BOOK OF ABSTRACTS OF

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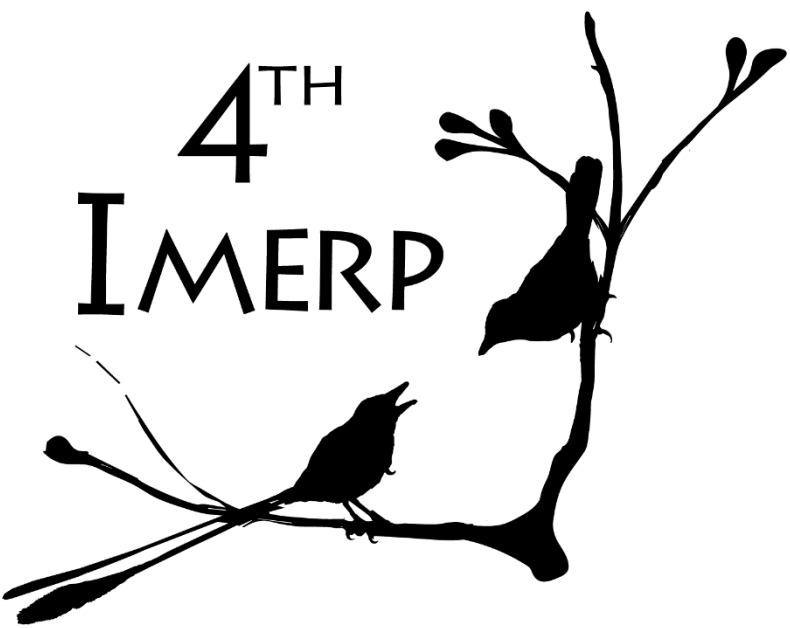

ABSTRACT BOOK OF THE 4TH INTERNATIONAL MEETING OF EARLY-STAGE RESEARCHES IN PALAEONTOLOGY

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INDEX

CONTRIBUTIONS

CONTRIBUTIONS

A refined molecular clock calibration for the mouse and rat models (Murinae): an interdisciplinary study combining phylogenetic, morphometric and paleontological evidence

T. Aghová

The diversification of Murinae, including two key mammalian model organisms as the lab mouse (*Mus*) and rat (*Rattus*), is crucial for several biological disciplines such as biomedicine, physiology, evolutionary biology, among other. Recent studies implemented fossil records exclusively based on fossil descriptions from paleontological studies. The advances in divergence time estimation (*e.g.* tip dating, fossilised birth-death processes) enable the integration of fossil taxa directly into molecular phylogenetic analyses using morphology as well. To improve the placement of fossil taxa into the phylogeny of living taxa, we quantified variation in tooth morphology (first molar, M1) across murine rodents (150 fossil species plus 450 extant species) using high-resolution micro CT scanning. This study is the first to use fossils, genetic and quantitative morphology in a rigorous phylogenetic approach, which could improve one of the most important molecular clocks calibration for mammals, thus contributing in the understanding of the evolutionary history and diversification of the most abundant mammalian subfamily.

Acknowledgements: This study was supported by internal grant of National museum P19/01IG-AG and the Ministry of Culture of the Czech Republic (DKRVO 2019, National Museum, 00023272).

Virtual reconstruction of a braincase and neuroanatomy of an early actinopterygian from the Upper Carboniferous/Lower Permian of Uruguay

S. Álvarez-Parra, A. Pradel, C. Martínez-Pérez, H. Botella

Paleozoic and Mesozoic early actinopterygians have been traditionally identified as "Palaeonisciformes", but the definition and phylogenetic relationships of this order of fishes remain highly debated. Recent studies have resolved this taxon as paraphyletic, although the relationships among early actinopterygians are still obscure. In this context, CT scanning is a technique that can be applied to the study of their inner structures and braincases to better understand of both their external and internal anatomy in order to clarify their relationships. A virtual 3D reconstruction of the braincase and endocranial cavity of an early Upper Carboniferous/Lower Permian actinopterygian from the Paso de las Bochas locality (San Gregorio Formation, Uruguay) is presented herein. The studied specimen is enclosed in a carbonatic nodule which was scanned at the University of Bristol using a Nikon XT H 225. The generated images were segmented and prepared using Avizo 8.1 and Geomagic Studio 2012 softwares respectively. The braincase preservation is exceptional, although the ethmoidal region is incomplete. Several dermal bones, including the parasphenoid, a possible rostral and a right intercalar are also preserved. The cranial endocast displays lateral cranial canals and bifurcate canals for oculomotor nerves, as other actinopterygians. The overall braincase morphology is very similar to other Carboniferous "Palaeonisciformes" braincases. Furthermore, the studied specimen has morphological affinities with *Kentuckia deani* and *Lawrenciella*, such as the crus commune located ventral to the cranial endocast roof and the parasphenoid morphology. This work restarts the out-of-date study of the San Gregorio Formation fossil fishes and provides new information about the morphology and relationships of early actinopterygians.

From the field to the interpretation centre: The Upper Cretaceous Tamajón tracksite (Guadalajara, Spain)

J. Audije-Gil, F. Barroso-Barcenilla, M. Berrocal-Casero, S. Ozkaya de Juanas, V.F. dos Santos, M. Segura

The Tamajón tracksite is a middle-upper Cenomanian (Upper Cretaceous) outcrop located in the region of Guadalajara (Spain) that has provided numerous crocodyliform tracks, a theropod dinosaur footprint, and several fish-fin tracks. It belongs to a geological unit (Arenas de Utrillas Formation) that has been considered almost azoic until recent times and, therefore, has a great scientific value. Moreover, it also has a relevant educational and outreach importance, which can be used to promote Natural Sciences education and geotourism. In view of this, the University of Alcalá, the Tamajón Municipality and the Guadalajara Regional Government decided in 2018 to begin a research and geoconservation strategy for the palaeontological site. In a first phase, the ichnites were restored, studied, photographed, scanned and covered for their conservation. Simultaneously, an assessment of the locality was carried out concluding that it was not possible to transfer the ichnites into a museum due to the dimensions and characteristics of the site. A second phase of the intervention is being currently developed in order to design an innovative interpretation centre in Tamajón. It will hold a mixed exhibition with three-dimensional replicas of the most representative tracks of the site and a model of a Cretaceous crocodyliform, as well as original material from the same and nearby outcrops (some of them very rich in fossil invertebrates). This material is being selected and prepared following preventive conservation techniques. The concept of interpretation centres and their social role has changed over the years, so the future permanent exhibition is being conceived as an interactive, three-dimensional and didactical space for the development of educational activities, along with for the socioeconomic development of the region.

Acknowledgements: Ayuntamiento de Tamajón, Diputación de Guadalajara, Ayudas de Iniciación en la Actividad Investigadora de la UAH, Contratos de la UAH y la UCM, y Proyecto CGL2015-66604 del MINECO (España).

First histological examination of ovarian follicles in a Cretaceous enantiornithine

A. M. Bailleul, J. K. O'Connor, Z. Li, Q. Wu, Z. Zhou

Since the discovery of the first feathered dinosaurs from the Jehol Biota, thousands of specimens have been reported with rare soft-tissue preservation, such as remnants of ovarian follicles in nine specimens of fossil birds, including enantiornithines. This discovery helped clarify the early evolution of the avian reproductive system, suggesting the earliest birds were similar to extant birds in that they had already lost the function of one ovary to reduce mass and facilitate flight.

To shed light on the specific tissues preserved, we provide the first histological examination of ovarian follicles in a Cretaceous enantiornithine from the Jehol Biota (STM10-12), using paraffin histology, paleohistochemistry, scanning electron microscopy (SEM) and Energy Dispersive Spectroscopy (EDS). We compare the fossil to the microstructure of chicken ovaries and ovarian follicles, and to a fossil seed preserved in Jeholornis (IVPP V13274). The latter comparison is included because of the persistent hypothesis that these purported ovarian follicles are misidentified as seeds.

The follicles in STM10-12 are pink, rounded structures within much paler sediments. SEM data show a dark sheath with fibrous material and EDS shows it is organic, with an enrichment in carbon. Qualitative histological examination shows that this layer is about 100µm thick, with structures resembling thick bundles of collagen fibers. There is no comparable structure found in seeds. Three histochemical stains, Masson's trichrome, Picrosirius red and Sudan black, commonly used in veterinary medicine, suggest some of the original histochemistry is also preserved.

Results show that these structures in STM10-12 are most likely remnants of the ovarian theca that surrounded the ovarian follicles in life, allowing the preservation of their original, circular shape. This study clarifies the exact histological composition of these important biological structures and rejects the possibility of plant material. These types of microscopic analyses provide further insight into the evolution of extinct animals beyond their skeletons.

Coprolites as a tool to record digestive strategies

S. Barrios-de Pedro, A. D. Buscalioni

The coprolites from Las Hoyas fossil site are so exceptionally preserve that they can be used to infer the digestive strategies of the faecal producers from this Barremian ecosystem. The digestive strategies are analysed by studying the taphonomic properties of the undigested material. The inclusions of 23 coprolites were metrically and qualitatively analysed using a Scanning Electron Microscope (SEM). The features observed correspond to the pitting, corrosion lines, shape of the fractures at the end, and the size, number and arrangement of the inclusions. In general, the inclusions size for the Las Hoyas coprolites is less than 2 mm, and few reaches up to 14 mm. We demonstrate that an increase in the length of the inclusions is related with the coprolite diameter. Around 56 % of the specimens exhibit inclusions with no marked chemical signals and alterations, which makes possible to identify some of the inclusions (*e.g.*, vertebrae, teeth, ribs). On the other hand, other coprolites show inclusions that are very altered (exhibiting pitting and corrosion lines) as well as being partially broken, which does not allow identification. Non-metric, multidimensional scaling ordination to identify the similarities among the inclusion features and morphotypes were carried out, resulting in the characterization of three different digestive strategies: (1) ingestion of the prey with an absent/limited processing in the mouth, scarce or less effective digestion and defecation in a short period of time; (2) ingestion of the prey with mastication prior deglutition, long retention time of food on the digestive system and defecation over a longer time; and (3) mastication of the prey prior deglutition and more effective digestive system with a longer retention time of food. The results suggest that the first strategy was shared by a variety of producers, with different coprolite morphotypes, whereas the second and third strategies were more limited.

Ecological specialization and elevated ambient temperature at the MMCO underlie modern shark species richness and distribution

M. Bazzi, N. Campione, B. Kear, J. Lilja, H. Jacobson, H. Blom, P. Ahlberg

The evolutionary history of lamniform and carcharhiniform sharks spans almost 140 million years. Previous diversity analyses identified the Late Cretaceous as a time of peak diversity for lamniforms, which subsequently underwent widespread extinctions across the K/Pg boundary. Cenozoic ecological restructuring, following the mass extinction event, favored carcharhiniforms resulting in the most speciose shark radiation today ($N_{species}$>280). Although the transition between lamniform- to carcharhiniform-dominated communities across the K/Pg boundary is well documented, the precise timing and drivers are poorly understood. Here we reconstruct the morphological succession of lamniform and carcharhiniform sharks across the last 83 million years, using a geometric morphometric dataset of 3400 fossil and extant teeth. Our results show that both lamniform and carcharhiniform tooth disparities peaked during the Late Cretaceous, but noticeably declined in lamniforms during the Mid-Miocene Climatic Optimum (MMCO, 17–14.75 Ma). In contrast, the dental disparity of coeval carcharhiniforms increased across the same time interval. Large-bodied predatory sharks, such as *Carcharocles* (*Otodus*) *megalodon*, also appeared during this timeframe, coincident with climate-related changes in ocean productivity and the global diversification of baleen whales and larger ray-finned fishes. Shifts in ocean productivity may have also played a role in the success of carcharhiniforms, along with their generalist feeding strategies and ability to utilize intermittently available food resources at a time of environmental stress.

Analysing the diversity of *Cladophlebis* from Las Hoyas (Upper Barremian, Cuenca, Spain): a qualitative and quantitative approach

C. Blanco-Moreno, B. Gómez, A. D. Buscalioni

Genus *Cladophlebis* Brongn. is a sterile leaf morphogenus consisting of frond fragments with a high variability even within the same specimen, which makes it difficult to discriminate among species. In this study we use a qualitative and quantitative method based on a series of taxonomically informative characters to understand the diversity of *Cladophlebis* from the locality of Las Hoyas. Twenty-two specimens housed in the collections of the Museo de Paleontología de Castilla-La Mancha (Cuenca, Spain) are analysed. They consist of fragments of penultimate and ultimate pinnae preserved as impressions and compressions with beautifully preserved venation. Sixteen characters with taxonomic value are included: (1) dichotomy of secondary veins, (2) pinnule length, (3) pinnule width, (4) pinnule length/width ratio, (5) base of pinnules, (6) apex of pinnules, (7) number of veins at the margin of the pinnule, (8) the angle of lateral veins, (9) the angle of departing veins, (10) width of pinna rachis, (11) margin of pinnule, (12) the presence and structure of sporangia, (13) pinnule disposition, (14) pinnule morphology, (15) type of preservation, and (16) combination of vein angles. We have analysed the metric data by carrying out a Principal Component Analysis (PCA). The multivariate analysis differentiates three distinct morphotypes: (1) defined by a large length/width ratio, numerous veins at the margin, small departing vein angles, and alternate disposition (N=6); (2) defined by a constricted base, lobed margin, the presence of two dichotomies, and larger departing vein angle than lateral vein angle (N=6); and (3) defined by small length/width ratio and large departing vein angles (N=10). The heterogeneous distribution of these three morphotypes at Las Hoyas fossil site (*i.e.*, morphotype 2 is only present in the North, morphotype 3 only in the West, whilst morphotype 1 is widely distributed) suggests that each one would have belonged to distinct plant associations.

First Carboniferous representatives of Concavicarididae Schram, 2014 (?Crustacea, Thylacocephala) in Europe

K. Broda, Š. Rak, T. Kumpan

The arthropods belonging to the poorly known, extinct class of Thylacocephala (?Crustacea) are characterised by a poor fossilisation potential. Therefore, sites bearing their fossil remains are strongly scattered both in the stratigraphical and geographical terms. Due to this reason, the research on these organisms is particulary difficult.

The new species *Concavicaris viktoryni* Rak *et al*. 2018 from the Lower Tournaisian of the Brno area (Czech Republic) is the very first representative of Carboniferous Thylacocephala from Europe. The general shape of the species` carapace bearing a small optic notch with a slightly and ventrally curved rostrum and rounded caudal part is characteristic for the genus *Concavicaris*. However, the described species possesses a unique carapace macro- and micro-ornamentation. This pattern consists of parallel ridges (lirae), which are gently bent near the dorsal margin, marginal crest and ventral margin of the carapace having the form of triangular chevrons. Among the other Palaeozoic thylacocephalans *C. viktoryni* is the only species with such pronounced carapace ornamentation. The uniqueness of this pattern points out that the carapace macro- and micro-ornamentation may be an important taxonomic trait in Thylacocephala.

The carapace ornamentation pattern of *C. viktoryni* is similar to ornamentation of arthropods that are able to dig, which emphasizes the uniqueness of this species among Thylacocephala, since they are mostly considered as a free swimming organisms, sometimes even pelagic. However, to properly elucidate the lifestyle of this organism, it is required to discover its appendages is needed. The described species fits in the Permo-Carboniferous “gap” in European fossil record of Thylacocephala and definitely broadens our knowledge on these enigmatic arthropods.

Acknowledgements: This research was supported by the Czech Science Foundation (to T. K.; grant number GA16-11563S) and by NCN grant 2015/19/N/ST10/01527 (to K. B.).

Biometrical study of the autopodial skeleton of *Paracamelus aguirrei* (Tylopoda, Mammalia) from Venta del Moro (Valencia, Spain)

O. Caballero, P. Montoya, V. D. Crespo, J. Abella, J. Morales

Venta del Moro is a classical locality from late Turolian (or Ventian) (MN13, late Miocene) of Spain. This site is the type locality of the camelid *Paracamelus aguirrei*, which was defined by its superior dentition, a lower third premolar (p3) and some postcranial material. This genus is the only camelid present in Europe during the Mio-Pliocene and it rapidly expanded through all Eurasia from North America. The main aim of this work is to quantify and analyze most of the autopodial elements of *P. aguirrei*, in order to obtain a better understanding of the size of this species.

Compared to other species of *Paracamelus*, *P. aguirrei* is bigger than *Paracamelus alutensis* and *Paracamelus alexejevi*, and similar in size to *Paracamelus gigas*. *P. aguirrei* was bigger than the modern species of *Camelus*. All the measurements are considerably larger when compared to *Camelus dromedarius* and *Camelus bactrianus*. When compared to the extinct species of *Camelus*, the species in study was a little larger than *Camelus thomasi* but smaller than *Camelus knoblochi*, which was the largest camelid of Eurasia.

After the study of the autopodial measurements of *Paracamelus aguirrei*, we conclude that *P. aguirrei* was a considerably large camel like *Paracamelus gigas*, only surpassed by *Camelus knoblochi* in Eurasia and by the giant forms of North America.

