PALAEOLOGY: A SOLUTION TO A PROBLEM OR A PROBLEMATIC SOLUTION

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The rank of subspecies is regulated as the only rank below the species, according to the International Code of Zoological Nomenclature. In the case of botany and mycology, other infraspecific ranks are contemplated. The existence of an infraspecific rank comes from the need of some researchers for discriminating a population whose individuals present different characteristics from individuals of other populations of the same species. That difference can be phenotypic, genetic, geographic or behaviour based. These biologically based constraints make creating a subspecies an almost impossible task in palaeontology. Much like species is a concept that allows the differentiation of organisms into groups with well-defined characteristics, the same happens for subspecies. In palaeobiology, only the morphospecies concept is considered, as morphology is the solely available source of information. Similarly, when creating a subspecies in palaeontology, only the phenotypic and geographic criteria can be applied, limited by the fact that most fossil remains represent only a small part of the entire original organism and population studies in a geographically diverse fossil record are scarce. The common practice amongst most palaeontologists, is to classify/identify a fossil based solely on its individual morphological characteristics. If they differ “significantly” from what is described in the diagnosis of the species with the most similar characteristics, then a new species is classified. If the specimen differs only “slightly” from that diagnosis, then a subspecies is classified, more commonly in micropalaeontology. The ambiguity of this practice can be said to be identical to the one of differentiating a subspecies based on modern biological standards. However, fossils are evidence of past life, and past life obeys (as far as we know) to the same evolutionary laws of modern life. Therefore, the author proposes the abandoning of the above-referred practice in favour of a biological one, where species, as known biologically, represent the base of the taxonomic system, and the description of their intraspecific variability is included in the diagnosis of the species. Transitional or early-late forms may be identified, but not named as different taxa within the systematic framework.

**Keywords:** Systematics, Infrageneric taxa, Taxonomy, Phylogeny, Evolution, Philosophy of Science.

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## A VOLUNTEER EXPERIENCE AT THE DINO PARQUE LOURINHÃ LABORATORY

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In January 2022, the first author began the volunteer program, as a vertebrate fossil preparator, in the laboratory of the Dino Parque Lourinhã. At the beginning of volunteering, it was suggested to use the experience acquired to develop a project about volunteer work on preparation. The project, concerning palaeontology and preparation, was included in the citizenship project for the subject Geology, in Peniche High School (Portugal). The goal of the project was to disseminate to high school students what preparation is and what happens to the fossils: from the end of the fieldwork, with the arrival of fossils to the laboratory, until their exhibition in the museum. The methodology chosen to achieve better dissemination was to record a documentary video and prepare and implement a lecture. For five months, the first author was trained in mechanical preparation (learning to work with micro jack-hammers), consolidation techniques (with glues and adhesives), safety issues, vertebrate microfossil collecting techniques (selection under a binocular magnifying glass), and palaeontological-specific terms and museum concepts. Over those five months, the video scenes were filmed and edited, and the lecture was prepared. On June 13<sup>rd</sup> 2022, the video was shown, and a lecture was taught, with the presence of teachers and students attending. In the end, this school project work received the highest grade given in a high school and the first author was invited to give the same presentation again in the following years to other geology students. For the first author, the volunteer experience at Dino Parque Lourinhã overcame just the experience of working with fossils, becoming the opportunity of showing new knowledge and skills, applying it in school context, and reinforcing ideas for possible future university courses. Also, this experience has led to the lead author being assigned the complete preparation of fossils, albeit with the supervision of senior palaeontologists, and being proposed to attend the present scientific meeting.

