

PRESENTATIONS



CLIMATE VARIABILITY IN THE MONTE SAN NICOLA TYPE-SECTION (SICILY): HIGH-RESOLUTION CALCAREOUS PLANKTON FLUCTUATIONS OVER THE PLIOCENE-PLEISTOCENE TRANSITION

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The present research falls within the GELSTRAT project, launched in September 2021 within the INQUASQS International Field Workshop, with the aim to reinvestigate the Monte San Nicola - MSN section (Gela, Sicily). The section includes the Global Boundary Stratotype Section and Point (GSSP) for the Gelasian Stage (ca. 2.58 Ma), the chronostratigraphic boundary that marks the base of the Quaternary System. We present high-resolution results on calcareous plankton assemblage and correlation with stable isotope record on planktonic foraminifera across the Pliocene-Pleistocene transition (PPt), not available so far in the type-section. The observed calcareous plankton variations display cyclic change of different magnitudes and non-cyclical trends. Major fluctuations could be interpreted in terms of sea surface productivity and temperature variations. The abundance pattern of key taxa suggests that changes in paleoproductivity are related to precession-induced variations, with productivity increase and the development of deep chlorophyll maximum occurring during sapropel formation. The reconstructed surface water temperature variation, expressed by cyclical changes of specific taxa, is mainly related to obliquity-driven glacial-interglacial cycles, as indicated by the matching with the new oxygen isotope record obtained through the section. Surface water temperature changes also respond to insolation forcing in good agreement with other coeval Mediterranean and Atlantic records. The present work describes the climate signature recorded in the Gelasian type-section improving the recognition and interpretation of climate variability across the PPt and the correlation of the Gelasian GSSP outside the type-section.

**THE HIGH DINOSAUR BIODIVERSITY IN THE APULIA CARBONATE PLATFORM:
EVIDENCE FROM THE LAMA BALICE TRACKSITE (UPPER ALBIAN, SOUTHERN ITALY)**

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The upper Albian ichnoassemblage from Lama Balice (Bari, Apulia, southern Italy; Spalluto & Caffau, 2010) consists of hundreds of tracks, produced by both bipedal and quadrupedal dinosaurs. The dinosaur tracks occur on two distinct track-bearing surfaces of Mazzitelli and Robles quarries belonging to the Calcare di Bari Fm. They were investigated by combining traditional methods and high-resolution digital photogrammetry, with the aim of improving the results of ichnological analyses. The succession cropping out in the quarry also shows the occurrence, at distinct stratigraphic horizons, of several tracks exceptionally exposed in cross-section. The medium-sized tridactyl tracks, some of which arranged in bipedal trackways, reveal a high affinity with the theropod tracks from the Upper Jurassic-Lower Cretaceous of Algeria and Morocco (Belvedere et al., 2010; Bessedik et al., 2019). Numerous quadrupedal couples are characterised by morphological features comparable with the narrow-gauge sauropod trackways from the Upper Jurassic of Morocco. The ichnoassemblage also evidences the presence of ankylosaurian tracks, confirming the existence of a high dinosaur biodiversity in the Apulia Carbonate Platform, thus providing further constraints for a palaeogeographic review of the Periadriatic area during the Cretaceous.

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**COCCOLITH INPUT INTO THE RECONSTRUCTION OF SEA SURFACE DYNAMIC:
IBERIAN MARGIN AND NORTH ATLANTIC OCEAN**

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Two pivotal areas for paleoceanographic studies are here compared through coccolith assemblage analyses of two different Integrated Ocean Drilling Program sites: U1385 and U1313, respectively located along the Western Iberian Margin (WIM) and in the central North Atlantic. The study aims to present surface water dynamics, starting from the Last Glacial Maximum until the Holocene, occurring at both sites, comparing the surface paleoproductivity fluctuations and water column stratification, as well as differences concerning the coccolithophore calcification process. The latter is investigated analysing variations of the coccolith size-normalized thickness and total coccolith calcite per slide, in addition to dissolution/preservation indices, to understand coccolithophores response to environmental parameters. The overall reduction of the different species size-normalized thicknesses at both sites testifies the effects of the increasing CO₂ concentrations during the last 25 kyr. During the Heinrich Stadials (HS) values between the two sites differ greatly, while Younger Dryas and Holocene are intervals of constant size-normalized thicknesses at both latitudes. A general high coccolithophore paleoproductivity characterizes the Site U1313 in particular during both HS, concurrently to increasing terrigenous input. The Principal Component Analysis better highlights that conditions of high productivity and terrigenous input are consequence of icebergs influence transporting nutrients and ice-rafted debris over the area. Different calcareous nannoplankton paleo-assemblages define glacial and interglacial phases at Site U1385: glacial conditions are due to the prevalent Portugal Current influence and the southward shift of the Intertropical Convergence Zone, while interglacial conditions correspond to a strong Iberian Poleward Current influence.