3D technologies applied to monitor the taphonomic processes of a Quaternary deposit

E. Cadavid-Melero, J. González-Dionis, C. Jiménez-Gomis, C. Castillo

From the beginning of the 21st century, 3D technologies are applied on a daily basis to the study of the fossil record. Specifically, they are used for the scientific study of fossils and, to a lesser extent, of in situ palaeontological deposits. In this project, we applied 3D technologies to analyse the taphonomic processes of a vertebrate concentration of the Quaternary from Tenerife (Canary Islands, Spain). The methodology used in this work is photogrammetry, which consists in overlapping several photographs to obtain the shape, dimension and position of any object in space. The deposit studied is located in the north of the island, in the palaeodune of Jover. Due to the high concentration of remains, it is thought that this deposit could have a scatological origin. The first step of this study was to verify it by studying the remains found and comparing them with contemporary materials. On the other hand, the photogrammetry technique was used to track the deposit, so we can observe how it is affected by different biostratinomic agents of the fossilization process, such as wind, rain and marine spray. Sadly, the anthropological effect is significant, since this deposit does not have the necessary protections for its good conservation. In conclusion, this project allowed us to carry out a study of the fossil record, which is essential in terms of conservation, especially considering the context of the island (volcanic and oceanic). In addition, 3D technologies, in particular photogrammetry, can be validated for the analysis of taphonomic processes in scatological concentrations.

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Phylogenetic signal *vs*. environmental constrictions in two extinct genera of rodents

P. M. Carro-Rodríguez, P. López-Guerrero, A. R. Gómez-Cano, M. Á. Álvarez-Sierra

Cricetodon and *Hispanomys* are two extinct genera of the tribe Cricetodontini recorded during the Miocene. These rodents are a useful tool in biostratigraphy and to characterize environmental changes. Previously, we performed several morphometrical analyses, including Fourier Shape Analysis, that concluded the following: *Cricetodon* show basal characters while *Hispanomys* exhibit more derived characters of their tribe. One of the main differences is related to the outline morphology of the upper first molar (M1). Using Fourier Shape Analysis, we established that *Cricetodon* is characterized by a straight outline on the labial region, while *Hispanomys* show a trilobed outline on the same region.

Nevertheless, we ignored if this morphological distribution was due to phylogenetic signal or an environmental constriction. In order to assess the phylogenetic signal (a tendency of related species to resemble one another) of these morphological traits, we used the "Phylosig" function of the "Phytool" R package. We collected Fourier Coefficients and the phylogenetic information to then carry out a Blomberg *et al.*´s K, Pagel´s λ and a scatter plot with the morphological values and the record age. The results for the phylogenetic signal analysis showed that there is no relation between the outline morphology of the labial region of the M1 and how phylogenetically related are the species, since the values for K and λ are closer to zero than to one. Although we did not find any phylogenetic signal that explains the change in the outline pattern of *Cricetodon* and *Hispanomys*, the acquisition of the trilobed shape and the hypsodont molars of Hispanomys match with a climate change during the Miocene. This change promoted an alteration of the landscape in the central basins of the Iberian Peninsula causing an increase of prairie ecosystems and therefore a dietary change for these species.

Ichnological analysis of the core 977 at the Alboran Basin: incidence of climatic changes during the last glacial cycle at the deep-sea bottom

S. Casanova-Arenillas, F. J. Rodríguez-Tovar, F. Martínez-Ruiz

The Alboran Sea, within the western Mediterranean, is generally considered as a natural laboratory, highly sensitive to climate forcing. It is a semi-enclosed basin, at a latitude where southern and northern climate systems interact, and with a short water residence.

The profusely studied core 977 is situated in the Alboran Sea. In this research, the ichnological analysis from this core has been conducted based on detailed image treatment on core photographs. This information has been contrasted with previous climatic and paleoenvironmental interpretations, evaluating the incidence of the fast climate events, which occurred recurrently during the last glacial cycle, to the macrobenthic tracemaker community.

Ichnological analysis reveals abundant bioturbation through the core, with differentiation between discrete traces with sharp contacts, and diffuse biodeformational structures determining a mottled background. The ichnological record is neither continuous nor homogeneous but showing an apparent cyclic pattern in diversity and abundance from highly bioturbated sediments showing a mottled background to laminated sediments without bioturbation. Comparison with previous data shows that sediments corresponding to the last glacial maximum appear heavily bioturbated, evolving to much less disturbed at the beginning of the interglacial period. However, there is not a clear correlation between sea surface temperature and seafloor environment at the Alboran Basin due to the Western Mediterranean Deep Water being generated at the Gulf of Lion.

Thus, a comparison between the climatic variations occurred during the last glacial cycle at the Gulf of Lions and the ichnological information from the Alboran cores could validate this relation. Moreover, the use of the ichnological approach as a useful tool in the study of deep-water environment during the last glacial cycle.

Acknowledgments: The study was funded by projects CGL2015-66835-P and CGL2015-66835-P (Secretaría de Estado de I+D+I, Spain), and the research of Casanova-Arenillas by a pre-doctoral grant from the Spanish Ministry (FPU).

Refuge length selection in Late Pleistocene Iberian bears

J. M. Casero Peinado

Two large ursids appear together in Late Pleistocene Iberia: the brown bear, *Ursus arctos*, and the extinct cave bear, *U. spelaeus*. The former has a sparse Pleistocene record and appears through the whole Peninsula; while the latter is locally abundant and restricted to the Cantabrian area, Pyrenees, a land stripe from the Basque Country to Madrid and Guadalajara provinces, and one find in the south Cordoba province. Because this range loosely coincides with the Eurosiberian part of Iberia, it is tempting to think that the restriction was due to the reliance of the more vegetarian cave bear on Eurosiberian-type vegetation. However, its presence on Mediterranean sites casts doubts on this explanation. An alternative is that cave bears sought longer, deeper caves for hibernation, which are more common in northern Iberia. This study selected 100 Iberian Pleistocene sites with reported brown bear and cave bear remains and used STATISTICA to compute correlations between their presence and total cavity length. A significant correlation was found between cave length and cave bear presence, although no significant correlation was found for the brown bear presence. Since average length of *U. spelaeus* sites was 465% longer than those with *U. arctos*, it is possible to argue that cave bears indeed selected, and depended on longer refuges than the more generalist brown bears and that this is the main explanation for their range differences in Iberia. This conclusion is supported by the correlation between brown bear presence and occasional, non-hibernating cave occupiers like hyenas and to a lesser extent lions and wolves who should be indifferent to refuge length. In contrast, no correlation was found between cave bear presence and other large carnivores.

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The Extinct Ghosts of Christmas: which disappeared browsers is *Ilex aquifolium* afraid of?

J. M. Casero Peinado

The European holly tree (*Ilex aquifolium*), traditionally used in Christmas decorations, was mentioned by Connie Barlow in The Ghosts of Evolution (2000) as a rare Eurasian example of "evolutionary anachronism", *i.e.*, an extant species with features best explained through coevolution with extinct taxa. Holly tree's leaves on lower branches have spiny margins, while upper ones are smooth. This is a presumed strategy against herbivory, but spines may still appear at 400 to 500 centimetres over the ground, which is far above the reach of modern browsers. However, Barlow did not propose a disappeared browser that could explain this. This study examined Eemian (MIS 5e) fossil faunas within, or near *I. aquifolium*'s current range in Britain, France, Germany, and Spain. The Eemian was chosen because it was the last stage before the arrival of Homo sapiens into Europe that had a global average temperature similar to the present. Year-round and seasonal browsers genera still present in the area (*Capra, Capreolus, Cervus, Dama* and *Rupicapra*), extinct locally (*Alces, Bison* and *Hippopotamus*), and globally (*Dihoplus, Megaloceros* and *Palaeoloxodon*) were considered. As expected, higher spines are well above the reach of the current tallest browser C. elaphus (120 cm on the withers) as well as the tallest Holocene browser, *A. alces* (233 cm), but are only slightly above the estimated reach of the tallest Quaternary browser, *P. antiquus* (400-430 cm). Consequently, it is proposed that *I. aquifolium*'s leaf shape evolved at least partially in response to predation by *P. antiquus*. This result is a reminder that even modern ecosystems restored to an early Holocene state may be "incomplete" and missing long-established elements and ecological partnerships that were present in the Pleistocene, but may not be automatically apparent to a modern observer.

"With your fossil… To the past!" A paleontological escape room proposal for the XVIII Science Week in Madrid

M. A. Cervilla-Muros, I. Rodríguez-Castro, I. Vitón, J. Salas-Herrera, A. Acedo, A. García-Frank, O. Fesharaki

Paleontological dissemination is a powerful tool to bring this science closer to everyone. Previous Non-Formal Education experiences showed that learning about the history of life or study methods in paleontology become easier and much more understandable with activities like paleoroutes or workshops. We describe here a paleontological escape room designed, developed and tested by the UCM-UAH University Master in Advanced Paleontology students for the XVIII Science Week in Madrid, an emerging initiative from the Paleontological Heritage subject, and its preparation process. The Project mentioned above is based on a fictitious time machine developed by a research group (the MSc students) in search of a better understanding of extinct life forms and their living environments. Starting from this point, one of the researchers will guide each group of participants towards the time machine, going through the three Phanerozoic eras: Paleozoic, Mesozoic and Cenozoic, represented in three different rooms. Every room contains characteristic fossils and different specialists will teach the main events and living organisms of each era. At the end of the explanation in the Mesozoic room, a technical failure will lock the door of the time machine and both researchers and participants must solve several enigmas in the form of riddle-like puzzles to escape. Therefore, the participants will put into practice the recently acquired knowledge while enjoying an alternative dissemination activity. Furthermore, for the MSc students, this activity involves important competences such as selection of concepts, organization of events or teamwork, with the aim of improving the audience's experience.

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Morphofunctional evolution of the humerus in crown birds (Ornithurae, Aves)

M. Costa-Pérez, A. Martín-Serra, F. J. Serrano

With more than 10.000 living species occupying a large range of habitats and ecological niches, birds are one of the most successful groups of tetrapods. A significant proportion of this evolutionary success can be ascribed to wing-propelled locomotion. Therefore, morphological variability of birds' wing reflects adaptation to different locomotory strategies (*e.g.* flapping, gliding, and diving). As the main muscles involved in wing movement inserts on the humerus, this bone is an excellent candidate to explore the link between morphology and locomotion throughout the evolution of crown birds. In this study, we explored morphological variation in the humerus among Ornithurae—the clade comprising modern birds and the Late Cretaceous taxa *Ichthyornis*—using 2D Geometric Morphometrics. We analyzed the humeri of 155 species of birds including 5 extinct taxa to quantify the influence of phylogenetic signal, allometry and function. A principal components analysis showed two groups clearly different from the rest: a) Apodiformes (*i.e.*, swifts and hummingbirds), which presented a unique highly robust humerus, that is correlated to their hyperaerial specialization; and b) penguins (O. Sphenisciformes) and auks (Fam. Alcidae), which are separated from the rest of birds mainly due to the deltopectoral crest (DPC) length. This could indicate a convergent specialization towards the use of wings for diving, typical of these two taxa, but further analyses are needed to confirm such hypothesis. Besides these functional aspects, we also found a significant phylogenetic signal in the humeral shape variation among Ornithurae. In this way, the humeri of the extinct species analyzed from Columbidae (*i.e.*, *Raphus cucullatus* and *Pezophaps solitaria*) and Alcidae (*i.e.*, *Pinguinus impennis* and *Mancalla milleri*) were similar to those of their modern closest relatives.

Anagenesis and cladogenesis in the vertebrate fossil record — A case study for protoceratopsid dinosaurs

Ł. Czepiński

Cladogenesis (evolutionary splitting of the ancestral species into two or more descendant lineages) is often considered to be the most frequent form of the speciation recognizable in the fossil record. Nevertheless, some recent studies have focused on anagenetic speciation (transformation of the ancestral species without splitting) among extinct vertebrates. Recognition of the anagenetic process, however, requires dense stratigraphic sampling with a rather complete fossil record, a situation which is rather rare in vertebrate paleontology.

Studies on protoceratopsid dinosaurs from the Gobi Desert of Mongolia and China reveal another example of possible anagenesis. This remarkable material includes dozens of complete individuals coming from different localities and time horizons thus allowing a detailed analysis of phyletic evolution in this lineage. The presence of intermediate morphology in some individuals, as well as the mosaic distribution of apomorphic features further complicates the evolution of this group, thus indicating issues related to taxonomic bias and species definition in the vertebrate paleontology.

New data on the Late Triassic vertebrate locality with archosaur and turtle remains in Kocury, Poland

Ł. Czepiński, T. Sulej, T. Szczygielski, A. Lewczuk, D. Dróżdż, W. Pawlak

Since 1990, several localities with terrestrial vertebrate remains from the Keuper strata (upper Middle to Upper Triassic) were discovered in Southern Poland. Here we report new data on the poorly known locality of Kocury near Dobrodzień. There, the first remains of a dinosaur from the modern territory of Poland were collected and described in 1932 under the name of *Velocipes guerichi* von Huene, 1932.

Excavations have been performed there since 2012, providing further diagnostic vertebrate material. In addition to a neotheropod dinosaur, the bones and osteoderms of a typothoracisine aetosaur, carapace fragments of a proterochersid turtle, and a tooth plate of a ptychoceratodontid lungfish were collected. Available material suggests faunal and environmental similarities with the turtle-dominated Poręba locality, Norian in age.

Actinopterygian fishes from the late Permian of Fore-Sudetic Monocline (SW Poland)

D. Dankina-Beyer, A. Spiridonov, S. Radzevičius

The Kupferschiefer Formation in Zechstein Basin is known for its preservation of a variety of invertebrate and vertebrate taxa, but no actinopterygian remains have been formally described from these late Permian rocks in SW Poland.

The present study examined two late Permian actinopterygian fish specimens, which were collected from the Kupferschiefer black shales in the underground Lubin mine below 600 m (Fore-Sudetic Monocline). These fish fossils are represented by partially preserved trunks including dorsal fins and scales sculpture from different fish body parts. The scales are divided into several morphotypes according to their various characteristics. The fish taxonomic study of the two newly discovered actinopterygians indicate the occurrence of ?*Palaeoniscum* sp.

The fish specimens were photographed using a Nikon D100 digital camera and a binocular Leica DMS 1000 with software Leica Application Suite v 4.2 at the University of Valencia (Valencia, Spain). The digital illustrations were prepared using Adobe Photoshop and AutoCad programs.

A description of this new data enable a better understanding of the poorly known late Permian fish diversity from SW Poland.

Acknowledgements: The authors would like to thank the mine workers from Lubin city (SW Poland) for providing an important palaeontological material.

New well-preserved tetrapod ichnites from the middle Muschelkalk (Middle Triassic) of the Catalan Basin

C. De Jaime-Soguero, E. Mujal, J. Fortuny

Middle Triassic vertebrate footprints with skin impressions provide direct information about the taxonomy and morphology of the trackmaker. They are known from several outcrops in Europe, but only few studies have described the skin patterns in detail. The discovery of a large group of ichnites in two new outcrops (Penya Rubí and Puigventós) from the Catalan Basin (NE Iberian Peninsula) provides a window to use them to deep on peri-Tethys ecosystems with coastal influence. The footprints appeared on the detrital middle Muschelkalk facies (late Anisian-early Ladinian, Middle Triassic), in greyish dolomites and reddish sandstones and mudstones. The sedimentary succession was deposited during a short regression interval within the main marine transgression represented by the Muschelkalk facies. Several 3D models of selected footprints were generated by using photogrammetry, to carry out morphological descriptions and further analyses such as the estimation of the trackmaker's pressure-weight distribution and the locomotion-substrate interaction. Based on the 3D models and the excellent preservation of the ichnites, it was possible to obtain paleoecological and ichnotaxonomical results. The paleoenvironmental reconstruction shows two different landscapes, one potentially composed by a tidal flat covered with microbial mats (Penya Rubí ichnosite), whereas the other one would have corresponded to a sabkha-like area, with salty waters (Puigventós ichnosite). Two skin patterns were described for the studied ichnotaxa, which offered direct information about the trackmakers. The results show that the ichnites correspond to *Rhynchosauroides*, Procolophonichnium and *Chirotherium*, frequent morphotypes of the Anisian–Ladinian coastal and distal alluvial settings. Furthermore, these new ichnosites show that ichnotaxa distribution is constrained by the paleoenvironmental setting.

Staying Preserved: complementary compositional data of "Hoces de Beteta" Lower Cretaceous bone remains (Cuenca, Spain)

H. Del Valle, I. Prieto, F. Barroso-Barcenilla, P. Sevilla

The Lower Cretaceous vertebrate sites of Vadillos-1, Vadillos-2 and El Tobar are located in the northern part of Cuenca Province, in the Iberian Ranges. These three sites belong to Tragacete Formation, dated as upper Barremian. Their lithology is mainly siliciclastic, consisting of a stratigraphic sequence of brown, grey and red clays with interbedded sandstones, conglomerates and limestones. By applying a systematic and holistic view of taphonomic processes, diagenetic information was collected on the bones and their surrounding sediment. In order to characterize the bone diagenetic processes that took place in these sites, we decided to focus on a microscopic scale. A previous petrographic analysis showed the good preservation of all the histological structures. Sparry calcite cement was found to be the main inner filling of the bone in all the studied cases, with occasional presence of iron oxides and clay minerals. Our main aim was to understand the preservation variability of the dinosaur bone remains discovered in the grey clay intervals from these three sites. Subsequently, a combined approach using Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS) and Fourier Transform Infrared spectroscopy (FTIR) was conducted on bone fragments and their surrounding sediment to analyze mineralogical composition and taphonomic features. Different diagenetic parameters were chosen to represent the state of bone preservation. Mainly, we examined Crystallinity Index, CO3/PO4, Cal/PO4 ratio and the different mineralogical phases present in the bone specimens. Further analyses will be conducted in the near future as part of a larger project that will deal with other aspects of diagenetic processes in the area.