**Keywords:** Volunteering, Vertebrate fossil preparation, Science outreach, High School.

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## PHYLOGENETIC RELATIONSHIPS OF *KARYDOMYS* (CRICETIDAE, RODENTIA) REEVALUATED THROUGH MAXIMUM PARSIMONY AND BAYESIAN INFERENCE ANALYSES

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*Karydomys* is a rare Democricetodontine genus, distributed throughout Asia and Europe during the Miocene. There are only seven species recognized: the central Asian species (*K. debruijini* and *K. dzerzhinskii*), the Greek species (*K. boskosi*, *K. symeonidisi* and *K. strati*) and the central-western European species (*K. wigharti* and *K. zapfei*). Previously it has been carried out a phylogenetic analysis of the above-mentioned species together with other closely related taxa (*Cricetodon* and *Democricetodon*) to test the monophily of *Karydomys* using a matrix of 32 morphological dental characters. In this work, we have added 19 new characters and extended the ingroup to some taxa belonging to *Democricetodon*. *Eucricetodon wangae* has been kept as outgroup. The data matrix has been built with Mesquite 3.04. Maximum Parsimony Analyses have been run in TNT, and Bayesian Inference Analysis have been performed using Mr.Bayes v.3.2.6. Maximum Parsimony and Bayesian Inference analyses show quite similar results. Both evidence that *Karydomys* forms a clade within *Democricetodon*, which constitutes an array of successive sister-species to *Karydomys*. These results agree with the previous phylogenetic analysis, in which the validity of the genus is questioned. It is possible that the taxa considered up to date as belonging to the genus *Karydomys* are in fact derived representatives of the genus *Democricetodon*. This is a first step to understand the evolution of the subfamily Democricetodontinae, an important and diverse group along the Miocene of the Holarctic region.

**Keywords:** Miocene, Democricetodontinae, Evolution, Phylogeny, Europe, Asia.

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## FOSSIL RECORD OF THE ALLUEVA FORMATION, A DINOSAUR-BEARING ALLUVIAL UNIT FROM THE UPPERMOST CRETACEOUS OF NORTHEAST IBERIA (TERUEL, SPAIN)

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The Upper Cretaceous (middle Campanian–earliest Maastrichtian) Allueva Fm. is a fossil-rich continental unit deposited in the early stages of the Montalbán and Aliaga intramountain sedimentary basins formation (localities of Bea, Allueva and Segura de Baños, Iberian Range, Teruel province, Spain). The Allueva Fm., deposited in a middle-distal alluvial system, is a 500–700 m-thick red mudstone-dominated succession, with intercalations of sandstones and conglomerates. Towards the middle-upper part of the unit, lacustrine-palustrine carbonates are locally dominant. Mudstone and limestone are the most fossil rich lithologies in the Allueva Fm. The first approach to the fossil faunas reveals that titanosaur sauropod dinosaurs are the most frequent among the identifiable remains (mainly caudal vertebrae). The presence of medium-sized titanosaurs is consistent with the current knowledge of these dinosaur faunas from southern Europe during the late Campanian. Other vertebrate clades present in the fossil assemblage are ornithopod dinosaurs, crocodylomorphs, and testudinatans. Microfossil assemblages mainly contain charophyte remains and eggshell fragments. Up to seven species of charophytes have been identified, some of them presenting high biostratigraphic value that allow dating the upper–mid part of the Allueva Formation as Campanian. On the other hand, eggshell fragments have been classified as morphotypes related to theropod dinosaurs and crocodylomorphs. Sedimentation during the Campanian-Maastrichtian was irregularly distributed in the interior areas of the Iberian basin, with a patchy distribution of the subsiding continental-dominated areas, being the Allueva Fm. in relation to further increase of the tectonic activity during the middle part of the late Campanian. The vertebrate fossil content of the Allueva Fm. shows similarities with other Iberian fossil remains such as *Lirainosaurus* of the northern Castillian domain, comprised within the late Campanian–earliest Maastrichtian interval, previous to the faunal turnover that took place in the Ibero-Armorican land-mass around the onset of the late Maastrichtian.