REAPPRAISAL OF THE UPPER OLDUVAI BEDS (TANZANIA): INSIGHTS FROM A NEW FAUNAL ASSEMBLAGE FROM GEOLOCALITY 83

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Fieldwork carried out in Geolocality 83 (Olduvai Gorge) by the THOR (Tanzanian Human Origin Research) team in 2018–2022, has resulted in the recovery of a rich and well-preserved faunal assemblage. While research in Olduvai has been traditionally focused on the lower part of the succession (Beds I–IV), much richer in paleoanthropological evidence, our discovery provides an opportunity to reappraise the geological and paleontological features of the upper Olduvai Beds (Masek, Ndutu, and Naisiusiu Beds). Our radiocarbon dating of fossil eggshells from Geolocality 83 gives results spanning from ~38 to ~33 ka, making the assemblage the only Late Pleistocene one with a confident date in Olduvai, and one of the few in eastern Africa. The exceptional preservation of the fossils from the site allowed to carry out a detailed systematic analysis, with an approach rarely used in Olduvai. The assemblage includes the following taxa: *Crocodylus* sp., *Struthio* sp., *Crocota crocuta*, *Lycaon pictus*, *Canis lupaster*, *Vulpes rueppellii*, *Caracal caracal*, *Acinonyx jubatus*, *Panthera pardus*, *Equus quagga*, *Taurotragus oryx*, the extinct buffalo *Syncerus antiquus*, *Nanger* sp., *Eudorcas* sp., *Madoqua* sp., *Aepyceros* sp., *Alcelaphus buselaphus*, *Connochaetes taurinus*, *Damaliscus* sp., *Phacochoerus africanus*, *Pedetes* sp., and *Gerbilliscus* sp. Most of the identified taxa are still found in the Serengeti savannah; however, some taxa which are extinct or limited today to drier areas of the continent, indicate that the Olduvai paleoenvironment must have been more arid in the latest Pleistocene than it is today, in agreement with literature data on eastern African paleoclimate.

OLD WORLD EARLY PLEISTOCENE CANIDAE RECORD: A BIOGEOGRAPHIC PERSPECTIVE

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The Early Pleistocene was time of change in the faunas across Africa and Eurasia: important climatic oscillations affecting the environment globally produced, with a certain degree of simplification, a trend of progressively increasing aridity. The decrease of humidity allowed the expansion of more and more open habitats and, consequently, the dispersal across and between these continents of taxa adapted to these environments. Canidae radiated greatly during the Pliocene in Eurasia and Africa and reached a considerable diversity, possibly in consequence of these environmental changes during the Late Pliocene-Early Pleistocene. Vulpini are represented by the genera *Nyctereutes* and *Vulpes*, both widespread across Eurasia and Africa although the record of the latter is scarcer and less diverse than the former. *Nyctereutes* is a typical element of the Pliocene of Eurasia but reaches its highest diversity in the Gelasian, before disappearing shortly after 2.0 Ma. Unlike *Vulpes*, whose species can adapt to open/arid environments, *Nyctereutes* was possibly related to closed/wooded habitats. Although during the Pliocene the genus *Eucyon* ranged across the three continents, records of the Pleistocene remained limited to Europe and Asia and, in the Gelasian, the number of its species dwindled until it remained confined to central and eastern Asia. Compelling evidence suggests that members of the genus *Canis* started their dispersal shortly after their appearance in Eurasia and Africa (i.e., Late Pliocene). The Gelasian marks the moment of radiation of the medium- to large-sized true dogs with distinct modern cursorial adaptations. Moreover, from this timeframe on, *Canis*-grade canids occupy prominent roles in the respective carnivore guild of Eurasia and Africa. Observing the taxonomic composition of the Early Pleistocene canid guild, a predominance toward more cursorial and carnivorous forms is a clear evolutionary trend, especially for the medium-large species and for the small species, respectively.