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Santa Margarida (Algarve) a new exceptionally rich microvertebrate site and one of the oldest in the Pleistocene of Portugal

D. Estraviz-López, O. Mateus

Santa Margarida (Municipality of Loulé, Algarve, South Portugal) is situated in the karst of the Picavessa formation, Lower Jurassic in age. Several blocks of breccia and cemented *terra rossa* with numerous cranial and postcranial remains of microvertebrates were recovered by a team of the FCT-UNL in 2017 from a traditional rural man-made wall. After chemical preparation with a water softener, fossils were picked out from around 0.5 kg of sediment disaggregated from the blocks. More than 300 remains of vertebrates, plus the two gastropods *Pomatia elegans* and *Paralaoma servilis*, were recovered (housed at FCT-UNL). The vertebrates comprise indeterminate squamates, dental remains assigned to Chiroptera, dental and mandibular remains of *Sorex* sp. and *Crocidura* sp. and a distal *Oryctolagus cuniculus* humerus. Rodents represent the most common group (+90%), with the presence of *Eliomys quercinus*, *Apodemus sylvaticus*, *Allocricetus bursae* and the arvicolines *Iberomys cabrerae*, *Iberomys brecciensis*, *Iberomys huescarensis* and *Victoriamys chalinei*. These last two Southern European taxa are recorded herein for first time in Portugal. The presence of three chronospecies of *Iberomys* implies that the remains represent, at least, two Pleistocene moments: The first moment around 800.000 YBP (late Calabrian, mid Pleistocene) biochronologically dated by the presence of archaic *I. brecciensis* plus *I. huescarensis* and *V. chalinei*. The second from around 120.000 YBP (early Late Pleistocene), being characterized by the abundant remains of *A. sylvaticus* as well as the presence *A. bursae*, *I. cabrerae* and advanced *I. brecciensis*. This makes Santa Margarida one of the oldest known vertebrate localities for the Quaternary of Portugal and one of the richest, comparable in age with the sites of Morgadinho and Algoz, both in Algarve.

Acknowledgements: We would like to thank the photographer Jorge Graça for communicating the discovery and Pedro Callapez, Juan Manuel López, Raquel Moyá-Costa and Pavlos Piskoulis for their help identifying the fauna.

The cave of Lapa da Canada (Alvaiázere): abundant Holocene vertebrates from Portugal

D. Estraviz-López, O. Mateus

Lapa da Canada (District of Santarem, municipality of Alvaiázere, Portugal) is an uncharted cave situated in the karst of the "Maciço Calcário Estremenho". Vertebrate remains were collected in October of 2014 from four (A, B, C and D) galleries of the cave. These recovered remains belong to at least nine vertebrate taxa: *Equus ferus* (right metatarsal), *Cervus elaphus* (left hemimandible with molar series, distal left humerus and complete left radius), *Capra* sp. (two immature associated skeletons), *Oryctolagus cuniculus* (dozens of bones), Arvicolinae indet. (mostly isolated teeth), Chiroptera (humeri and six skulls), *Genetta genetta* (complete skull), Passeriformes indet. (complete skull and several postcranial bones), and *Timon lepidus* (frontal). The presence of the genet in the assemblage restricts the age of the gallery B fauna to a maximum of about 2500 YBP, although the thickness of the calcareous crust deposited in the distal part of the horse metatarsal points towards an older date for the remains of gallery C. Three samples from the cave have been analyzed in the University of A Coruña by mass spectrometry, yielding in all cases an amount of Nitrogen >0,05%. This means that radiometric analysis of age and diet plus ancient DNA are likely possible on most of the remains of this locality.

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The basal sauropodomorph *Anchisaurus polyzelus* enlightens the sauropod skull evolution

M. Fabbri, G. Navalón, N. Mongiardino Koch, M. Hanson, H. Petermann, B.-A. S. Bhullar

The evolution of the skull morphology in sauropods is believed to have been mainly driven by paedomorphosis and biomechanical optimization for feeding specialization. However, the dearth of quantitative studies and the rarity of well-preserved sauropodomorph skulls make these observations largely qualitative and poorly investigated. Here, we studied the skull material attributed to the Early Jurassic basal sauropodomorph *Anchisaurus*. Compared to its closest relatives, *Anchisaurus* is a slender sauropodomorph and is traditionally considered the basalmost taxon of the clade Anchisauria, therefore closely related to Sauropoda. Skeletochronological analysis using histological techniques revealed that one of our specimens is a sexually mature and the other is likely an adolescent individual. MicroCT scan data enabled the digital reconstruction of the skull morphology for both the youngest and oldest individuals. Based on this new data, the cranial features of *Anchisaurus* are reevaluated: we found an interesting mosaic of basal and derived characters expressed in this taxon. The braincase rotates ventro-distally, shifting the lower temporal fenestra below the orbit, as in sauropods. On the other hand, the snout is elongated, but still retains a condition similar to other basal sauropodomorphs, such as *Massospondylus* and *Plateosaurus*. We performed geometric morphometrics on a dataset of 60 taxa and 80 individuals. The dataset includes early archosauromorphs, crocodiles, theropods, and sauropodomorphs, and all available ontogenetic stages for seven taxa. Our results suggest that an increased craniofacial growth acceleration was a driving variable for shaping the skull morphology of sauropods. However, we also found that a substantial amount of neomorphosis occurred in the ontogeny and in the evolution of Sauropoda: a complete developmental shift is found for the ontogenetic series of diplodocoids and macronarians. We conclude that *Anchisaurus* shows an intermediate condition in the evolution of the skull in Sauropodomorpha and that a combination of neomorphogenesis and heterochrony were key variables in the evolution of the largest land-dwelling animals that ever roamed the planet.

Taxonomical analysis of the early Pleistocene rhinocerotid fossil remains from Copăceni (Dacian Basin, southern Romania)

O. Flintașu, Ș. Vasile, I.L. Dumitrache

The Pleistocene continental deposits cropping out along the Argeș River, at Copăceni (Ilfov County, southern Romania), have recently yielded numerous vertebrate fossils, including fishes, amphibians, reptiles, and mammals. The mammal assemblage allowed a relative dating of the deposits that yielded the diverse vertebrate fossil assemblage to approximately 1.1-1 Ma.

Among the macrovertebrate fossils discovered in this area, there are also three rhinocerotid specimens: two third metacarpal bones, and a series of three deciduous premolars, belonging to the same individual. The morphometric measurements of these three specimens were compared to the existing ranges reported in scientific literature for three species of Pleistocene rhinocerotids: *Stephanorhinus hunsheimensis* (Toula, 1902), *Stephanorhinus etruscus* (Falconer, 1868), and *Stephanorhinus kirchbergensis* (Jäger, 1839). These are the most common European taxa from the 1.7-0.6 Ma time interval, which includes the estimated age of the assemblage from Copăceni.

Based on this analysis, the rhinocerotid remains from Copăceni fall within the ranges of both *S. etruscus* and *S. hundsheimensis*, but are closest in size to the average values reported for *S. etruscus*. The morphological features of the teeth and metapodia also suggest that the species found at Copăceni was more likely to have been *S. etruscus*, but additional material is needed for a definitive solution to this question.

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New post-cranial remains of a large teleosaurid in the Villar del Arzobispo Formation, Alpuente, Valencia, Spain.

A. Gamonal, M. Suñer, C. Santisteban

Teleosaurids were a successful and diverse group of marine crocodylomorphs that lived during the Jurassic and the Lower Cretaceous in different shallow and coastal marine ecosystems throughout the world. Teleosaurids were generalist predators with different adaptations that allowed them to seize a wide range of prey, from fishes to turtles, making them one of the most abundant thalattosuchians in the fossil record of Europe. In this work we present new postcranial remains that were found in the municipality of Alpuente, Valencia, comprising several vertebrae, osteoderms and teeth that can be assigned to a large teleosaurid, due to the morphological characteristics of the sacral vertebrae and ornamentation of the osteoderms. The presence of these remains in the Villar del Arzobispo Formation updates the vertebrate faunal list of the Ibero-Levantine Basin (Eastern Spain) during the Upper Jurassic-Lower Cretaceous, up to now mostly comprised by sauropod, stegosaur and theropod dinosaurs and invertebrate organisms. These new fossils could potentially shed light on the dating of the sediments of this region, widely discussed due to the complexity and extension of the Villar del Arzobispo Formation.

Acknowledgements: We will like to personally thank Daniel Romero and Juan Pablo Albir for their constant collaboration with the museum and for the finding of the remains.

Influence of the long-term environmental stress caused by Chicxulub impact and Deccan volcanism on early Danian planktic foraminiferal assemblages

V. Gilabert, I. Arenillas, J. A. Arz

The recovery of ecosystems immediately after the Cretaceous/Paleogene (K/Pg) boundary mass extinction is still a highly debated topic in the scientific community. A recent hypothesis suggested that the Chicxulub impact triggered the outburst of the Deccan traps massive eruptions, which delayed the recovery of the ecosystems. We have carried out a high-resolution biostratigraphic study with planktic foraminifera of the first 345 cm of lower Danian in the hemipelagic section of El Barranco del Gredero, Caravaca, SE Spain. We have analysed how the planktic foraminiferal assemblages evolved and changed in an almost empty niche within a potentially harmful oceanic state. We have assumed that almost most of the latest Maastrichtian species identified within the Danian sediments are reworked. Only the opportunist species of the triseral genus Guembelitria are considered as true survivors of the K/Pg boundary event. A scenario of sustained environmental stress (global warming, low oxygen concentration, and high concentration in toxic elements) in the oceans by the enhanced volcanism activity during several hundreds of thousands of years after the K/Pg boundary is supported by the presence of two acme episodes of opportunist guembelitriids and an anomalous abundance of aberrant forms among planktic foraminiferal species. Aberrant forms are significantly abundant during the guembelitriid blooms (Guembelitria acme in the K/Pg boundary dark clay bed, and Chiloguembelitria acme, from 130 cm above the K/Pg boundary to at least the top of the studied section). The ecological stress could last at least 300 kyrs after the K/Pg boundary. However, during this interval, two evolutionary radiations in planktic foraminifera occurred, suggesting that the increase in genetic mutation rates due to the long-term meteorite and volcanic pollution in the oceans could help to accelerate their evolution, but also to produce malformations and teratological forms.

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Dental 3D modeling of the Canarian chiropters applied to conservation Paleobiology

J. González-Dionis, E. Cadavid-Melero, C. Jiménez-Gomis, C. Castillo

Currently, thanks to the development of 3D methodologies, new modeling techniques have emerged, such as photogrammetry. This technique allows us to study and analyze both the fossil remains and the deposits in which they are found without affecting their integrity. In the Canarian archipelago there are seven species of chiropters; Four are classified as least concern in the Red List (*Pipistrellus kuhlii*, *Hypsugo savii*, *Nyctalus leisleri* and *Tadarida teniotis*); one of them is near threatened (*Barbastella barbastellus*); and the last two are vulnerable, being one of them an endemism from the Canary Islands (*Plecotus teneriffae*), whereas the other represents an endemism from the Macaronesia (*Pipistrellus maderensis*). The dentition of fossil and extant chiropters has been an important source of palaeobiological information. The aim of this project is to test the technical feasibility of photogrammetry to analyse their dental elements. We will present 3D models of tooth morphology from the chiropters species already mentioned. The models acquired will help us identify the fossil remains of the extant species from the Canary Islands, and to know their distribution and other characteristics of the species that can be used in their conservation. In addition, the results obtained extend the knowledge of the chiropters from the Canary Islands and promote the use of digital modeling techniques for the conservation of biodiversity and the fossil record.

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Ecological diversity of Serravallian (middle Miocene) Mediterranean Sharks based on placoid scale morphometric study

J. L. Herraiz, H. G. Ferrón, H. Botella, C. Martínez-Pérez

The Messinian salinity crisis (≈ 5.59 Ma) is regarded as one of the most determining events for the recent evolutionary and palaeobiogegraphic history of the Mediterranean biota. This event involved the almost complete desiccation of the Mediterranean Sea, drastically reducing available ecosystems and driving most species to extinction. The impact of this episode of isolation has usually been assessed by studying the associated taxonomic turnover, although there have been less interpretations from an ecological point of view. The present work studies the functional diversity of dermal denticles from a Serravallian (middle Miocene) locality from Southeastern Spain, providing a preliminary view into the pre-salinity crisis ecological diversity of sharks from the western Mediterranean, thanks to the importance of such denticles as a source of ecological information regarding elasmobranch taxa. The results, based on morphometric methodological procedures established in previous studies, reveal a comparatively high diversity of functional types of dermal denticles, including scales that prevent the settlement of ectoparasites and epibiontes, abrasion resistant scales, drag reduction scales and scales with generalized function. This variety of dermal denticles supports the presence of several ecological groups of sharks such as schooling, strong swimming species, demersal species, slow sharks of the open water and, possibly, bioluminescent taxa. The application of the same methodology to post-Messinian crisis fossil localities (Plio and Pleistocene) will be crucial to shed more light into the impact that the salinity crisis, as well as other recent geological events had in the Mediterranean from an ecological perspective. This will allow us to better understand the composition of shark communities and diversity in the current Mediterranean Sea and their evolutionary history.

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A new tool for palaeontological heritage outreach: University of Valencia Natural History Museum's Palaeoichnology virtual collection

J. L. Herraiz, J. A. Villena, A. Vilaplana, N. Conejero, H. Botella, A. García-Forner, C. Martínez-Pérez

The University of Valencia's Natural History Museum (MUVHN) is a university museum that preserves thousands of specimens with a high patrimonial and scientific value, including its remarkable palaeontological collection. As other museums, the MUVHN stores most of its collections under controlled conditions, exhibiting to the general public just a selection of specimens normally selected by their scientific and/or didactic value. Under these criteria, some fossils groups are systematically underrepresented in the exhibitions, due to their special maintenance conditions (holotypes), their size (microfossils), or because they can be more difficult to understand by the general public (*e.g.*, ichnofossils). However, the development and availability of new technologies, like 3D-model generation (*e.g.*, photogrammetry, laser scan) and online repositories, are helping to show all these fossils in an unlimited way. Therefore, and taking advance of this low-cost technologies, here we present the new MUVHN's 3D virtual collection, based on surface scans using photogrammetry. The best examples of the palaeoichnological collection were scanned and their 3D models were uploaded to a virtual and free access repository in http://Sketchfab.com. This new Virtual Collection follows the trend shown by different Museums worldwide, thus demonstrating the utility and low economic cost needed to preserve in such a way our palaeontological heritage, which is normally hidden in most museums. Most importantly, our work not only shows the benefits of non-barrier way of outreach, but also a way of sharing important information between researchers.

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A brief insight into new records of lower Turonian ammonites from Bohemian Cretaceous Basin

O. Kohout, M. Košťák

According to current knowledge, the Turonian ammonites from the Bohemian Cretaceous Basin (BCB) starts within the *Mammites nodosoides* ammonite Zone. This strongly contrasts as compared to the stratigraphic distribution of ammonite fauna in European basins, as well as the West Interior Seaway (WIS), north Africa and other regions. The majority of the middle/upper Lower Turonian ammonites in BCB are represented by the index species *Mammites nodosoides* (Schlüter, 1871) and other taxa of this Zone. However, our new records of genera *Fagesia* (Pervinquière, 1907) (10 specimens), *Paramammites* (Furon, 1935) (3 specimens) and *Watinoceras* (Warren, 1930) (1 specimen) clearly document older strata than previously suggested. These samples were collected in the first half of the 20th century and they come from area around village "Žďánice u Kouřimi" (ca 50 km east from Prague). Unfortunately, these very important localities are not exposed at present time. Based on these records, we extend the ammonite zonation down to the base (or to the lowermost strata) of the Turonian in the BCB. This significantly rises correlational potential, especially within ammonite faunas from the NW Tethys and the WIS.

Few other interesting species of the Turonian ammonites were recognized in older collections and they have recently been collected in the field – *i.e.*, *Prionocyclus albinus* (Fritsch, 1872). The taxonomic validity of enigmatic species of *Mammites curimensis* (*sensu* Soukup 1936 named after Kouřim town) is also discussed.

The Dasberg Event in terms of palynology (Kowala Quarry, Holy Cross Mountains, Poland)

M. Kondas

The Dasberg Event is considered as a component of the Late Devonian extinction, which was one of *the big five*. Kowala quarry gives an amazing opportunity to investigate the Late Devonian extinction record in terms of palynology. The quarry is located in the Holy Cross Mountains (Gałęzice-Kowala syncline). The investigated section comprises two horizons of black shales, which are related to the global Dasberg Event. A standard palynological investigation was carried out on 23 samples. All samples were taken directly from the outcrop and contained well preserved assemblages of palynomorphs.

Based on the miospore assemblage, the age of the samples was established as VF (*Diducites versabilis* – *Grandispora facilis*), which corresponds to the Middle/Upper Famennian.