**Keywords:** Mesozoic vertebrates, Titanosauria, Biostratigraphy, Campanian, Iberian Range, Continental sedimentation.



## POPPING OPEN THE TREASURE CHEST: PALAEOLOGICAL AND SEDIMENTOLOGICAL INVESTIGATIONS OF NEW LATE CRETACEOUS (MAASTRICHTIAN) VERTEBRATE FOSSIL LOCALITIES FROM THE VĂLIOARA VALLEY (DENSUȘ-CIULA FORMATION, HAȚEG BASIN, ROMANIA)

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At the beginning of the 20<sup>th</sup> century, Hungarian mapping geologist and palaeontologist Ottokár Kadić unearthed seven specimen-rich fossil localities around Vălioara in the Hațeg Basin that yielded the diverse latest Cretaceous vertebrate assemblages, including the holotype of the crocodyliform *Allodaposuchus precedens*, as described by Nopcsa. Unfortunately, historical circumstances resulted in the mixing of the collected material which, combined with the loss of all original field notes and observations made by Kadić, significantly diminished the collection's palaeoecological and stratigraphical importance. However, recent archive research succeeded to retrieve Kadić's original excavation map pinpointing the exact positions of the historical fossiliferous localities. Using this remarkable 'treasure map', the locations of the old excavation sites have been georeferenced and relocated, their hosting outcrops were resurveyed, and detailed sedimentological information was recorded for all seven localities. Between 2019 and 2022, we conducted several fieldwork sessions at and near these historical sites, leading to the discovery of a number of new (and occasionally extremely rich) fossil occurrences with hundreds of vertebrate fossils, including remains of turtles (*Kallokibotion* sp., dortokids), various crocodyliforms (*Allodaposuchus* sp., *Doratodon*-like ziphosuchians, *Theriosuchus*-like atoposaurids, *Acynodon* sp.) and dinosaurs (especially common rhabdodontids and titanosaurs, besides hadrosauroids and theropods), pterosaurs, and multituberculates. Most remarkable of these are large sets of well-preserved, associated rhabdodontid cranial and postcranial material from two different localities (at least some of these being reminiscent of *Z. shqiperorum*), as well as a set of associated (occasionally even articulated) titanosaur remains. A detailed stratigraphical and sedimentological survey was also performed on these localities that host one of the oldest known late Cretaceous (Maastrichtian) vertebrate assemblages in the Hațeg Basin. The ongoing sedimentological, palaeontological and palaeoenvironmental investigations of the historical and newly identified Vălioara fossil localities contribute to a deeper understanding of the composition, distribution, evolution, and palaeoecology of the Hațeg vertebrate faunas during the latest Cretaceous.

**Keywords:** *Zalmoxes*, *Allodaposuchus*, Dinosaurs, Bonebeds.

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# PALAEOCLIMATIC RECONSTRUCTION OF THE EARLY MIOCENE LOCALITY OF LES CASES DE LA VALENCIANA 1 (VALLÈS-PENEDÈS BASIN, IBERIAN PENINSULA) BASED ON FOSSIL HERPETOFAUNA AND MICROMAMMALS

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The Vallès-Penedès Basin (NE Iberian Peninsula) is a renowned area for the study of Miocene terrestrial vertebrate faunas in Western Europe. Even though the palaeoherpetological record is excellent, it has attracted little attention as compared to that of mammals. Renewed emphasis on the study of the herpetofauna has mostly been centered in systematics, generally omitting its potential for palaeoclimatic reconstruction. Due to their selective range for optimum temperatures, thermophilic ectothermic vertebrates allow estimating mean annual temperatures (MAT) based on their geographic distribution according to recent climatic zones. We provide a palaeoclimatic reconstruction for the late Early Miocene site of les Cases de la Valenciana 1 (LCV1) based on the recovered herpetofauna and micromammals. This site is included in the Subirats lacustrine unit and is precisely correlated to the early Aragonian subzone Ca (early MN4), yielding an estimated age of ca. 16.5–16.3 My. It has yielded a sample of 800 vertebrate remains, 150 belonging to the herpetofauna. Thermophilic ectotherms from LCV1, including crocodylians, turtles, and snakes, are used to estimate MAT by considering the lowest temperatures at which their closest extant relatives are distributed. As to the most thermophilic taxa from LCV1, the identification of cf. *Python* sp. represents the earliest appearance of the Pythonidae in the Iberian Peninsula. Furthermore, the micromammal fauna allows inferring mean annual precipitation, precipitation of the driest month, and precipitation of the wettest month, based on the relationship between these variables and the species richness of arboreal and invertivorous mammals. Our results indicate the climate was subtropical/tropical and relatively arid with marked precipitation seasonality resulting in a clear dry season, as in the African savanna. The local environment at the site is reconstructed as a seasonal freshwater body surrounded by open woodlands. Such results agree with palaeobotanical data from adjacent, chronologically close sites.