DISSCO RI: TOWARDS A EUROPEAN INFRASTRUCTURE FOR SCIENTIFIC COLLECTIONS

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European Natural Sciences Collections (NSCs) consist of around 1.5 billion specimens that are crucial for answering fundamental scientific questions about ecological, evolutionary, and geological processes. In the last decades the volume and diversity of information derived from NSCs exponentially increased due to the digital transformation. A holistic approach is therefore required, where cross-linked information effectively underpins the entire research life cycle and provides open access to mass and precise data for researchers. The Distributed System of Scientific Collections (DiSSCo) is a world-class Research Infrastructure (RI) for NSCs currently in its transition phase. The DiSSCo RI aims to create a new organisational model for collections that digitally unifies all European NSCs under common access, curation, policies and practices ensuring that all the data follow FAIR principles. DiSSCo thus represents the largest ever formal agreement between natural history museums and collection-holding universities. The digitisation of the NSC of the Natural History Museum (NHM) of the University of Florence - one of the largest and most diversified in Italy - is an ongoing, pioneering case study. The NHM of the University of Florence represents, in fact, the current Italian National Node of the DiSSCo Prepare Project (2020 – 2023) and is playing a key role in establishing innovative relationships between its internal Collection Management System (CMS) and: i) ArCo, i.e. the Knowledge Graph of the Italian Cultural Heritage promoted by the Italian Central Institute for Catalogue and Documentation and the Italian National Research Council (CNR), ii) the General Catalogue of Italian Cultural Heritage web portal created by the ICCD (almost 3 million catalogue records) and, finally iii) the DiSSCo RI. In particular, ArCo ontology network, adopted by Agenzia per l'Italia Digitale (AgID), allows the representation on the semantic web of ICCD standards for natural heritage.

MIDDLE TRIASSIC: THE ONSET OF MODERN TERRESTRIAL TETRAPOD FAUNAS

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At the start of the Mesozoic Era, the Triassic witnessed a world left devastated by the Permian-Triassic Mass Extinction (PTME), in which only about 10% of species had survived the PTME. The Early-Middle Triassic was a time of unusual diversification of life, leading to the development of modern ecosystems. On land, the recovery was slow and stepwise. The Early Triassic unbalanced “disaster fauna” gradually changed, eventually building more complex ecosystems at the beginning of the Middle Triassic. In this contribution, we present the preliminary results of a review of Middle Triassic terrestrial tetrapod faunas around the world, obtained by performing a semi-quantitative analysis of a comprehensive dataset. Cluster analysis performed on a taxon presence-absence matrix reveals the presence of three distinct major clusters: 1) a Gondwanan fauna in the Southern Hemisphere, dominated by therapsids, partly still reflecting a Late Permian and Early Triassic distribution of this group; 2) an Asian fauna inhabiting the Russian and Chinese regions, which clusters with the Gondwanan fauna, contrary to the condition characterising the Early Triassic; 3) a European-North American-North African fauna, occupying the Western part of the Northern Hemisphere, dominated by derived archosauriforms and lepidosauromorphs. From a more general perspective, a higher diversity in the Northern Hemisphere sub-equatorial zone is detected, as also reported for the Late Permian; temnospondyls were ubiquitous, although showing a preference for higher warm-temperate latitudes on both hemispheres; avemetarsalians are found both among the North-Western faunas and the Gondwanan faunas with no record from the Asian regions; pseudosuchians were particularly abundant in the Northern Hemisphere, with a distribution opposite to that of therapsids. Overall, these preliminary results provide insights into the evolution and establishment of stable terrestrial ecosystems during the Middle Triassic.

NEOGENE COLD-SEEP MICROBIAL CARBONATES (CROTONE BASIN - SOUTH ITALY)