Palynofacies analysis was done as well. The ratio of marine (acritarchs and prasinophytes) and terrestrial (miospores, phytoclasts) components was used as a marker for palynological organic matter characterization. All samples were strongly dominated by amorphous organic matter, phytoclasts and algae (*Leiosphaeridia*). Miospores were also numerous and within them few taxa were the most common (*Auroraspora* sp., *Diducites* sp., *Grandispora* sp., *Knoxisporites* sp.). Acritarchs occurred in a very limited number. There is no significant difference in palynofacies composition of both analysed black shale horizons. In general, the upper horizon contained more miospores and less prasinophytes than the lower one. The occurrence of acritarchs together with high number of prasinophytes might indicate low-oxygen environment. Considering all palynomorphs assemblage, the depositional environment may be described as a sub-oxic-anoxic shelf.

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The early Devonian phytoclasts from the Bukowa Góra Quarry (Holly Cross Mountains, Poland)

M. Kondas, P. Filipiak, Z. Wawrzyniak

The palynological investigation was carried out on the Early Devonian clastic sediments from the Bukowa Góra (Holly Cross Mountains, Poland). Three sections were analysed in terms of palynofacies. All analysed samples contained very high abundance of plant remains, mostly miospores and phytoclasts. Beside those palynomorphs fungi, algae, nematophytes and animal remains were observed as well. Based on the palynostratigraphy the age of the samples was established as the *douglastownense-eurypterota* Miospore Zone, which corresponds to the Emsian.

The phytoclasts assemblage was highly differentiated according to their translucency (opaque/non-opaque), colour (black, dark brown-black, yellow-brown, translucent), shape (lath, equant, planar, irregular, acicular), angularity (angular, rounded, irregular) and general outline (sharp, corroded, frayed). The ratio of opaque/non opaque elements in all analysed samples was similar; all phytoclasts assemblages were strongly dominated by translucent remains. Within all the three observed sections phytoclasts assemblages were dominated by the dark-brown-pale brown remains, with sharp outline and high angularity. This indicates a relatively short transport of the material and high rate of sedimentation. The ratio of equant and lath-shaped phytoclasts might suggest the deposition close to the fluvio-deltaic source area. Almost all of the observed phytoclasts were not degraded, which is a typical feature of proximal, oxic environments.

To sum up, the depositional environment can be described as a marginal marine/alluvial one.

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The earliest known record of the genus *Plagioptychus* (rudist Bivalvia) in the Cenomanian of the Bohemian Cretaceous Basin and its role in the Coral-Rudist Lithosomes

B. Křížová, M. Radoň, J. Sklenář, M. Košťák

One of the essential tools to determine the stratigraphy of a locality is biostratigraphy. Stratigraphic ranges of palaeontological taxa are crucial for biostratigraphic calibration. Rudist bivalves represent one of the prominent Cretaceous fossil groups. Ongoing research have provided a number of new discoveries that contribute to refine stratigraphic ranges of rudist genera and species. Additionally, all three easily distinguishable rudist eco-morphotypes are typical for different types of substrate and different environments. Therefore, the rudist bivalves are frequently used as an important tool for palaeoecological reconstructions. In our study, we used rudists for biostratigraphic and palaeoenvironmental analyses at two localities in the northwestern Czech Republic. The localities of this area have been the subject of numerous scientific studies for almost two hundred years. However, the stratigraphic interpretation remains unclear and no palaeoecological reconstruction is available. Recent comprehensive studies on rudist stratigraphy, narrowing the stratigraphic ranges of several taxa, allowed us to assign our localities to the upper Cenomanian. Moreover, within the studied fossil material, we identified one species with uncertain first occurrence (FO). Since we had determined the stratigraphic position of the localities, we had to re-define the FO of the rudist species *Plagioptychus haueri* (Teller, 1877) and consequently the entire genus *Plagioptychus*. In addition, we were able to classify the studied communities. We assigned them into the rank of palaeoecological group “Coral-Rudist litohosomes”, based on co-occurrence with diversified coral assemblages. This group has been exclusively reported from the post-Cenomanian deposits. In agreement with our ascertainment on the stratigraphy, we show that the studied communities correspond to the earliest Coral-Rudist Lithosomes known. Additionally, using our newly collected and carefully interpreted data we have made a pilot palaeoecological reconstruction of the localities in the area under study. Altogether, our stratigraphic and palaeoecological analyses assign the species *Plagioptychus haueri* to its stratigraphic and palaeoenvironmental range.

A preliminary assessment of lateral semicircular canal orientation in flying birds using geometric morphometrics

J. Lazcoz-Cornago, J. Marugán-Lobón

The inner ear encompasses three semicircular canals that act as a physiological accelerometer to stabilize gaze, by informing the brain about the position of the head while in locomotion. The 3D spatial organization of this system of canals within the skull is such that each canal is oriented orthogonally to each other. The orientation of this entire system relative to head structure, however, varies interspecifically in birds and dinosaurs and it is unknown whether this differential patterning has a physiological meaning. A classic study measured the lateral semicircular canal (LSC) orientations in a few species of birds and proposed that the LSC tended to be held horizontal when the animals were in alert, but statistical analyses of these data refuted this hypothesis. Moreover, the known physiology of this organ implies that if its position is related to head morphology and/or head posture, it is more likely that this pattern is related to locomotion (*e.g.*, active flight). To test this hypothesis, a digital sample of pictures of flying birds in lateral view was collected from the internet (N=275) and processed using geometric morphometrics to standardize the position of their heads in flight. Thereafter, the posture of the LSC measured in alert in each bird species was assessed according to their corresponding orientation in flight using multivariate statistics. The obtained results showed that the range of orientations of the LSC in flight is as high as it is when the animals are in alert (more than 55 degrees between most extreme cases), showing that there is no preferential orientation of this organ in birds in any of these activities. Consequently, it is probable that the orientation of the LSC in birds and non-avian dinosaurs is structurally related to changes in skull morphology, and that its physiology may not be affected by head orientation.

Can the fossil record of insects and dinosaurs show their coevolution patterns?

A. Łazuka

Dinosaurs have inhabited the the Earth for the last 250 million years. Their main radiation took place in the Jurassic but the highest biodiversity is known from the Cretaceous. On the other hand, the oldest insect fossil record dates back to Early Devonian, about 400 Mya, with all modern groups of insects known since the Mesozoic. The number of Insecta families always outnumbered the number of coexisting tetrapod families, which may indicate that their influence on terrestrial vertebrates was considerable. It has been shown that there were numerous interactions between dinosaurs and insects.

One interaction is the presence of insects within dinosaurs' scats. Scarabaeoidea superfamily members have been identified thanks to the ichnofossils within coprolites. Other example are mecopterans (scorpionflies), one of the most numerous flying insects during the Mesozoic. Some of them bear numerous adaptations to a parasitic lifestyle in feathers. Another parasitic insects are Siphonaptera (fleas). Mesozoic fleas possibly evolved together with small mammals, but there is the possibility that they were also able to feast on dinosaurs. At the same time, there were dinosaur species known to be adapted to insectivory, like *Shuvuuia deserti.* This species possessed characteristic upper limbs as well as narrow snout, which are ideal to break termite nests.

Insects and non-avian dinosaurs lived together for more than 180 million years. As these animals developed many sophisticated interactions, they may have affected each other. Thanks to rare fossils showing these interactions, we can study these connections. It is worth to mention that these groups always had enormous importance for the fauna and flora.

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Evolutionary trends in Polyxenida (Miriapoda: Diplopoda): promoters and constraints of morphological change

E. K. López-Estrada, P. C. Rodríguez-Flores

Determining the main drivers of morphological change is one of the major goals of evolutionary biology. Some authors consider ecological pressures as the foremost driver of phenotypic evolution. However, the existence of organisms with highly conserved body plan for hundreds of millions of years somewhat challenges this idea. Paradoxical as it may appear, understanding the causes of morphological stasis could help deepening in the causes of morphological evolution. Here, we studied a case of opposite modes of morphological evolution in the order Polyxenida. This order encompasses less than 200 extinct and extant species, which display a highly conserved general body plan, with the first fossils of these millipedes being from the Lower Cretaceous and already displaying a body plan comparable to extant species. Nonetheless, some characters and structures greatly vary among taxa and clades. For instance, the evolution of the number of ommatidia per eye seems to be under a more relaxed process with multiple changes within subclades. Here we aimed to identify the evolutionary mechanisms that have acted as constraints of the general body plan, and as promoters of the lost and gain of some structures like the ommatidia. To this goal, we estimated phenotypic evolutionary rates and measured the fit of some characters such as tergite and ommatidia numbers to several models of trait evolution using a recently published phylogeny for the order, and incorporating to the analyses all the information available from the fossil record to increase the inference power of these methods.

An assessment of limb morphological disparity and integration in the macroevolutionary transition from non-flying maniraptorans to crown birds

S. M. Nebreda, M. Hernández Fernández, J. Marugán-Lobón

Limbs are one of the most studied structures in maniraptoran dinosaurs because of their importance in locomotion and flight evolution. The relationship between the evolution of locomotor modules (*i.e.*, limb modularity and morphological integration) has a fundamental importance on the evolvability of maniraptoran clades. Here, we used a novel morphometric approach to assess the integration between forelimb and hindlimb evolution across a large sample of maniraptorans (150 specimens, both fossil and extant). We transformed traditional morphometrics into Procrustes data and used the normal multivariate statistical toolkit of geometric morphometrics to determine the patterns of variation in the fore- and hindlimbs, and the covariation structure of these data. We found a starck difference in forelimb morphological organization between non-avian maniraptorans and avian grades (excluding some basal birds), whereas in the hindlimb the differences were more subtle, showing the greatest shape disparity in the neognathan legs. Interestingly, the main morphological changes in forelimbs and hindlimbs occur in the same region, whereby the autopods (hand and pes) change concomitantly, but independently between limbs. Surprisingly, covariance between forelimb and hindlimb is not statistically significant in any of the maniraptoran grades, showing a clear macroevolutionary decoupling between 'wings' and legs. First, the paravian radiation showed an early increase in forelimb disparity, whereas hindlimb variation was apparently more constrained. After, (*i.e.*, during the neornithine radiation), most of the change was located in the hindlimbs. These results suggest that similar developmental pathways act on both fore- and hindlimbs in the same way (*i.e.*, modifying the same structures), but not in the same direction. This wide and strong decoupling is enough to shape each locomotor module in a semi-independent way, according to different locomotor specialization associated with the evolution of flight and the use of the legs as a versatile limb.

The "culture of copying" in paleoart. The case of Cariamiformes, Fürbringer, 1888 (Aves, Dinosauria)

E. Manzanero

Paleoart has worked as a valuable dissemination tool of paleontological knowledge, usually systematizing its procedures to reach more efficiency. Nevertheless, there were several cases of lack of its fundamental purposes, such often happens in most popular taxons.

This issue is particularly noticeable in the case of Cariamiformes, a clade of Cenozoic theropods recurrently depicted in paleoart. Due to their fame, Cariamiformes are one of the groups more affected by the "culture of copying"; term employed to depict paleoartists making reconstructions based on previous artworks. This work analyses the consequences of the "culture of copying" in this clade, including some of its members that are sometimes informally called "terror birds". Considering that in this designation are included neognaths from different lineages, it is especially interesting to compare the appearance depicted in both, cariamiform and non-cariamiform "terror birds".

Procedures applied to depict a scientifically accurate cariamiform are shown in the case of *Llallawavis scagliai*, species chosen due to the exceptional preservation of the holotype, in order to provide an example.

Geochemical variation into *Gigantoproductus* shells and "Mg-effect" in the calculation of palaeotemperatures using $\delta^{18}O$

J. R. Mateos-Carralafuente, I. Coronado, S. Rodríguez

Stable oxygen isotopes from brachiopod shells have been widely used to calculate palaeotemperatures because they are less susceptible to diagenetic alteration (composed by low-Mg calcite). Unfortunately, numerous equations have been developed for reaching that milestone on the basis of synthetic carbonates, foraminifers, mollusc or brachiopod shells, which show large discrepancies in their calculation. In the last years, a direct relation between $MgCO_3$ partitioning and $\delta^{18}O$ fractionation was reported in synthetic calcites and *recent* brachiopod shells, which could explain the observed differences between equations. This contribution addresses the effects of Mg on the palaeotemperature calculations in the well preserved *Gigantoproductus* shells (from San Antonio section, Mississippian, Carboniferous).

Seven elements (Ca, Mg, Sr, S, Na, Mn and Fe) have been analysed into *Gigantoproductus* brachiopod shells by electron microprobe analysis (EMPA), 345 punctual analyses, 65 compositional maps of 11 regions and 45 analyses of $\delta^{13}C$ and $\delta^{18}O$ have been measured by a triple collector isotope radio mass spectrometer.

Five shell parts have been distinguished into the tertiary layer of the ventral valve according to differences in growth line spacing, named: Umbonal, Outer, Central, Anterior, Inner-Anterior, and Inner part. Moreover, variations of aforementioned elements have been encountered inthe different shell parts with more proportion of Mg and S in the Anterior part, less Ca and Na in the Inner part or more Mn in the Umbonal part. These variations may be related to the growth rate of different ontogenetic stages and therefore, it should be considered as 'vital effects'. Anterior and Inner-Anterior parts have the highest $MgCO_3$ proportions and on the contrary the Inner part the lowest proportion. A difference of ~0.47 % mol of $MgCO_3$ between the shell parts was measured, which implies an additional variation of +0.08 ‰ in $\delta^{18}O$ produced by such 'vital effects'.

Nannoplankton of Campanian deposits of the Crimean plain and Near-Sivash region

L. Matlai

In the last classification, the Campanian stage in the International Commission on Stratigraphic is divided into three substages. However, no official recommendations concerning the basic markers for the boundaries of the Middle Campanian and near-boundary strata are currently available. Therefore, we mention the attempts to reconsider the local and regional stratigraphic schemes. The new data allow us to make the location of the Campanian deposits more precise in a section of stratigraphic levels by the nannoplankton in the sections of Genicheskaya-5 and Kashtanovskaya-1 boreholes.

In the marls on the interval 1963-1967 m of Genicheskaya-5 boreholes, we have determined the following nannoplanktonic complex: *Arkhangelskiella cymbiformis*, *Reinhardtites levis*, *Zeugrhabdotus biperforatus*, *Biscutum magnum*, etc. (UC13 zone of the Early Campanian). We have established the first occurrence of the species *Broinsonia parca parca* in the marls on the interval 1941-1945 m and the species *B. p. constricta* on the interval 1922-1926 m. The limestone complexes on the interval 1834-1945 m of the borehole belong to the nannoplanktonic zones UC14-UC15 (of the upper part of the Early – Middle Campanian). The maximum of a transgression of the sea basin is observed on the interval 1829-1971 m of Genicheskaya-5, and the above-lying deposits testify to the completion of a single sequence of the accumulation of deposits. In limestones on the interval 1553-1714 m of Kashtanovskaya-1, we have found the complex with the species *Reinhardtites anthophorus*, *Broinsonia parca parca*, *B. p. constricta*, *Eiffellithus eximius*, *Zeugrhabdotus biperforatus*, *Markarius inversus*, *Prediscosphaera stoveri*. (UC15 zone in the volume of the Middle Campanian – lowermost strata of the Late Campanian).

At the present time, the available data give no possibility to reliably separate the deposits of the Middle Campanian.

Upper Cretaceous fauna from southern Poland – new data on lesser known groups

D. Mazurek

Recent research efforts in the Bohemian and Saxonian Cretaceous basins, carried out by various students, resulted in a new wave of descriptions and redescriptions of lesser-known macrofaunistic elements from these settings. Studies on Cretaceous fauna in southern Poland, on the other hand, were up to now mainly devoted to biostratigraphically important groups (inoceramid bivalves, ammonoid cephalopods), or groups that are diverse and/or represented by character-rich remains (*e.g.* sponges, echinoids). This kind of bias is generally widespread in paleontology, with groups such as starfish, ophiuroids, cirripeds and some bivalves, being the scientific focus of only few specialists, even though these fossils are often common, when specifically probed for. The present author announced some initial findings on these lesser known groups, based on a material from Opole (Turonian-Coniacian) and Kraków (Campanian), at the 3rd IMERP, held in Poland. Herein, new data from Opole concerning: 1) asterozoans, 2) scalpellid-dominated cirripede assemblage, 3) early representatives of unnamed (Xylophagaidae plus Teredinidae) bivalve clade, and 4) a unique rudist bivalve specimen collected in 2018, are being presented with greater insight.

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Biochronological position of Batallones 4 among the Cerro de los Batallones fossil system based on the evolutionary state of *Hispanomys moralesi*

V. Medina-Chavarrías, A. Oliver, P. López-Guerrero, P. Peláez-Campomanes, M. Á. Álvarez-Sierra

The Cerro de los Batallones fossil system is composed of nine pseudokarstic fossiliferous localities of Late Miocene age located on the vicinity of Torrejón de Velasco (Madrid, Spain). The evolutionary state of the cricetid *Hispanomys moralesi*, evidenced that the cavities of the Cerro de los Batallones were not filled synchronously, but one after the other, beginning with the southern side of the butte (Batallones 10) and progressing towards the north, being Batallones 3 the youngest locality.