**Keywords:** Ectothermic vertebrates, Thermophilic fauna, Pythonidae, Palaeoenvironment, Palaeo-temperature, Palaeoprecipitation

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## THE COMPLEXITY OF MATRIX REMOVAL REGARDING THE FOSSIL MATERIAL FROM THE POYOS DEPOSIT (SACEDÓN, SPAIN)

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Intervention on palaeontological material is a complex task that, in addition to preparation, also consists of collections conservation to be put at the service of research and the general public. These interventions are determined by the state of preservation of the fossils. One of the factors most affecting this state is the way that fossils are extracted in the field, which determines the most appropriate subsequent action protocol for each piece. In the case of the palaeontological site of Poyos (Sacedón, Guadalajara, Spain), its location on the banks of the Buendía reservoir demands a particular fossil extraction methodology, because changes in water level caused fluctuations in humidity and crystallization of the soluble salts found inside the fossils (among other deterioration factors). These alteration processes have caused some of the fossil remains to fragment (losing their cohesion and the continuity of their surfaces), with one of the most specific deterioration characteristics of the site being a layer of small bone fragments that are mixed in with the matrix and salts that cover the entire surface of the fossils in a way that makes it very difficult to intervene since it limits the ability to locate the periosteum. Therefore, the methodology to be followed in these cases has to be based on a detailed multidisciplinary study, in order to determine how the specimen is to be prepared. The elimination of the matrix is complicated, and starts with a small superficial mechanical examination to locate the surface of the fossil and, in the case that it is totally altered, to adjust (as much as possible) the parts of periosteum that are well arranged, to at least reconstruct the broken surface of the fossil, before finally carrying out the consolidation and structural reintegration of the entire block.

**Keywords:** Cleaning, Consolidation, Excavation, Methodology.

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## THE LUSITANIAN BASIN IN THE SINEMURIAN (LOWER JURASSIC): AMMONOID RECORD AND ITS PALAEOBIOGEOGRAPHIC IMPLICATIONS

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The most continuous Sinemurian stratigraphic succession of the Lusitanian Basin (LB) outcrops in São Pedro de Moel. In this area, ammonoids have been found that have allowed the characterisation from *Obtusum* Zone (*p.p.*) up to the *Raricostatum* Zone. The oldest occurrence of ammonoids in the LB is registered in the middle part of the Coimbra Formation, which has been attributed to the *Obtusum* Zone. Their record is scarce and discontinuous, but two endemic genera have been recognised, *Ptycharietites* (five species) and *Epophioceroides* (one species), as well as rare specimens of *Asteroceras* sp., *Aegasteroceras* sp. and *E. cf. landrioti*. This high rate of endemism makes difficult the correlation with other basins. However, the record of *E. cf. landrioti*, together with *Asteroceras* and *Aegasteroceras*, shows that in some periods of the *Obtusum* Zone, it could exist a connection with the basins of the NW European Province. In the *Oxynotum* Zone, several species are in common with other NW European basins, e.g., *Gagaticeras gagateum*, *Oxynoticeras simpsoni*, *O. oxynotum* and *C. cf. accipitris*. In the upper part of this zone, it has been recently described *Plesechioceras rochai*, an endemic species for the LB. Therefore, in the boundary from *Obtusum* to *Oxynotum* zones was established a stronger connection with those other basins from NW Europe. The lowermost part of the *Raricostatum* Zone, the *Densinodulum* Subzone, is characterised by the presence of some species in common with Yorkshire localities (United Kingdom), such as *Cruciloboceras densinodulum* and *Oxynoticeras lymense*, being different from the North of Spain and France. Above these levels, the ammonite succession is dominated by the family Echioceratidae, to which the widely distributed genus *Echioceras* belongs. In the upper part of this zone, the cosmopolitan species *Paltechioceras tardecrescens* is registered. This marks the uppermost part of the Sinemurian as an interval with the strongest connections between basins.