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For the first time, the Neogene cold seep carbonate deposits of the Croton Basin (south Italy) are described. These deposits form a carbonate body reaching a maximum length of 350 m and a thickness of 40 m and are characterized by a conduit facies made of authigenic carbonates filling the previously active gas/fluid escape pipes. In addition, a pavement facies is observed, which consists of early carbonate-cemented bioclastic and siliciclastic sediments commonly colonized by a chemosynthetic macrofauna dominated by articulated and in life-position Lucinids bivalves. The conduit facies is characterized by the inward accretion of dark micritic laminae alternating with clear crystalline layers. The micritic laminae show a microbial peloidal to dendrolitic fabric, which commonly incorporates planktonic foraminifera and coprolites. These contrast with the crystalline layers, which are characterized by microspar laminae and sparry crusts made of prismatic zoned calcite crystals. The pavement facies is characterized by laminated microbial boundstones, bioclastic bearing micrite, foraminiferal oozes and hybrid arenites. The foraminiferal assemblage is characterized exclusively by planktonic forms which, together with the relative proportion of sandy/silty grains, suggest a deep-water setting with occasional siliciclastic coarser sedimentary flows. The pavement facies shows common brecciation features, possibly indicating the establishment of post-depositional overpressure conditions due to gas/fluid injection. Clasts of breccias show overgrowth by primary fibrous to acicular isopachous to fan-shaped calcite cement. Stable isotope analysis of all the studied facies reveals negative $\delta^{13}\text{C}$ values (-6.82 to -37.39 ‰) and relatively positive $\delta^{18}\text{O}$ values (-0.04 to 3.39 ‰), most probably indicating the presence of a complex mixture of methane with other hydrocarbons and the destabilization of gas hydrates and/or dehydration of clay minerals.

EOCENE STILT WALKERS: UNIQUE ROTATORY GROWTH STRATEGY OF THE SCLERACTINIAN CORAL *STYLOCOENIA*

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The diversity of scleractinian corals is marked by a plethora of their growth forms. At least some of these habits are considered adaptive to different environmental factors, and consequently, coral growth forms are often used as indirect paleoenvironmental indicators in the fossil record. Most shallow-water colonial corals attach to the hard substrate, but exceptions include some free-living taxa and some spherical coral colonies that are entirely covered by living tissues. The latter are described under different names, i.e., rotatory, circumrotatory, and coralliths, but also informally called “rolling stones”. Various authors have provided different, sometimes controversial interpretations of their growth mechanism and strategy. As a result, their fossil record is poorly explored, and only a few studies focused on comparing present-day rotatory corals to Pleistocene (scleractinians) and Silurian (tabulates) corals. Herein, we provide the first comprehensive analysis of the “rotatory” strategy of extinct, Cenozoic colonial scleractinian *Stylocoenia*, known from some Eocene species. We examined macro- and micromorphology and skeletal microstructure of 60+ specimens of Eocene *Stylocoenia* sp. from Veneto region (N Italy) and Bavaria (Germany) that we found in several museums and private collections. Representatives of *Stylocoenia* form perfectly spherical cerioid colonies with unique, long pillars developed between the corallites. Intercorallite pillars of variable length and thickness show a multi-layered structure and longitudinal ridges. Similar but much smaller pillar-structures (or styles) are developed only in some modern pocilloporiids (*Pocillopora*, *Stylocoeniella*). Although some tissue-protective functions were suggested for styles in modern pocilloporiids, in *Stylocoenia*, these structures could also play the role of “stilts” to avoid sinking in mobile and fine-grained sediments. This interpretation, together with taphonomic signatures, allows us to reconstruct the original habitat of these corals otherwise only known from collections.

CUTICLES: A WORLD WAITING TO BE DISCOVERED

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Cuticles are poorly studied and not well-known, both in botany and in paleobotany, also because they preserve as fossils only under special conditions. However, cuticles are essential parts of a plant. They permit plants to live under aerial conditions and protect them from desiccation and high mutation rates, among others. This waxy coating layer, composed of cutin, covers all plant organs dealing with photosynthesis, and protects them from excessive transpiration while allowing them, at the same time, to exchange oxygen and carbon dioxide. To convey the importance and beauty of the cuticles, a workshop has been designed for adults and/or students. The workshop includes a theoretical part that introduces to the topic and a practical part with hands-on experience with preparation of modern cuticles. Several extracting and staining methods for cuticles were tested, the easiest one turned out to be a “peeling method” of certain leaves such as tulips and cyclamens, which did not necessitate any colouring to be observed. The obtained cuticles were drawn and described with the help of observation keys and explanatory drawings for the study under the microscope. As the last step, participants try to extrapolate the acquired knowledge on extant cuticles by observing exceptionally preserved cuticles from the upper Permian of the Bletterbach. The presence of simplified drawings of the cuticle structures, previously identified in the area, permit participants to identify also 260 million years old cuticles. This does not only consent to fill the gap between botany and paleobotany but it allows as well to form interested citizen scientists.