The aim of this work is to test the latter hypothesis studying the cricetid remains from Batallones 4, a site geographically intermediate among the previously studied localities that, therefore, should present an evolutionary state intermediate between the southern and northern assemblages. We describe the new abundant material of *H. moralesi* found in Batallones 4 (129 molars, nine lower jaws, ten maxilla fragments and four skull remains) using morphometrics. We compare this new assemblage with the ones found in other sites within the butte (Batallones 1, 3, 5 and 10) by taking into account dental traits such as the development of posterolophids and anterolophids, the presence/absence of a mesolophid and the number of roots of the upper molars.

The obtained results showed that the evolutionary stage of the fossils from Batallones 4 are slightly more modern than the specimens from Batallones 10, and also have more primitive features than the ones from Batallones 1, 3 and 5.

These results highlight the potential use of *Hispanomys moralesi* (and therefore other small mammals with similar traits) as a tool which can be used as high-resolution biochronological indicator that can help us to relatively date fossil sites.

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First record of *Macaronichnus* in contouritic sediments: palaeoenvironmental implications

O. Miguez-Salas, F. J. Rodríguez-Tovar, W. de Wenger

The present study reports the first record of the trace fossil *Macaronichnus* in contourite deposits, from upper slope to outer shelf, in the late Miocene Rifian Corridor (Morocco). *Macaronichnus* is a typically shallow marine deposit-feeder trace fossil related with the activity of opheliid polychaetes in high to intermediate latitudes. Thus, *Macaronichnus* has been considered as indicator of shallow marine environments. The present study shows for the first time an abundant and well-preserved record of large *Macaronichnus* from the deep-sea environment. The specimens are 7–15 mm in diameter with straight to slightly sinuous burrows. They are preserved as endichnia without predominant orientation with respect to the stratification. The burrows are actively filled by slightly light-coloured sand with respect to the darker surrounding mantle. We suggest that the occurrence of abundant large *Macaronichnus* can be related with bottom current activity determining nutrient-rich waters fluxes carried out along the Rifian Corridor through the Mediterranean-Atlantic gateway. The study remarks the importance of bottom currents on ecological and depositional conditions and its incidence on the macrobenthic tracemaker community, determining the presence of *Macaronichnus* producers in deep-sea environments with high nutrient availability at the seafloor. This new record of *Macaronichnus* has significant implications, providing valuable information for oceanographic and environmental reconstructions in the complex deep-sea environment.

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Planktonic foraminifer stable isotopes record of the Early Pleistocene glacial-interglacial cycles at the SW Iberian Margin

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The transition of the Late Pliocene to the Early Pleistocene (3.4 – 2.3 Ma) is characterized by the initiation of the Northern Hemisphere glaciation. It has been suggested that physicochemical changes in the Mediterranean Overflow Water (MOW) may have played a significant role in modifying thermohaline circulation in the Atlantic Ocean during this transition. This work is part of the project CINNAMOW, which is examining the mechanisms that caused this climatic transition, by studying the sediments of the SW Iberia margin. We are using sediments from Site U1391 recovered during Expedition 339 of the Integrated Ocean Drilling Program (IODP). This Site offers a good record of the Early Pleistocene, which could give information to compare and link the variations of MOW with regional climate changes. Within the CINNAMOW project geochemical analysis ($\delta^{18}O$, $\delta^{13}C$, and Mg/Ca) in benthic foraminiferal tests were performed with the final purpose of inferring the temperature and salinity variations of this locality, as well as to generate a precise age model. The object of this work is to obtain isotopic data of $\delta^{18}O$ and $\delta^{13}C$ in planktonic foraminiferal tests of Early Pleistocene marine deposits to evaluate temperature and salinity fluctuations of the sea surface. We used the species *Globigerina bulloides* d'Orbignyi, 1826 and *Globigerinoides ruber* (d'Orbignyi, 1839) to obtain a record of climatic fluctuations in the Iberian Margin during the first glacial-interglacial cycles of the Pleistocene. We also compared the sea surface data with the bottom water record obtained with the benthic foraminifera *Cibicidoides pachyderma* (Rzehak, 1886) to explore the coupling between sea surface and deep water conditions.

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Extraordinary Palaeontological sites at reach: musealization project of the Upper Cretaceous sites of Tamajón (Guadalajara, Spain)

S. Ozkaya de Juanas, J. Audije-Gil, F. Barroso-Barcenilla, M. Berrocal-Casero, M. Segura

Outreach is a fundamental step in Earth Sciences. It helps not only to inform the scientific community about recent findings, but also allows society to be aware of what is going on with the Palaeontological Heritage. In addition, it enables the participation of the public in Geoconservation by raising awareness about the importance and relevance of this heritage. Furthermore, Geotourism promotes the economic development of depressed rural areas. In this way, an innovative musealization project is currently under development to show the palaeontological richness of Tamajón (Guadalajara, Spain). The Upper Cretaceous sites of the locality include numerous land plant remains, an extraordinary concentration of crocodyliform tracks (numerous sets of isolated digit impressions and, at least, two trackways), a footprint probably produced by a theropod dinosaur, and several fish fin traces (*Undichna unisulca*). They also yield diverse scleractinian corals, bryozoans, brachiopods, molluscs (many bivalves, gastropods and ammonites, and a nautiloid), echinoderms (echinoids), and decapod crustaceans, together with osteichtian and chondrichthyan fishes, and marine reptiles, among many other remains. The high scientific, educational and outreach values prompt through these sites will be displayed at the future Interpretation Centre of Tamajón, including fossils, replicas and didactical resources, considering that one of the main objectives in this outreach is to raise awareness about the need of conservation and preservation of the Palaeontological Heritage. This will be done by numerous activities, some of them already designed and put into practice by the first author, such as the project "Paleosenses: Discovering the Upper Cretaceous of Tamajón (Guadalajara, Spain)" and "Palaeontology and its Didactics in Primary Education: designing and applying activities based on Cretaceous Sites and their fossils".

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Head pholidosis of giant lizards of the genus *Gallotia* (Boulenger, 1916)

S. Palacios García, C. Castillo Ruiz, P. Cruzado Caballero

The Canary Islands correspond to an archipelago of volcanic origin located in the northwest Africa. In these islands, there is an endemic group of lizards that belong to the genus *Gallotia (Boulenger, 1916)*, which comprises seven extant and two extinct species. In this work the pholidosis of the skull of the giant species was studied: *Gallotia stehlini* (Schenkel, 1901) from Gran Canaria; *G. simonyi* (Steindachner, 1889) from El Hierro; *G. bravoana* (Hutterer, 1985) from La Gomera; and *G. intermedia* (Hernández *et al*., 2000) and *G. goliath* (Mertens, 1942) from Tenerife. The pholidosis of *G. goliath*, the extinct species, could be studied thanks to the mummified remains that were found in the volcanic tubes of Tenerife, where the temperature and humidity conditions perfectly preserved the scales. All these lizards have scales that help to differentiate between species. *G. simonyi* and *G. goliath* are the most similar species in number, size and position of the scales, while *G. stehlini* differs from the rest, which is consistent with previous studies. These results allow to recognize and differentiate between species of the same genus and will help us support the evolutionary trees made so far.

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Dental microwear as a proxy for trophic inferences on extinct species: Sharks as subject of study

M. V. Paredes-Aliaga, C. Martínez-Pérez, A. Romero, H. Botella.

In the absence of other data, dental morphology is typically used to predict about the trophic ecology and the role of a species. However, there are numerous studies that provide a limited support to the belief that dental morphology is a good predictor of them. In contrast, dental microwear, a technique that enables to link the stretchmark patterns produced by the food and its physicals properties of them, enables to make trophic inferences in a quantitative way. This technique has been applied to a wide variety of taxa and has been proved useful to know the dietary preferences and to study niche diversification, as well as to determine which changes on the diet of a group have marked the evolution of certain characters. Nevertheless, dental microwear has never been applied to the group of sharks. In a first attempt to bring this technique to extinct species, we have created a framework for comparison with current species using technique of dental microwear. To this end, we have made replicas of 22 specimens, deposited in the Cau del Tauró (L'Arboç, Tarragona) museum, which have been photographed using a scanning electron microscope and subsequently analysed by quantifying the present microstrips to relate the patterns according to the diet of each species. Our results show that the technique can be applied to this group, that there are patterns that relate diet and microwear and that this technique provides further morpho-functional inferences. Therefore, the importance of this technique applied to extinct shark species in future studies is highlighted, since most of the trophic inferences in the group of sharks have been solely based on dental morphology.

Pareisactus evrostos, a new basal iguanodontian (Dinosauria: Ornithopoda) from the Upper Cretaceous of southwestern Europe

J. Párraga, A. Prieto-Márquez

We describe a new genus and species of a basal iguanodontian ornithopod dinosaur, *Pareisactus evrostos*, from the lower Maastrichtian strata of the Conques Formation in the south-central Pyrenees of northeastern Spain. This animal is solely represented by a scapula characterized by having a dorsoventral extent of the proximal constriction as deep as it is thick; a lateral surface of the proximal region of the scapula under the acromion process forming a deep and thick roof over an extremely deep deltoid fossa; and an elongated apex of the glenoid that accounts for half of the maximum depth of the proximal region of scapula. *Pareisactus* is recovered as a member of Rhabdodontidae, sharing with *Rhabdodon* a well-demarcated deltoid ridge. *P. evrostos* represents the seventh species of rhabdodontid in Europe and the third specimen of this endemic clade of European iguanodontians in the eastern Tremp Syncline of the southern Pyrenean region. The finding of *Pareisactus* documents yet another instance of co-occurrence of rhabdodontids and hadrosaurids during the final stages of the lower Maastrichtian of southwestern Europe.

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Late Maastrichtian fossil association of Veracruz 1 site (Veracruz, NE Spain): where the land met the sea

M. Pérez-Pueyo, V. Gilabert, M. Moreno-Azanza, E. Puértolas-Pascual, B. Bádenas, J. I. Canudo

Late Cretaceous outcrops of the southern Pyrenees (Huesca province, NE Spain) have yielded relevant findings about the last tetrapods that inhabited North Iberia before the K/Pg extinction event. Maastrichtian deposits in this area correspond to the lower part of Tremp Fm, which is divided in two informal units: '*Grey Garum'*, formed by marls and limestones deposited in transitional environments; and the overlaying '*Lower Red Garum'*, dominated by continental mudstones and sandstones, but with signs of tidal influence.

The present work focuses on the analysis of a new fossil site of the Tremp Fm, Veracruz 1 (VE1), situated in the upper part of the *Grey Garum*. The fossiliferous level is a metric bed of bioturbated grey marls with plant remains. It includes a rich fossil association of invertebrates, vertebrates and microfossils. Vertebrates are represented by osteichthyans, testudines, crocodylomorphs and hadrosaurid dinosaurs. The latter are represented by eggshells fragments, identified tentatively as *Spheroolithus aff. europaeus*, and isolated bones, with clear evidence of resedimentation. Invertebrate fossils include bivalves, gastropods, crabs and bryozoans, denoting marine influence. Sample sieving allowed to recover charophyte gyrogonites and planktic foraminifera. The latter are very scarce but they are compatible with a Maastrichtian age for this site and the nearby sections dating.

VE1 could be interpreted as a low-energy, transitional-shallow marine environment (*e.g.* lagoon), with fine-grain, mixed sedimentation. This environment was inhabited by a rich community of invertebrates, receiving occasionally remains of terrestrial vertebrates from the continent, which were resedimented there. Due to its location in the area where the land met the sea, VE1 allows to establish part of the diversity of the Late Maastrichtian terrestrial and marine ecosystems in this part of Iberia.

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Late Pleistocene bats (Mammalia: Chiroptera) from Loutra Almopias Cave (Pella, Macedonia, Greece): preliminary results

P. Piskoulis

Loutra Almopias Cave (LAC) has been extensively excavated over the past years, yielding a rich fauna, which includes mainly ursid remains, but also other large and small mammals, reptiles, amphibians, birds and fish. Amongst the numerous small mammals, a significant number of chiropteran specimens is also present (over 7000), and they are currently under study. Chiroptera is an understudied group in Greece; therefore, this research aims to become the first complete study of this group in Greece and here some preliminary data is presented.

Six chambers were excavated: LAC I, LAC Ib, LAC Ic, LAC II, LAC III and a very small chamber (LAC Ia), which is located northeastern of chamber LAC I and ~5 m higher than the chamber's floor. The sediments from LAC Ia chamber are of Latest Pleistocene age, whereas the sediments from the cave's floor are from the Late Pleistocene. The results from the study of the bats collected from the cave's floor sediments are presented here.

3375 specimens have been collected and studied (dental elements and humeri) under a JENA stereo microscope with x10 eyepieces. The morphological features of the recovered specimens, based on qualitative analysis, indicated the preliminary presence of 20 taxa: *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros*, *Rhinolophus euryale*, *Rhinolophus mehelyi*, *Rhinolophus blasii*?, *Rhinolophus* sp., *Myotis myotis*, *Myotis blythii*, *Myotis bechsteinii*, *Myotis emarginatus*, *Myotis myotis*/*blythii*, *Myotis* sp., *Nyctalus leisleri*, *Nyctalus noctula*, *Pipistrellus pipistrellus*, *Pipistrellus kuhlii*, *Eptesicus serotinus*, *Barbastella barbastellus*, *Miniopterus schreibersii* and Chiroptera indet. It should be noted that the bat fauna from LAC is possibly one of the richest and most diverse in Greece until today.

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Cave hyena's role in European Upper Pleistocene ecosystems

P. Portnicki, A. Marciszak, J. Ślimok

Cave hyena *Crocuta crocuta spelaea* (Goldfuss, 1823) was an extinct, larger subspecies of the modern spotted hyena *Crocuta crocuta* (Erxleben, 1777), which was widely distributed across Eurasia in the Middle and Late Pleistocene. The cave hyena was usually regarded as an aggressive scavenger and kleptoparasite, but it was also an active hunter and one of the top carnivores in Eurasian paleocommunities. The main competitors of the cave hyena were the cave wolf *Canis lupus spelaeus* (Goldfuss, 1823), the cave lion *Panthera spelaea* (Goldfuss, 1810) and the steppe bear *Ursus arctos priscus*. The species is known from numerous Eurasian sites, however climate changes, habitat loss and increasing competition with wolf and humans led to their extinction ca 15 ka BP.

In the Late Pleistocene, this species is known for using caves as shelters in which they raised their cubs and stored meat portions of scavenging and hunting animals. This activity has made them the main taphonomic agents among large Late Pleistocene carnivores, together with human and leopard. Particularly massive dentition and immense development of jaw muscles allowed the cave hyena to crush even the bones of giant pachyderms like mammoths and rhinos. This behaviour is well documented in hundreds of Eurasian Late Pleistocene caves, where bones with signs of the hyena's activity (crushing, digesting, cracking etc.) mixed with coprolites and young hyena remains clearly confirmed the site as a hyena den. Studying cave hyena remains from sites like Biśnik cave can provide useful data about the paleoecosystems in which they lived.

Homo erectus paleoenvironments in the early Pleistocene Denizli Basin: an integrated paleontological, sedimentological and geochemical approach

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The early Pleistocene travertines from the Denizli Basin (Turkey) that host the only one known *Homo erectus* from Anatolia (Kocabaş) are laterally interfingering with a succession of shallow, alkaline lake deposits. We studied the sedimentary succession, micro- and macropaleontology of the deposits and stable isotope compositions ($\delta^{18}O$ and $\delta^{13}C$) of the mollusc shells in order to reconstruct paleoenvironments for these early hominins and explore the opportunities and limiting landscapes providing their life. Three units are defined in the upper part of the Quaternary succession which consists of a partially coeval succession of shallow lake carbonates, bedded fine-grained carbonates and travertines. The age of the studied fossiliferous travertine units is constrained by a variety of approaches between 1.2 and 1.6 Ma. The vertebrate fossils (*Archidiskodon meridionalis*, *Palaeotragus*, *Metacervoceros*, *Cervalces*, *Stephanorhinus* and two species of *Equus)* including *Homo erectus* derive from the uppermost travertines that formed at the shore of a shallow alkaline lake. The ostracods derived from the underlying lake deposits are abundant and well preserved. The assemblage consists of a mixture of brackish or strongly alkaline taxa (*e.g. Cyprideis*, *Tyrrhenocythere*, *Loxoconcha* and *Amnicythere*) together with fresh water ostracods (*e.g. Candona*, *Pseudocandona*, *Eucypris*, *Lineocypris*). The molluscs from the shore zone deposits experienced diagenetic alterations, probably caused by the travertine forming process, resulting in a unique recrystallization. Both ostracod and mollusc associations suggest the presence of an anomalohaline (or strongly alkaline) lake setting, constraining the habitat of the *Homo erectus*. The presence of travertine terraces next to the alkaline lake may have posed challenges on hominin occurrences, their habitat and landscape adaption.