**Keywords:** Ammonite, Endemism, *Obtusum*, *Oxynotum*, *Raricostatum*, Portugal.

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## FAUNAL COMPOSITION OF THE LATE TRIASSIC SITE IN MARCISZÓW, ZAWIERCIE (SILESIA, POLAND)

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Marciszów in Zawiercie is one of multiple palaeontological sites in Upper Silesia known for occurrences of various animal fossils. It represents Upper Triassic, middle Norian fluvial, mainly freshwater deposits. The outcrop started as a niche dig for city dump in 2000 and now is fully covered. First bone material was spotted *ex-situ* in a slag heap in 2009. All other specimens from Marciszów were collected later in the same way of searching the mound consisting of mixed deposits. Here we report new occurrences of tooth plates of the dipnoan fish *Ptychoceratodus* and dermal bones of a plagiosaurid temnospondyl from the subfamily plagiosauridae. Dipnoans and plagiosaurids were not found in Marciszów before, but their remains were excavated from Lipie Śląskie claypit, probably representing a similar palaeoenvironment and stratigraphy. Those new findings can make the site in Zawiercie easier to compare in terms of faunal composition and provide new data for better understanding Triassic ecosystems in German Basin. The published material from the site consists of teeth, a humerus, femur, ischium, and vertebra assigned to the genus Smok—a large, early-diverged theropod or a pseudosuchian included in now defunct taxon “Rausuchia”. There are also long bone fragments of indeterminate dicynodonts from Marciszów, with a prominent example of a tibia belonging probably to a subadult or adult specimen with bite marks of two carnivores—probably a sign of archosaur scavenging. Moreover, there were reported various hypichnia: Grallator-like tracks made by archosaurs; and isometric dicynodont-like tracks; a single track made by undetermined plantigrade animal and a single track of archosauriform. Also, site is known from numerous unioid bivalves similar to *Silesunio parvus*.

**Keywords:** Dipnoi, Temnospondyli, Plagiosauridae, Archosauria, Dicynodontia, Unioida.

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## LATE TRIASSIC FRESHWATER SHARKS FROM LISOWICE (POLAND)

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Here we present results of the study of the Late Triassic shark fossils from Lipie Śląskie site in Lisowice, located in Upper Silesia, Poland. Analysed material consist of 164 microfossils, mostly dental, including 156 Hybodontoidae teeth that represent at least three genera: *Parvodus*, *Pristrisodus* and *Lissodus*. Other fossils include fish (both Chondrichthyes and Osteichthyes) elements such scales and cephalic spines. Those three hybodont shark genera are considered cosmopolitan and euryhaline taxa, but the geological premises and existing fauna found in the Lisowice locality lead to conclude that it was a freshwater environment. What is more, the presence of the species *Pristrisodus tikiensis* may suggest some level of association with Tiki Formation in India, where this species was firstly described from. This would suggest the existence of some connections between the freshwater environments located along the Tethys Ocean and support the idea that *Pristrisodus* was an euryhaline taxon.

**Keywords:** Hybodontidae, Chondrichthyes, Mesozoic, German Basin.



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