THE RHAMPHOSIDAE (TELEOSTEI, SYNGNATHIFORMES) FROM THE EOCENE OF BOLCA

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The family Rhamphosidae is a peculiar group of extinct bony fishes exclusively known from the Eocene of Europe, the majority of which has been discovered from the upper Ypresian Konservat-Lagerstätte of Bolca (Verona Province, Italy). The first fossils pertaining to this family were found and described in the 18th century (Volta, 1796-1809), cursorily reviewed by Eastman (1914) and Nielsen (1960), and more recently discussed by Pietsch (1978). A revision of the Rhamphosidae allowed to refer this family to the order of Syngnathiformes, revealing a close affinity to the Pegasidae and Dactylopteridae. The examined material consists of 21 specimens from the “Pesciara” site of Bolca and is housed in the collections of the Museum of Natural History of Verona (Italy), the Museum of Nature and Humankind of the University of Padova (Italy) and the Carnegie Museum of Natural History, Pittsburgh (Pennsylvania, USA). Rhamphosidae are also reported outside Italy from the Fur Formation of Denmark, being represented by a few specimens assigned to the species *Rhamphosus rosenkrantzi*. The morphological analysis of the skeletal anatomy of the members of the Rhamphosidae revealed a suite of skeletal features that are shared with those belonging to the families Dactylopteridae and Pegasidae.

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THE DAWN OF MOORISH IDOLS (TELEOSTEI, ZANCLIDAE) IN THE EOCENE OF BOLCA

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The acanthuriform family Zanclidae comprises sponge-eating reef fishes exhibiting bright colours. These fishes, commonly known as moorish idols, have a deep and laterally compressed body, accentuated by elongate dorsal-fin spines and a pronounced snout with setiform teeth. Substantial morphological and ontogenetic evidence supports a sister-group relationship between moorish idols and surgeonfishes of the family Acanthuridae (e.g., Tyler et al., 1989). Today, the family Zanclidae is represented by a single species, *Zanclus cornutus*, which is widespread throughout the Indo-Pacific. The known fossil record of the moorish idols is restricted to four specimens from the Eocene of Bolca referred by Blot & Voruz (1970, 1975) to the species *Eozanclus brevirostris*. A detailed revision of the available material from Bolca, including a recently discovered specimen, revealed the presence of two separate taxa, one of which has not previously been recognized and represents a new genus and species. The new and previously undescribed taxon represents the sister group to the extant *Zanclus cornutus* with which it shares a number of morphological features (e.g., body discoid and very deep, snout greatly elongate, pre-anal distance >70% SL, pectoral disc notably expanded, one supernumerary dorsal-fin spine). Therefore, the analysis of the fossil record suggests that the zanclids might have originated in the early Cenozoic and that their morphological diversity was higher in the Eocene.

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ARE THE MISSISSIPPIAN MUD-DOMINATED CARBONATE BUILDUPS OF DERBYSHIRE “MUD MOUNDS”?

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The upper Mississippian succession of the Derbyshire Carbonate Platform (UK) hosts lens-shaped, decimeter-scale, carbonate mud-dominated buildups. The buildups host abundant bryozoans, brachiopods, siliceous sponges, and crinoids, which do not form a rigid framework. Carbonate mud is both detrital (allomicrite) and precipitated in situ from biologically-induced and influenced processes associated with microbial mats and siliceous sponges (automicrite). Being laterally confined biogenic structures, these buildups can be included in the definition of reefs by Flügel & Kiessling (2002). The detailed study of the Derbyshire buildups raised the need to investigate the nature of Mississippian reefs, which usually lack a skeletal framework and are mud-rich. In literature, they have been referred to different categories based on the amount of carbonate mud, automicrite vs allomicrite, inferred role of microbial mats and metazoans and content and type of skeletal biota. Various terms were introduced in the literature such as mud mounds, carbonate mounds, mud banks, reef knolls, microbial mounds, reef mounds. However, most are interpretative subjective terms which meaning changed through time. Literature review shows that most Mississippian reefs may be included in the definition of mud mounds given by various authors in the '90s: carbonate buildups having depositional relief and being composed dominantly of carbonate mud, or micrite (Bosence & Bridges, 1995). In particular, the Derbyshire buildups represent a newly defined sub-category of mud mounds dominated by fenestellid bryozoans, brachiopods and sponge spicules.