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The gorges of the rivers Huécar and Júcar: a geological educational route adapted for Primary School children

I. Rodríguez-Castro, I. Prieto

The shortage or even the absence of Geology in schools' syllabus, especially during Primary School, creates the necessity of resorting to dissemination and outreach tasks, in order to raise public awareness and mitigate the lack of interest in Earth sciences observed during childhood. It has been proven in numerous occasions the importance of outdoor activities when it comes to geological dissemination and education. Multiple recent outreach experiences have had positive outcomes, even though most of them were aimed at teenage and academic audiences, leaving out younger children. The city of Cuenca has a privileged position when it comes to this kind of outreach activities, due to its location being classified as a "LIG" (a place protected because of its special geological value) because of the spectacular gorges of the rivers Huécar and Júcar. Here we suggest a series of activities and games aimed at adapting an educational route previously designed by Geodiscover through these gorges to a walkthrough with primary school children (five to twelve years old). It is a 4.6 km long circular course close to the city of Cuenca, with several programmed stops and breaks to give explanations and conduct the activities. The aim of this proposal is that the children learn a bit more about the fieldwork of a geologist, his tools and methodology, the formation of the landscape, sedimentary rocks and fossil record, and geological hazards, in order to increase their curiosity about the nature and the environment that surrounds them. To this purpose, several children's games, riddles and tests of geological content will be proposed, so that the children can get involved with the activities and not be passive spectators.

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Changes in bottom water conditions at the SW Iberian Margin during the Early Pleistocene based on benthic foraminiferal assemblages

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The Pliocene-Pleistocene transition represents one of the major climate changes in the history of planet Earth. This transition was characterized by a shift from a warm climate with high atmospheric CO_2 concentrations to a colder climate with high amplitude glacial-interglacial cycles that gave rise to the Northern Hemisphere glaciation (NHG). The present work belongs to the CINNAMOW project, which is assessing the potential role of the Mediterranean Outflow Water (MOW) in this climatic transition by analysing the IODP Site U1391 sediments. Site U1391 is located in the pathway of the MOW at the Southwestern Iberian margin. It was drilled in 2012 during the IODP Expedition 339, aboard the scientific drilling vessel *JOIDES Resolution.* Here, we present benthic foraminifera assemblages from the Early Pleistocene, between Marine Isotopic stages (MIS) 101 to 97, to better understand changes in deep water conditions such as oxygenation and nutrient concentration and their relation to MOW oscillations. We performed cluster and factor analyses to study the variations in the foraminiferal assemblages to assess palaeoenvironmental changes over time. The data obtained from benthic foraminifera assemblages were combined with geochemical analyses on the epifaunal benthic foraminifer *Cibicidoides pachyderma* (δ18O, δ13C and Mg/Ca). Our results show that the assemblages at this site are mainly determined by local export of sea surface productivity linked to seasonal upwelling periods. Furthermore, an increase in oxygen concentration during interglacial stages seems to be related to periods of enhanced influence of the MOW at the studied site.

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Graphoglyptids from Miocene sediments of Cyprus: ichnological criteria for identification of turbidites in a mixed succession

F. J. Rodríguez-Tovar, O. Miguez-Salas, F. J. Hernández-Molina, H. Hüneke

The ichnological analysis of the Pakhna Formation at the Agios Konstantinos section (Miocene, Cyprus), reveals, for the first time, the presence of graphoglyptid structures. The Pakhna Formation consists of a mixed succession dominated by pelagic/hemipelagic sediments, together with contourite, reworked turbidite, and turbidite facies. Thus, a complex interaction between pelagic, bottom-current and gravitational processes is envisaged. The differentiation of facies is sometimes difficult in outcrop, based principally on stratigraphic and microfacies features. The record of several specimens of *Helminthorhaphe*, as components of the graphoglytid group, supports the presence of turbidites and facilitates their distinction with respect to other facies. Identification of the *Nereites* ichnofacies, consisting of graphoglyptids, reflect rapid/short changes in paleoenvironmental parameters related to turbiditic episodes, in a context of background environmental conditions associated with the dominant *Zoophycos* ichnofacies. This record offers significant advances in the study of bottom-current and gravitational processes through outcrop examples.

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Paleogeography and paleoecology of Nova Varoš

B. Šaković, A. Savković

The paleontology, paleoecology, stratigraphy and sedimentology of Nova Varoš were examined to better understand the historical geology of this location. Laboratory and paleontological materials were analyzed - both based on previous research as well as field observations carried out in the wider area of Nova Varoš. The obtained results suggest that the sediments of this area were formed during the Triassic, Jurassic, Paleogene and Miocene. The analyzed terrain was created in different sedimentation conditions. The geology of the area comprises limestone, marl, chert and granodiorites. The Jurassic rocks of the area contain radiolarians of *Striatojaponocapsa conexa* and *Protunum turbo*. In addition, the Miocene sediments contains microfauna of the following ostracod species: *Mediocypris* sp., *Limnocythera* sp.

Preliminary palaeoenviromental characterization results of the Paracuellos-3 and Paracuellos-5 sites (Middle Miocene, Madrid Basin, Spain)

J. Salas-Herrera, P. López-Guerrero, O. Fesharaki, I. Menéndez, M. Á. Álvarez-Sierra

A series of palaeontological studies (characterization of dental mesowear of ungulates and body size community structure analysis) of the Paracuellos-5 (13.7 Ma) and Paracuellos-3 (12.8 Ma) fossil sites have been carried out in order to characterize the middle Miocene environment of Paracuellos del Jarama (Spain). The analysis of the dental mesowear was performed on 13 molars and premolars of even-toed ungulates, examining the dental crown height and the buccal apices of tooth cusps. We also used the body size structure of the Paracuellos community to infer quantitative data on temperature and aridity, based on 19 climate inference models, previously stablished by other authors. The results show that, the environment in Paracuellos, during the middle Miocene, experienced a significant change, starting from an arid savannah-like environment (Paracuellos-5 site); towards a slightly more wet conditions, with open environments coexisting with dry tropical forest areas (Paracuellos-3 site). These results provided a more complete idea of the changes registered in the Madrid Basin during the Miocene.

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Preliminary results of the histological bone study the family Plagiosauridae

M. Samborska, E. M. Teschner, D. Konietzko-Meier

Plagiosauridae is a family of extinct amphibians belonging to the order of Temnospondyli. So far, six genra have been identified: *Gerrothorax, Megalophthalma, Plagiosternum, Plagiosaurus, Plagioscutum* and *Plagiobatrachus*. These were Triassic vertebrates living in water reservoirs. This Temnospondils were distinguished from other Temnospondils by a wide, flat skull with large orbits and a strongly flattened body with short limbs. One of the elements of the skeleton of *Gerrothorax pustuloglomeratus* is the presence of arches, which implies the existence of gills in individuals living in the Triassic period. The relationships within this family are still not completely understood.

One of the methods used to study the relationship between species is paleohistology. Admittedly, there is still much controversy as to whether bone microstructure can help to elucidate phylogenetic relationships or if it is rather the result of inter-environmental interactions.

Twenty-three microscopic cuts made of skin bones - clavicle, interclavicle and osteoderms - of the *Gerrothorax* and *Plagiosternum* genera from the Triassic of Germany and Russia were analyzed. Macroscopic and microscopic analysis of the samples allowed us to generate a graph showing common features and differences at the level of Plagiosauridae family.

It was often not possible to differentiate into the three layers typical for skin bones (external cortex, internal cortex and porous layer) because the whole bone has a homogeneous structure.

All bones of Plagiosauridae, regardless of geological age and taxon, are characterized by high primary porosity, which indicates a relatively fast growth rate.

In all samples the rate of bone remodeling is low. the different structure of the skin bones from other Tempospondyls could be the result from their different biology (preserved gills) and probably neoteny.

Mammalian isotopic biogeochemistry of the Ventian Corral de Lobato locality (Guadalajara, Spain)

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We investigate resource and habitat use by means of biogeochemical analyses at the Spanish Ventian locality of Corral de Lobato (MN13, Late Miocene) situated near Molina de Aragón (Guadalajara, Spain). We selected 47 tooth enamel samples from medium and large-sized mammalian species (~16-2350 kg) and carried out carbon and oxygen isotope analyses on the carbonate fraction of bioapatite ($\delta^{13}C_{CO3}$ and $\delta^{18}O_{CO3}$, respectively). We analysed eight species: *Hipparion concudense*, *Dihoplus schleiermacheri*, *Tragoportax gaudryi*, *Gazella deperdita*, *Pliocervus* aff. *matheroni*, *Hippopotamodon major*, *Adcrocuta eximia* and *Thalassictis hipparionum*. Herbivore and omnivore $\delta^{13}C$ values point to a continuum from woodland-mesic C_3 grassland to open woodland-xeric C_3 grassland. Tooth enamel $\delta^{18}O$ values indicated to different hydrological conditions and/or water economy among the studied taxa. The results obtained from predator–prey interactions, statistical *post-hoc* tests and a mixed model output based on stable isotope analyses allowed us to differentiate the dietary behaviour of the hyaenids *Thalassictis hipparionum* and *Adcrocuta eximia*, with the former preferentially preying on smaller species from more closed areas (*Pliocervus* aff. *matheroni*), whereas latterconsumed larger taxa from more open spaces (*Hippopotamodon major*). The low $\delta^{13}C$ values of *Thalassictis hipparionum* suggest the existence of a missing prey.

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Fossil fauna from Risovača cave (Central Serbia)

A. Savković, M. Jovanović

In this work the fossil fauna from Risovača cave is described. This site is located near Aranđelovac, a small town in central Serbia, and it is one of the several caves in Serbia that have been affected by karstification processes. This cave, formed in Cretaceous limestone, is a significant archaeological, paleontological and speleological locality. Tectonic movements during the Cretaceous formed a crack system, moreover the erosion of underground waters spread forming channels and caves. The cave length is 114 meters, and the total length of all channels is 159 meters. Abundant fossil material of large and small vertebrates have been recovered. Around 20 species of mammals have been recognized, predominantly members of the steppe fauna: *Ursus arctos*, *Ursus speleaeus*, *Lepus* sp., *Spalax leucodon*, *Canis lupus*, *Vulpes vulpes*, *Crocuta spelaea*, *Panthera spelaea*, *Sus scrofa*, *Cervus elaphus*, *Bison* sp., etc. It is also thought that Neanderthals occupied the cave during the Middle Paleolithic based on artifacts such as leaf-shaped knives, spike, dagger made of bone and polisher that were found in the cave.

Paleontological Heritage Conservation in civil engineering. The Forestalia megaproject in Aragón

I. Segarra Oliveros

Since the first renewable energy auction was carried out by the Spanish Ministry of Energy in January 2016, Aragón has been awarded 241 wind and photovoltaic energy projects. Of these, 78 are already in construction phase, and some have been located in areas of special interest from a paleontological perspective, or very close to them. For this reason, control and monitoring work has been required during ground movements, in order to supervise and preserve the possible findings in these areas. Those works have consisted of: marking the susceptible areas to transport passage, periodic samplings and stratigraphic contextualization of the zones, as well as analysis by levigate and triage techniques.

The wind farms and photovoltaic plants are scattered throughout the Moncayo and the districts of Las Cinco Villas, Campo de Borja, Valdejalón, Campo de Cariñena, Daroca, Belchite, and the Jiloca region. Due to this distribution, the geology is highly variable, ranging from the Paleozoic to the Quaternary. Of all the aforementioned places, only Campo de Borja and Valdejalón are excluded from the control and monitoring tasks.

Therefore, it can be concluded that monitoring and supervision by a technician paleontologist in any civil engineering project is essential to preserve and protect the heritage. Even more if we consider that, in coming dates, new constructions could be carried out in the Maestrazgo Region and in the limit with Castellón, fruitful areas in terms of paleontological record.

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Making science accessible to everyone – when scientists and artists work together: the case of brachiopods

M. Simonet Roda, E. Manzanero

It is highly important to find a way to make science accessible to a non-scientific public. In a globalized world, where the interaction between different research fields is constantly growing, science needs to be understandable by other researchers and by funders. On the other hand, environments with a poor scientific background can be easily found, and this makes increasingly necessary an interdisciplinary collaboration between artists and scientist.

An important tool to make science informative is Paleoart, a discipline with the capabilities of representing scenes of ancient life using the best accuracy allowed by scientific data. Historically, paleoart has adapted its elements to generate compositions where the images of ancient life forms and their environments have a great cultural component. This situation usually implies feedback for most popular taxa, which eclipse most of the known ancient life forms in media.

In this work, we present the case of brachiopods, a group with low scientific outreach broadcasting. Funded by the European project BASE_Line Earth, scientists shared their scientific results with an international non-scientific community. The collaboration with publicity specialist and artist was key in this venture, as we observed in the results. The creation of didactic models and videos shared in public events, the work through social media or the used of self-explanatory paleoreconstructions helped to (1) increase the interest of young people in science; (2) explain the importance of science for society; (3) increase the curiosity for unknown research fields; (4) enrich scientist with the knowledge of how to share with success their data with a diverse publics; (5) improve multidisciplinary methodologies for reconstructing ancient life; and (6) build more references from the paleofauna, especially useful to paleoartists to create more complete scenery of paleobiota.

Redescription and new information on the cranium of *Euparkeria capensis* Broom, 1913

R. B. Sookias, D. Dilkes, I. Werneburg, A. Arcucci, B.-A. Bhullar

Archosaurs (crocodiles and birds) represent a major part of modern ecosystems, moreover fossil taxa dominated the land fauna during the Mesozoic. Understanding the origin of their success and astonishing radiation is thus of great importance in evolutionary palaeobiology. The taxon *Euparkeria capensis*, from the Middle Triassic (Anisian) of Eastern Cape (South Africa) has been of continued scientific interest since its description in 1913. Originally considered an ornithosuchid, it has subsequently been placed outside the crown, and has been of special interest because of its morphology placing it very close to the crown group, but the taxon possessing no features which link it to pseudosuchians or ornithodirans. This has made it an ideal outgroup widely used in a diverse phylogenetic analyses, and a potential analog for the ancestral archosaur. Here we present a redescription of the cranium of *Euparkeria*, using all available material and making full use of computed tomography scanning. The taxon was described monographically in 1965, but in the intervening years our knowledge of archosauriform evolution and imaging techniques available have improved significantly, allowing new light to be shed on the taxon. Previously uncertain anatomical details are clarified, including the presence and nature of vomerine dentition, the morphology of the epipterygoid, the arrangement of the anterior palate and the number of teeth in the premaxilla. A number of previous scorings of phylogenetic characters are corrected, including the ectopterygoid, which is found to be double-headed, and the palatal teeth, which are confirmed as forming a field rather than rows. The place of *Euparkeria* within wider trends of tetrapod evolution is considered, including the reduction in olfaction an increase in visual sensitivity, the concomitant increase in brain size, and its cranial complexity network compared to other sauropsid taxa.

Paleohistological playground at the Late Triassic locality of Krasiejów (SW Poland)

E. M. Teschner, D. Konietzko-Meier

It is known that paleohistology is an invasive method and therefore, accessible research material is very limited. However, the Late Triassic clay pit in Krasiejów (SE Poland) offers an exception. It is well-known for its numerous and well-preserved fossils which enables destructive studies of complete ontogenetic series. Long bone histology of *Metoposaurus krasiejowensis* provides new information about the animals' biology. Here we compare the growth pattern of different animals from the same locality occupying various living niches, the aquatic amphibian *Metoposaurus*, an aquatic reptile *Paleorhinus* sp., and a terrestrial *Stagonolepis olenkae*. The main aim is to analyze if the histology of various taxa from the same locality representing different life modes can provide the same environmental signal. *Paleorhinus* bones' inner cavity is empty with a thin layer of endosteal bone. The inner cortex possesses large secondary osteons and the remodeling process is advanced. Further, the tissue becomes higher organized with sparse vascular canals (zone). Following that, a thin layer of lamellar tissue with no vascular canals can be observed (*annulus*). Also, a very distinctive line of arrested growth (LAG) can be observed. At least four zones and annuli can be observed, whereas the zones are twice as wide as the annuli. In the growth pattern of *Metoposaurus*, a similar pattern is visible, however, both the zones and annuli are thick and no clear LAG can be recognized. In contrast to that are the sections of the terrestrial *Stagonolepis*. The inner cavity is also empty and a thin layer of endosteal bone is preserved. The remodeling process is more advanced. In the innermost thick zone, bunches of vascular canals are preserved. Following that the tissue becomes more parallel-fibred with less vascular canals. Interestingly, few very thin annuli are preserved. The comparison of the growth pattern of those species living at the same time in the same area but in different habitats enables to make an assumption on the environmental conditions. Both aquatic animals possess distinct zones and annuli. Here, the *Metoposaurus* was less generalistic and more adaptive to food change due to the unfavorable period (thicker annuli). The phytosaur had a more specialized diet and could not get along with the dry period. Moreover, in *Stagonolepis*, where the growth pattern resembles in wide zones and very thin annuli, it is shown, that the dry period had an impact on the diet of terrestrial animals.