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**RISPOSTA DELLE ASSOCIAZIONI A FORAMINIFERI ALLE OSCILLAZIONI CLIMATICHE
DURANTE IL GELASIANO- CALABRIANO: DATI OTTENUTI DALLA SUCCESSIONE DI
CAPO ROSSELLO (SICILIA)**

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Il Gelasiano rappresenta il primo piano del Pleistocene (2.58-1.80 Ma) ed è stato definito nella successione di Monte San Nicola (MSN) Gela, poco sopra la base del sapropel “NICOLA BED” (MIS 103), quasi in coincidenza con l’inversione magnetica Gauss/Matuyama. Dal punto di vista biostratigrafico, la base del Gelasiano non coincide con alcun evento biostratigrafico a foraminiferi e nannofossili calcarei, anche se poco sopra la base inizia la drastica riduzione dei discoasteridi con la conseguente estinzione di *Discoaster pentaradiatus* e l’aumento in abbondanza di *Neoglobobulimina atlantica*. Capo Rossello rappresenta una delle successioni più complete al mondo dell’intervallo Messiniano-Calabriano ed è stata calibrata astronomicamente. Essa è una eccellente successione, per confronto e correlazione con quella di MSN, che ricopre l’intervallo compreso tra 2.60 a 1.53 Ma (MIS 103-53). In questo lavoro presentiamo i dati sugli isotopi stabili, misurati sui gusci di *Uvigerina peregrina*, e le oscillazioni a foraminiferi. I dati, correlati anche con gli alchenoni, evidenziano una forte riduzione della temperatura nei MIS 100, 78 e 66. In particolare, nel MIS 66 (1.85 Ma) è stata riscontrata una forte riduzione della temperatura delle acque superficiali (circa 8°C), che coincide con la diminuzione delle specie di acque calde e con un drastico cambiamento nell’associazione bentonica.

**TEMPO E MODO NELL'EVOLUZIONE DELLA NICCHIA CLIMATICA IN DINOSAURIA
(SAUROPSIDA: ARCHOSAURIA)**

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Il clade Dinosauria è un ottimo candidato per lo studio degli effetti del clima sulla macroevoluzione dei vertebrati, avendo attraversato numerosi cambiamenti climatici e paleogeografici sin dalla sua origine, ~235 milioni di anni fa (Ma). Per questo studio è stato generato un registro basato su esemplari di tutti i taxa di dinosauri fossili ad oggi noti (uccelli inclusi), includendo la loro provenienza geografica e cronostratigrafica. Le coordinate paleogeografiche, una volta ricostruite, sono state calibrate con modelli paleoclimatici del Mesozoico (HadCM3L). Una serie di matrici filogenetiche sui principali sottogruppi di dinosauri (Ornithischia, Sauropodomorpha, Theropoda) è stata analizzata con analisi Bayesiane. L'evoluzione della nicchia climatica dei dinosauri è stata quindi ricostruita calibrando variabili climatiche e alberi filogenetici tramite metodi analitici di filogenesi comparata: ciò ha permesso di confrontare le tendenze evolutive nella nicchia climatica dinosauriana con modelli di evoluzione a regimi multipli (Ornstein-Uhlenbeck). Mappando l'esplorazione dello spazio adattativo dipendente dal paleoclima, sono emersi regimi evolutivi multipli in Theropoda, con una sostanziale accelerazione nell'occupazione di una più ampia nicchia climatica rispetto al Triassico Superiore nel Giurassico Medio (170 Ma). Ornithischia ha occupato un ampio spazio climatico sin dalla sua comparsa nel registro fossilifero durante il Giurassico Inferiore (200 Ma). Sauropodomorpha mostra un'accelerazione di tasso evolutivo durante il limite fra Triassico e Giurassico (201 Ma), esplorando uno spazio climatico più ridotto e fortemente determinato da una ristretta gamma di temperature rispetto agli altri gruppi. Questi risultati hanno permesso di verificare in maniera quantitativa, applicando principi macroevolutivi originariamente definiti da G. G. Simpson, come i cambiamenti climatici a grandi scale spaziali e temporali, abbiano influenzato la macroevoluzione dei dinosauri.