Toothy grins and none akin: theropod dental diversity in the Maastrichtian of the Haţeg Basin, Romania

M.-R. Văcărescu, M. Bucur, A. Roman, Z. Csiki-Sava, Ş. Vasile

The uppermost Cretaceous (Maastrichtian) continental deposits of the Haţeg Basin have yielded a diverse and unique assemblage of vertebrates, including fishes, frogs, albanerpetontids, turtles, lizards, snakes, crocodyliforms, pterosaurs, dinosaurs, birds and multituberculates. Fossils of herbivorous dinosaurs are abundant, as opposed to the rare theropod remains, consisting mainly of isolated teeth. Nevertheless, the diverse morphologies that can be recognized within the available theropod teeth sample suggest a moderately high taxonomic diversity of small theropods despite their relatively low abundance. For a more detailed understanding of the abundance, diversity and patterns of distribution of the theropod taxa represented in the uppermost Cretaceous of the Haţeg Basin, the existing sample of isolated theropod teeth from the collections of the Laboratory of Paleontology (University of Bucharest) was studied both morphologically and morphometrically. The recorded dimensional data were statistically analyzed and plotted against a global and taxonomically comprehensive dataset, and morphospaces were generated for the main groups. Based on our results, the studied Romanian specimens cluster into three morphospaces, corresponding to three different theropod clades: Dromaeosauridae, *Richardoestesia*, as well as a new, not previously defined, morphospace. The taxonomic composition thus conforms to that identified from the Haţeg Basin (although solely on morphological grounds) in previous studies that documented the common presence of theropods referable to velociraptorines, *Richardoestesia* and *Euronychodon*. Most of these taxa have a wide geographic and stratigraphic distribution in the uppermost Cretaceous of the Haţeg Basin. The composition, and especially the relative abundances recorded within the Haţeg theropod assemblage, differ from those reported in other European fossil-bearing uppermost Cretaceous continental deposits, suggesting a high degree of intra-continental faunal heterogeneity, driven by differential local evolutionary processes. Such differences are yet another reflection of the high-level faunal provinciality that characterizes the continental faunas of the Late Cretaceous European Archipelago.

Early Pleistocene freshwater fish fauna of Copăceni (Dacian Basin, southern Romania) – preliminary data

Ș. Vasile, O. Kovalchuk

The fluvio-lacustrine Pleistocene deposits of the Dacian Basin (southern Romania) yielded numerous, but mostly isolated, megafaunal remains. Vertebrate assemblages of a higher taxonomic diversity are rare, but give information on various early Pleistocene intervals (*e.g.*, the 2 Ma-old Slatina 2, and the 1.6 Ma-old Tetoiu assemblages). A recent addition to this list is the 1.1-1.0 Ma-old vertebrate assemblage from Copăceni. Large mammals were first reported from the site, but they were shortly followed by the finding of small vertebrates, once an intensive screen-washing of the sediment was used. This led to the discovery of not only small mammals, but also the first early Pleistocene ectothermic vertebrates from the Dacian Basin, including rare reptilian as well as abundant amphibian and fish remains.

Due to the poor preservation, most fish remains are only identifiable to the level of genus, and only a handful of specimens can be tentatively assigned to species. Pharyngeal teeth and fragments of pharyngeal bones belonging to cyprinids (family Cyprinidae) are the most numerous elements found. The dental morphologies identified so far were assigned to *Leuciscus* sp., *Rutilus* sp. (two distinct species), *Scardinius* sp. (two species, one of which is morphologically similar to *S. ponticus* from the late Miocene and Pliocene of Ukraine and Moldova), *Abramis* sp., *Barbus* sp., *Carassius* sp., and *Tinca* sp. Pikes (family Esocidae) were also present at Copăceni, being represented by *Esox* sp. This fish assemblage is the only one reported so far from the Romanian Pleistocene, and adds to recent reports of Pliocene fishes from the Dacian Basin, improving the knowledge on the evolution of freshwater fish faunas in this area.

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Virtual range of motion analysis of the neck of *Amargasaurus cazaui* (Sauropoda: Dicraeosauridae)

D. Vidal, A. Serrano-Martínez, G. J. Windholz

Amargasaurus cazaui, a dicraeosaurid sauropod from the Lower Cretaceous of Neuquén (Argentina), had extremely elongated and forked cervical neural spines, a notable condition among its group. These peculiar, extremely elongated neural spines (with an orientation ranging from slightly anteriorly oriented in the posteriormost cervical vertebrae to a quite posteriorly inclined in middle to anterior ones) have led to propose several functional hypotheses. In order to test them, we have conducted a range of motion analysis using high-resolution 3D photogrammetric scans of the original fossils. To measure heights and angles in relation with the body, we have digitally mounted all preserved fossils. The osteologically induced curvature of the dorsal series, not very well preserved, compares favourably with the exquisitely preserved dorsal column of *Brachytrachelopan mesai* (another dicraeosaurid). The snout of our reconstruction is at 1.98 m above the ground in an osteologically neutral pose (higher than the 0.70 m obtained in previous studies). The prezygapophyseal facets are extremely large and antero-posteriorly elongated in all cervical vertebrae up to the cervicodorsal transition, substantially more than in *Brachytrachelopan* or other diplodocids (*i.e.*, *Diplodocus* or *Apatosaurus*). Dorsiflexion is limited due to the elongated, posteriorly directed spines, whereas ventriflexion is not. Ventriflexion allows the snout to reach the ground without dislocation or flexing/abducting the forelimbs, while maximum dorsiflexion allows a maximum height of 4.5 m. This implies that *Amargasaurus* was a medium to low browser, as previously proposed. Greater intervertebral flexibility than in other diplodocoids supports the absence of a double sail in the neck of *Amargasaurus*, as well as the ability to perform potential display and/or agonistic behaviors.

Acknowledgements: Thanks to M. Ezcurra, G. Aguirrezabala and M. Miñana (MACN) for access to the *A. cazaui* holotype and to D. Pol and E. Ruigomez for access to the *B. mesai* holotype.

A Method for the automatic digitalisation of fossils based on hardware supported image acquisition

W. Wojtkiewicz, K. Wojtkiewicz

Paleo-biology research mainly focuses on discovering and examining of fossils, which can be the remains of plants or animals, but also their traces. One of the most important aspects in this matter is the uniqueness and low durability of fossils that are doubled by their low occurrence and discoverability. The issue of durability is particularly important in the context of possible unsuitable storage of specimens that may lead to permanent damage. One has to keep in mind that some aspects of paleontological research reaches beyond visual analysis and requires activities that interfere with fossils structure. Such examinations may include histopathological procedures, which require cutting the bone to make appropriate in-depth analysis. For most paleo-biologists it is obvious to supplement a description of a fossil with some type of visualization. In early days it was mainly considered to be a drawing or a photography. Nowadays, it is increasingly common to use digital methods, that include both high-resolution photography and 3D models design. The latter is less common and can be performed with the use of laser scanners or regular photography. In order to preserve the high-quality of the models' texture, the second one is used more often. However, it the acquisition is particularly time-consuming, consisting of a series of pictures taken from different angles. The processing of images is also demanding and depends on the acquisition method. In this work, we present a method for the automatic digitization of fossils based on hardware supported images acquisition, as well as software-based 3D visualization. The idea is to use a commercial product used in digital marketing for the creation of virtual reality (VR) web content and tune it for academic research in the field of paleontological digitalisation. Tuning of the system mainly consists in choosing the appropriate parameters, such as ISO, aperture, shutter speed, etc. One of the outcomes of presented method is a 3D presentation model that can be used for either visualisation of the fossil, as well as for further processing that includes 3D mesh generation.

KEY TALKS AND WORKSHOPS

LAURA DOMINGO

STABLE ISOTOPE AND BIOGEOCHEMISTRY

BIOGRAPHY

Assistant Professor at the Faculty of Geology (Complutense University of Madrid, Spain), Associate Researcher at the Geosciences Institute (UCM-CSIC, Spain) and Assistant Researcher at the University of California, Santa Cruz (USA). She completed her BSc in Geology and PhD in Paleontology with honors at the Complutense University of Madrid and was a three-year postdoctoral fellow at the University of California, Santa Cruz. Her interests focus on the research of past environmental, ecological and climatic variability by means of biogeochemical analyses on geological and paleontological archives. She specialized on stable isotope biogeo-chemistry of Mesozoic and Cenozoic fossils and organic matter enclosed in the sediment, although she has used a range of biogeochemical proxies such as trace elements, RREs and biomarkers. Dr Domingo has participated in projects, and taken part on field campaigns in Spain, USA and Argentina. She is the co-director of the Middle Miocene Somosaguas fossil site, located at a campus of the Complutense University of Madrid. She is also a National Geographic explorer and her 2017-2018 grant focused on the investigation of the Great American Biotic Interchange from the perspective of the South American fossil record. She is very active at implementing outreach and educational activities to promote the dissemination of Science, with emphasis on children and young people. Dr Domingo is also involved in actions aimed at giving visibility to women in Science and at fostering early STEM vocations among girls. She has also been a teaching assistant within BSc and MSc studies at the Faculties of Geology, Biology and Education of the Complutense University of Madrid

Isotopic Paleontology. Paleoclimatic, paleoenvironmental and paleoecological inferences through the biogeochemical imprint of fossils

L. Domingo

The research of past climatic and environmental variability has become a powerful tool to characterize the magnitude, duration and direction of current global change, as well as to evaluate and predict potential consequences in forthcoming scenarios. The Intergovernmental Panel on Climate Change (IPCC) highlights this premise on its last evaluation report. Climatic and environmental perturbations may bring about profound biotic changes that may lead to irreversible mechanisms such as species extipartions and/or extinctions, ecosystem loss or massive migrations. The paleoarchives of the geological and paleontological record entail an enormous informative potential since i) they are rich and varied (*e.g.*, fossils, ice, speleothems), ii) they record a wide range of climatic and environmental variables (*e.g.*, temperature, precipitation, vegetation), and iii) they provide different levels of temporal and geographical information (*e.g.*, daily *vs.* seasonal *vs.* annual, local *vs.* regional *vs.* global).

The application of biogeochemical techniques on fossils constitutes a highly informative tool as it enables us to characterize ancient global change processes as well as to determine the mechanisms and responses at abiotic and biotic levels within a temporal resolution that goes beyond instrumental records. The marine geological record has been more thoroughly surveyed from the biogeochemical standpoint, and specifically from the stable isotope perspective since this methodology was initially applied on marine paleoarchives. Hence, it is essential to boost the biogeochemical research on proxies of the terrestrial record with the goal of attaining a global knowledge of the climatic, environmental and ecological dynamics of our planet. Throughout my scientific career, I have developed different research lines at the interplay between Paleontology, Biogeochemistry, Paleoclimate, Paleoenvironment, Paleoecology and Sedimentology using stable isotope, mineralogical/elemental characterization and biomarker analyses on terrestrial geological and paleontological archives during critical periods of the history of Earth.

My talk will focus on the analysis of oxygen and carbon stable isotopes on vertebrate fossils at different geological events of the Cenozoic in the Iberian Peninsula and South America. I will focus on two studies: in the first

one, we explored the regional expression of climatic and environmental shifts in southwestern Europe throughout the Miocene-Pliocene transition by constructing long-term records of carbon and oxygen isotope variations in tooth enamel of different large herbivorous mammals from Spain. We detected, for the first time by means of stable isotope analyses on mammalian tooth enamel, key regional and global climatic and environmental episodes, such as the Vallesian-Turolian turnover event, the Pliocene Warm Period and the onset of the Northern Hemisphere glaciation.

The second study aims at assessing resource and habitat use, niche occupation and trophic interactions from a stable isotope perspective on fossil mammals from the Argentine Pampas (Buenos Aires and La Pampa provinces) during the Great American Biotic Interchange (GABI). More than 400 samples belonging to 10 endemic and immigrant mammalian orders were analysed, spanning a temporal range from ~9.5 Ma (Late Miocene) to ~12 ky (Late Pleistocene). Our stable isotope data indicates that the expansion of C_4 vegetation opened up new niche opportunities, probably alleviating resource competition among endemic and immigrant taxa.

Studies like these ones support the premise that Stable Isotope Biogeochemistry is among the novel lines of Paleontology successfully applied to the determination of past climatic, environmental and ecological conditions.

Acknowledgments: Throughout my scientific career, my research has been supported by multiple institutions and organisms. I particularly thank the Spanish Ministry of Science, Innovation and Universities, the Complutense University of Madrid, the Spanish National Research Council, the University of California Santa Cruz and National Geographic Society. I am also indebted to all the people that have helped me to develop my projects.

ANNE-CLAIRE FABRE

FUNCTIONAL MORPHOLOGY AND BEHAVIOUR

BIOGRAPHY

Research co-investigator at the Natural History Museum in London (United Kingdom). She is an evolutionary biologist principally interested in shape evolution in relation to functional morphology and behaviour. She completed a joint PhD between Paris (MNHN) and London (UCL) with Dr. Stéphane Peigné and Prof. Anjali Goswami as supervisors. During her first post-doc (at Duke University funded by the Fondation Fyssen) she studied the evolution of grasping and locomotor behavior using a primate model system. This allowed her to link behavior, morphology, and mechanics and to make more solid inferences on fossil taxa. In her second post-doc (Marie-Skłodowska Curie fellowship at the Natural History Museum in Paris) she explored arboreal adaptations in primates and other tetrapods with manual grasping abilities. Within each clade she compared the use of the forelimb, its anatomy, and its function in both arboreal and terrestrial animals. She showed that the arboreal origin of fine manipulative capacities precedes the origin of grasping behaviour in several lineages. Dr. Fabre is currently working with Prof. A. Goswami at the Natural History Museum in London on the mosaic evolution of vertebrates with a special focus on shape evolution of the skull in relation to developmental strategies, functional traits, and ecology. Thus, her research on macroevolution is highly integrative linking different research areas in biology in order to understand the evolution of the shape of a structure in relation to function and behaviour. Her work has been published in leading international journals and she has been invited to present her work at international meetings and symposia.

How *in vivo* data on extant species can shed light on the paleoecology of extinct species?

A.-C. Fabre

The reconstruction of the palaeobiology (ecology, behaviour and lifestyle) of an extinct species is a difficult exercise. Unfortunately, a fossil is rarely well-preserved; and thus teeth, bones, or parts of bones, are the main material with which palaeontologists work due to the fact that soft tissues rarely fossilized. As such palaeontologists need to understand the adaptive nature of the morphology of the skeleton in extant species and its relation to behaviour while accounting for effects of shared ancestry. Palaeobiological reconstructions assume that the morphology of a species reflects its ecological adaptation(s). Bones allow movement and, whilst supporting loads, also need to respond and resist to muscular forces. As bones are shaped by force and motion, their morphology is likely to be intimately related to the movements executed which are, in turn, the result of muscular contractions. Thus, to understand the adaptive nature of the morphology of the skeleton it is essential to study the relationships between bones and muscles in living species and their relation to ecology, locomotion, or behaviour while taking into account potential effects of shared ancestry. In this presentation, in a first example, we show how the study of forelimb shape in relation to locomotor performance and grasping behaviour can shed light on the evolution of early primates. To do so, we used a data set of 25 living strepsirrhines for which we acquired *in vivo* quantitative locomotor performance data as well as data on their grasping behaviour. These data were then analysed in relationship to the shape of each long bone of the forelimb. Our results showed that the shape of the forelimb long bones can be used to make quantitative inferences on locomotion and grasping behaviour in stem primates. In a second example, we studied the cranium and mandible shape in relation to bite force in order to make integrative inferences on performance and diet in extinct species of strepsirrhine primates. To do so, we used a data set of 21 living species of strepsirrhines for which data on the shape of the bones of the feeding system (skull and mandible) and quantitative myological data, as well as *in vivo* bite force data were acquired. Our results showed show that there is a significant impact of the masticatory muscles on cranial shape but not as much as on the mandible. In contrast, bite force strongly impacts mandibular shape but not the skull. Thus, we mainly used the cranial shape to reconstruct the myology of extinct

species whereas we used the mandibular shape to reconstruct the bite force. These quantitative inferences on extinct species allowed us to shed light on the evolution of diet in extinct species.

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JINGMAI O'CONNOR

ORIGIN AND EARLY EVOLUTION OF AVES

BIOGRAPHY

Senior professor at the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) of the Chinese Academy of Sciences (CAS). Jingmai O'Connor is a Chinese-Irish American paleontologist whose research focuses primarily on the origin and early evolution of Aves during the Mesozoic. Her first course with Dr. Donald Prothero at Occidental College, where she attended for undergraduate studies, ignited a strong passion for Paleontology. She began her research as an undergraduate studying Cenozoic mammals with Dr. Xiaoming Wang at the Natural History Museum of Los Angeles County. O'Connor received her PhD from the University of Southern California where she studied Mesozoic birds with Dr. Luis Chiappe. Currently and for the past nine years she has been working under Dr. Zhonghe Zhou at the IVPP of the CAS in Beijing, where she is a senior professor. She is also an adjunct professor at the University of the CAS and Lingyi University, a research associate at the Natural History Museum of Los Angeles County, honorary reader at the University of the Witwatersrand, and an editorial board member at Scientific Reports. Her research is not limited to any one aspect of early avian evolution, touching on feathers, aerodynamics, reproduction, ecology, anatomy, systematics, ontogeny, taxonomy, histology, and other topics as exceptional specimens arise. The results of some of her research have been published in top science journals including Nature, and she regularly attends domestic and international conferences. She has helped to train several Master's and PhD students, and participates in outreach activities whenever opportunities arise. She collaborates with scientists worldwide and has conducted field work in six countries as one of the world's leading experts on Mesozoic birds.

Soft tissue preservation in fossil birds from the Early Cretaceous Jehol Biota

J. O'Connor

Palaeontology is typically viewed as the study of skeletal remains of long extinct organisms. Although certainly dominated by the remains of mineralized tissues (bone, teeth), soft tissue preservation is far more prevalent than envisioned by most. Archaeopteryx, the oldest and most primitive bird, was identified as such based on soft tissue remains in the form of integumentary structures today unique to this clade – feathers. Soft tissues continue to provide data critical to the understanding of the evolution of birds from their closest dinosaurian relatives among the Paraves. The study of early avian evolution during the Mesozoic has grown enormously during the last three decades, revolutionized by the discovery of the Early Cretaceous Jehol Biota in northeastern China. An enormous wealth of specimens haS been uncovered from these volcanolacustrine deposits, recording a diversity of feathered theropod dinosaurs including at least one volant form, Microraptor, and several stem avian lineages intermediate between Archaeopteryx and the Ornithothoraces, a grade of avian evolution documented nowhere else in the world. More recently this data has been supplemented by the discovery of the older middle to Late Jurassic Yanliao Biota, which includes the unsuccessful experiment with volant behaviour documented in the enigmatic Scansoriopterygidae and feathered paravians on the cusp of flight (*e.g.*, Anchiornis) which are critical to understanding the evolution and success of Aves. The specimens belonging to these two biotas are characterized by exceptional preservation, typically nearly complete and articulated and commonly boasting soft tissue remains in the form of feathers. The large number of specimens preserving these and other integumentary structures have revealed a huge wealth of data concerning the feathering of paravians including patterning, coloration, the presence of sexual ornamentation, the evolution of asymmetry, and the presence of extinct feather morphotypes. However, interpretations are hindered by two-dimensional preservation in these compression fossils. The deposits that produce these two biotas are most unique with respect to the extraordinary number of specimens yielded thus far: hundreds of specimens of the paravians Anchiornis and Microraptor and thousands of the stem bird Confuciusornis are reported. With such an enormous wealth of specimens, rarer forms of soft tissue preservation occasionally are identified. These

include internal organs with lungs and ovarian follicles documented thus far. Lung tissue in the basal ornithuromorph Archaeorhynchus indicates respiratory function similar to living birds. Ovarian follicles in Jeholornis, Eoconfuciusornis, and several enantiornithines appear much less derived, lacking the strong hierarchy present in neornithines although all specimens suggest that the function of the right ovary was lost early in avian evolution. The study of these soft tissue structures is yet in its infancy with early identifications typically relying on morphology and anatomical position. However, new methods currently being developed to study these and other soft tissues will surely provide new insights into the biology of extinct organisms and revolutionize the field of palaeontology.

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ALBA SÁNCHEZ-GARCÍA

ARTHOPODS AND AMBER

BIOGRAPHY

Researcher at the University of Barcelona. Alba Sánchez is an organismic and evolutionary biologist with extensive paleobiological expertise. She obtained her MSc in Palaeontology and PhD in Earth Sciences with honors from the University of Barcelona, working on the systematics and paleobiology of several arthropod groups, namely crustaceans, arachnids, and hexapods. Although grounded in taxonomy, her works aim to extract paleoecological, paleoethological, and taphonomic data. Her research has studied exceptional preservation localities, namely amber deposits. To date, Dr Sánchez has published papers on fossil arthropods related to continental aquatic and edaphic environments, i.e., crustaceans (tanaidaceans), arachnids (mites), and hexapods (i.e., springtails, beetles, and semi-aquatic true bugs) in internationally renowned journals like Scientific Reports and Plos One and Journal of Systematic Palaeontology. Overall, she has described about thirty taxa new to science. For over six years, Dr Sánchez has taken part of two multidisciplinary research teams funded by governmental funds in competitive calls that study the Early Cretaceous amber from Spain. She also collaborates in the study of other Cretaceous ambers of international importance, such as those from Lebanon, France, Myanmar, and New Jersey. Throughout her career, she has been a visiting scholar at different research institutions from Spain, USA, France and Germany. Dr Sánchez is currently working on several projects: An overview of bristletail diversity in the Lebanese and Spanish amber faunas, building upon the body of data available for understanding the Cretaceous evolution of this basal insect order; the description of termites newly recovered from Cretaceous amber in Spain; and an overview of terrestrial isopod diversity in the Spanish amber fauna.

Palaeobiology of edaphic and aquatic arthropods from Early Cretaceous Spanish amber

A. Sánchez-García

The ability of resin to encapsulate small portions of the palaeoecosystem in a relatively fast and quasi-unaltered way, and to preserve them for millions of years, gives amber palaeobiological significance, and explains why amber inclusions are especially valuable for studying how organisms interacted in the past. Cretaceous amber has gained a distinctive interest among researchers during the past few decades because of the valuable evolutionary data provided on fossil insects during the ecological expansion and diversification of angiosperms. At least two different families of conifers produced the resin that originated the Albian amber of Spain: Cheirolepidiaceae and an indeterminate conifer in the northwestern deposits (El Soplao); Araucariaceae close to the genus *Agathis* in the northern deposits (Peñacerrada); and possibly Cheirolepidiaceae in the eastern deposits (San Just). A number of hexapod orders have been found: Archaeognatha, Blattodea (including Isoptera), Coleoptera, Collembola, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Mecoptera, Neuropterida, Orthoptera, Psocoptera, Thysanoptera, and Trichoptera. Other arthropod groups have also been discovered, such as arachnids (Araneae, Acari, and Pseudoscorpiones), as well as crustaceans (Tanaidacea, and Isopoda).

The Spanish amber shows a distinctive ecological feature for a Cretaceous amber, which is that numerous arthropods trapped in this fossil resin, are representatives of the litter biota (i.e. the fauna living on the ground surface). The exceptional fossilization of the samples composed of litter-inhabiting fauna (litter amber) could be explained by and important fluidity of the resin, which allowed flows from the branches or the trunk to directly contact the soil, instantaneously entrapping organisms crawling on the soil surface. The superb preservation of the samples has allowed us to study not only their content, but also the peculiar, original relationship in space and time of their elements. It is remarkable that most of the litter-inhabiting organisms are preserved together with different elements typical of the forest floor, namely fungal hyphae, decayed plant and arthropod remains, and general debris interpreted as inorganic and organic soil components. The taphonomic analysis and inventory of arthropod inclusions of the litter amber pieces are relevant for palaeoecological reconstructions, in the same manner

of aereal pieces, and provide a unique insight regarding edaphic and aquatic arthropod biodiversity. This selective trap sampled the *in situ* fauna, important for the knowledge of the Early Cretaceous forest ecosystem.

The Spanish amber is also valuable in the abundance of syninclusions and samples that provide information about palaeoethology and palaeobiotic interactions, *e.g.* the earliest evidence of aggregating behavior in an entomobryomorhan species, *Proisotoma communis*, or the first evidence of male clasping organs for courtship and securing the female during copulation in a symphypleonan species, *Pseudosminthurides stoechus*. Such behaviors, while critical for the success of species, are frequently impossible to determine for fossil species, and its discovery reveal a generalized stasis for some ancient hexapod ethologies. Other noteworthy subjects of palaeobiological research have been the study of several aquatic arthropods that are very scarce in the worldwide fossil record.

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SARA VARELA

BIG DATA IN ECOLOGY

BIOGRAPHY

Postdoctoral researcher at the Museum für Naturkunde - Leibniz Institute for Research on Evolution and Biodiversity (Berlin, Germany). Sara Varela always wanted to be a biologist, and as a child she collected shells, feathers, leaves and rocks. She had a nice pile of labelled biscuit boxes and a photo album with her own herbarium. In her tenacious mission to defend the world, she started her career investigating the role of past climate changes on Pleistocene mammal extinction events, aiming to understand why we do not have spotted hyenas in Europe anymore. She developed her PhD in the Museo Nacional de Ciencias Naturales of Spain with Dr. Jorge M. Lobo, and found out that the extinction of this large carnivore was not likely related to past climatic changes. In those early years, she participated in excavations like Atapuerca (Spain), Dmanisi (Georgia) and El Caño (Uruguay). Since she finished her PhD, Dr Varela has worked for 5 research institutions in Spain, Czech Republic, Brazil and Germany. In her path to understand the hyena's extinction she explored foodwebs as a new method to incorporate biotic interactions into the discussion. Her programming skills also allowed her to help students to develop their own Species Distribution Models. She taught R programming, statistics, ecological modelling and GIS for ecologists in Europe and South America, and as a result, she developed collaborations with a nice group of pre and postdocs. She is concerned about how to work with big data in ecology, and in order to help herself and other researchers to use large open access biodiversity databases she programmed two R packages, rAvis and paleobioDB. Further, she started ecoClimate.org, a project with Matheus Lima Ribeiro and Carina Terribile (UFG-Brazil) to make an easy-to-use climatic database to work on global change ecology. Currently, Dr Varela is working to set up her own research group to investigate paleobiogeographic dynamics in deep time, and save some gorillas.

Using Ecological Niche Models to understand Pleistocene extinctions

S. Varela

Ecological Niche Models (ENMs) allow us to map the distribution of species in relation to climate. ENMs have been used to understand global biogeographic patterns, to predict the impacts of current climatic change on biodiversity, and to understand recent extinction events and the impacts that past climatic changes had on the distributions of species during the Late Pleistocene - Holocene.

In order to calibrate an ENM, we need data on species geo-referenced occurrences and information about the temperature and precipitation at those points. Normally, we use raster layers of temperature and precipitation (GIS format) to obtain the environmental niche of the species, and, after constructing the model, we can map the climatic suitability of our target species.

Pleistocene climate is characterized by its glacial and interglacial cycles. AOGCM models (Atmospheric-Oceanic General Circulation Models) are complex climatic models with a good spatial resolution that have been used to explore the climate of the past, mainly for two scenarios, the Last Glacial Maximum and the mid-Holocene (*e.g.* in www.ecoclimate.org). Thus, we can take advantage of these paleoclimatic reconstructions, and link the presence of fossil records with paleoclimatic data, to unveil how past climatic changes affected Pleistocene species, and understand large scale biogeographic dynamics.

In this talk, I will summarize the state of the art of paleobiogeographic reconstructions, how to use ENM for plotting past species ranges, and which methodological topics have been discussed in the recent years.

Acknowledgment: my research is funded by the Humboldt Foundation, Germany.

JASMINA WIEMANN

BIOMOLECULE FOSSILIZATION

BIOGRAPHY

PhD student at Yale University. From early childhood on, Jasmina Wiemann has been fascinated about how fossil remains can paint a picture of the past. Her favorite approach to paleontology is chemistry: at the age of 15, a German excellence stipend allowed her to study Chemistry at the Technical University of Dortmund. After graduation, she enrolled in the Geosciences Bachelor program at the University of Bonn, where she specialized in Geochemistry and Paleontology. She pursued her Master of Science degree in the Department of Biology at the University of Bonn. Jasmina's research focuses on mechanisms of biomolecule fossilization and its applications. The study of fossils comes with its challenges, since most of the biologically informative molecules and the soft tissues they constitute are thought to not survive through deep time. However, her work suggests that many biomolecules preserve through chemical transformation which also allows survival of original soft tissue morphologies over hundreds of millions of years. She discovered the process of protein fossilization in vertebrate hard tissues (from teeth to eggshells), and is currently optimizing protocols to extract for the first time phylogenetic, physiological and biomechanic information from protein fossilization products. Her motivation is to use fossil soft tissues and biomolecules as reliable paleobiological proxies. Aside from her work on the preservation of structural macromolecules, Jasmina is also interested in low-weight metabolites, such as tetrapyrrol egg color pigments. She traced "avian" egg color back to its single evolutionary origin in nonavian dinosaurs, and applies biomolecules preserved in fossil archosaur eggshells to infer nesting ecology, and breeding behaviors. For this work she was awarded the Steven Cohen Award for Excellent Student Research of the Society of Vertebrate Paleontology (2015). Excited about the opportunity to combine paleontology and chemistry, she is currently a PhD candidate in the Department of Geology and Geophysics at Yale University, advised by Derek Briggs.

Pushing the limits: how molecular preservation can change our understanding of ancient ecosystems

J. Wiemann

To understand organismic evolution, we use fossil remains to reconstruct which types of animals coexisted in a given environment, how they are related, and how they lived. Types of evidence include fossil morphology as a basis for phylogenetic analyses, paleohistology as a proxy for metabolic rates, and trace fossils as direct evidence for behaviour. However, all of these approaches suffer from incomplete preservation, and a lack of direct morphological evidence for metabolic and behavioural capabilities. I will show how commonly preserved fossil biomolecules represent a largely unexplored resource of paleobiological data on animal phylogeny, physiology, and behaviour. Raman microspectroscopic characterization of fossil soft tissues in a representative metazoan sample (n=240) highlights how proteins transformed diagenetically into N- and S-rich heterocyclic polymers still reflect original amino acid sequences (phylogeny) and metabolic signatures (physiology). Other stable N-heterocycles, such as porphyrin pigments, in a sample of vertebrate eggshells are directly tied to reproductive behaviours. I will showcase three examples of these applications. 1) A metazoan phylogeny based on protein fossilization products (PFPs) appears robust at a higher-rank taxonomic level. It requires specimens preserved in comparable depositional environments in order to reduce “molecular taphonomic noise” which would otherwise impact the resulting tree topology. 2) PFP-based quantification of metabolic rates in extinct vertebrates outcompetes histological approaches in accuracy, and offers a valuable complement to isotopic body temperature reconstructions. 3) Pigment-based reconstruction of dinosaur egg colors and inferences about associated nesting behaviours offer a novel insight into dinosaur reproductive biology. Such investigations show that fossil biomolecules provide an invaluable route to a more complete picture of ancient ecosystems by providing unambiguous chemical information on the paleobiology of extinct animals.

Science and social media: a new frontier for science communication

F. Gascó, A.R. Gómez-Cano

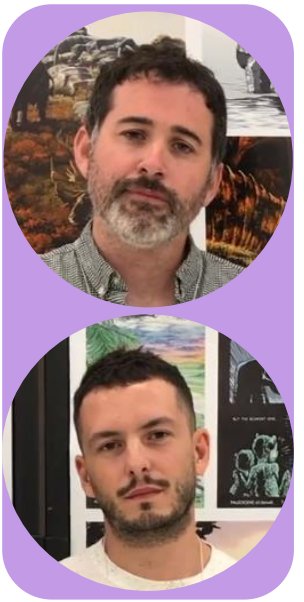
Science communication is defined as a group of practices with the objective of informing about science outbreaks, educating on scientific concepts and disciplines, and raising awareness of science-related topics. According to the level of scientific knowledge, science communication might be considered as science outreach (from scientists to non-scientific audiences) and science inreach (communication from experts to experts that might be working on a similar or different field of expertise).

In recent years, social media and websites have grown until they have become the main source of information for all audiences. Science communication has been growing recently around social media, and both categories, science outreach and science inreach, have found their own social media platforms.

Regarding science inreach, specific social media have been created to ease the communication among scientists around the world. These social media include Mendeley, Academia and Research Gate. The main interest of these specialist media is the possibility of sharing papers, abstracts and communities.

For science outreach, the generalist social media are recently growing and expanding. They include media used by every audience, such as Twitter, Facebook, Instagram, YouTube, Whatsapp or Telegram.

Social media (both specific to scientists or generalists) are excellent ways of disseminating scientific results directly by researchers, but they are also a perfect ways of networking scientists. These channels can be of great help and with numerous benefits for the academic and scientific world if used correctly. Once you know well the specific features of each social media and by using the appropriate tools you will be able to gain in efficiency when using them in your professional environment.



Preparing figures for scientific publications

O. Sanisidro, J. L. Cantalapiedra

During this workshop, we will learn how to improve graphics and assist in the creation, modification, and optimization of figures, streamlining the process of figure creation for scientific publications. Electronic publications have become increasingly popular in academic publishing in recent years hand-in-hand with the increase in artwork complexity. Finding appropriate tools to illustrate research is key for a correct transmission of information.

Two-dimensional computer-aid-design (CAD) programs constitute powerful tools to portray research data. These can be broadly divided into vector and raster graphic editors. In this course we will use the latest versions of the Adobe Design© package, considered the industry leading CAD software for design and artwork creation. Adobe Photoshop© will be used for raster image improvement and Adobe Illustrator© for vector design.

Vector graphics make use of geometrical primitives based on mathematical expressions such as points, lines, curves, shapes, or polygons. The main workhorse of vector design is Bézier curves. These are curved paths defined by mathematical formulas between two nodes with handles that modulate its trajectory. These curves help to define outlines, and are extremely helpful to design schemes or depict schematic subjects. Vector programs can be used to improve and give a professional look to graphs generated with statistical software. Due to their mathematical nature, vector-based graphics are infinitely-scalable, and, therefore, resolution-independent. As part of this introductory workshop we will learn how to improve graphs generated with Microsoft Excel©, R!©, or SPSS©.

Raster graphics, on the other hand, translate an image into a matrix, so-called raster, with information about the position and color of each one of the individual cells. Each of these cells are called pixel. In Paleontology, raster images include photographs of specimens, scanned drawings or schemes, or artistic illustrations planned for science outreach or scientific

papers. Raster-based graphics do not fare well when they are scaled, therefore, mastering document size and resolution is critical for a correct manuscript submission and/or document print. In this case, a correct management of color mode and depth, and document size and resolution are key to an effective figure submission. Works related with raster images enhancements include change in color, contrast, gradational improvement, sharpness, noise removing, and correcting small image imperfections.

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