CENOZOIC CARBONATE FACIES OF ASIA: THE HIDDEN POTENTIAL OF THE SHALLOW WATER RECORD

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The changes in carbonate facies over time are the result of both evolution and changes in environmental conditions. These biotic and abiotic elements are often hard to separate due to difficulties in tracking large-scale facies changes across time and space in a quantitative fashion. This research presents the results of a standardized re-analysis of 144 Paleocene to Miocene, shallow-water carbonates successions, situated in an area comprised between Levant and Bangladesh. Our results indicate that larger benthic foraminifera were the most important group of carbonate producers during the whole period, peaking in the Eocene. Colonial corals and red calcareous algae are common during the Paleocene, Miocene and, in particular, during the Oligocene; whereas they are essentially absent during the Eocene. Green calcareous algae are the fourth and least abundant group of carbonate producers and their abundance decreases from the Paleocene onward. The abundance of both larger benthic foraminifera and colonial corals displays a clear connection with global average temperatures, with extremely warm temperatures favoring the former and milder conditions favoring the latter. The similarity between colonial corals and red calcareous algae suggests that, overall, conditions favorable for the former are also good for the latter, and/or of a positive interaction between the two groups on the large scale. The progressive decline of green calcareous algae could be related to a preservation bias caused by the transition from early Paleogene assemblages with possibly calcitic taxa, to Neogene assemblages entirely constituted of aragonitic taxa with a limited preservation potential. Overall, these results display a significant agreement between the abundance of the various groups of carbonate producers and large-scale processes, showcasing the remarkable potential of shallow-water carbonates for global-scale paleoenvironmental reconstructions.

MOLLUSC SHELLS AS A TOOL TO RECONSTRUCT THE PALAEOENVIRONMENT AND THE PALAEOCLIMATE IN THE HAS1 SETTLEMENT (HOLOCENE, OMAN)

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Mollusc shells are a common component of many archaeological assemblages, as they occur in quite all the environments occupied or exploited by humans in the past. Therefore, shells from archaeological deposits have a significant and growing potential for reconstructing palaeoenvironments and human-environment interactions. For example, the HAS1 settlement (Iron Age and Classical Period) in the Khor Rori Archaeological Park in the Dhofar region, southern Oman, show rich mollusc assemblages in the circular structures within the settlement and in a shell midden nearby. By analyzing the environmental requirements of the mollusc species identified, we reconstruct the past coastal environment during human occupation (9th century BC - 2nd century AD). Also, to reconstruct the palaeoclimate, we analysed through a high-resolution sclerochronological approach ten pristine mollusc specimens belonging to three species, namely, *Anadara uropigimelana*, *Tivela stefaninii*, and *Oliva bulbosa*. Our results show that the environment surrounding the HAS1 settlement was characterised by partially rocky shores and shallow-water sandy to sandy-muddy substrates, where the local population was used to collect shells. Indeed, mainly intertidal to shallow infralittoral taxa were recovered, both infaunal and epifaunal ones. Characteristics species of mangrove settings were recovered in very few numbers, indicating that this environment was not present or was restricted during the analysed time interval.

**DOUBLE-PHASED BIOMINERALIZATION PROCESSES IN MARINE INVERTEBRATES:
THE EXAMPLE OF CIRRATULIDS (POLYCHAETA, ANNELIDA) FROM SOUTHERN PERU**

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Carbonate biomineralization in marine organisms normally occurs as three distinct types, known respectively as: “controlled”, “induced” and “influenced”. Among invertebrates, reef-building tubeworms belonging to the family Cirratulidae appear to provide us with the first known example of “double-phased” biomineralization as they simultaneously combine controlled and induced biomineralization types in the formation process of their tubes. Miocene (*Diplochaetetes*) and Recent (*Dodecaceria*) bioconstructions from southern Peru were studied to investigate the mineral structure of cirratulids: the primary ultrastructure of the tube walls points to controlled biomineralization, while the “intertube” areas between walls filled by a calcareous matrix, frequently with agglutinating extraneous sand grains, are deemed the product of an induced biomineralization. The means by which this double biomineralization process occurs have yet to be described in detail. This study is therefore focused on this aspect by examining cirratulid aggregates via optical microscopy, epifluorescence, SEM, EDS analyses and morphometry. Results have also been statistically evaluated in order to detect the possible relationship between the size and chemical composition of the skeletal component and the morphology of the bioconstructions which in turn hints to environmental parameters. Both fossils and recent specimens show similar correlations among composition and morphometric parameters, suggesting that the development/evolution of these bioconstructions is presumably unaffected by environmental chemical/physical conditions. The peculiar double phased biomineralization system of cirratulids seems not evolved since the Eocene, when they appeared.

SEASONAL GROWTH PATTERNS OF PECTINIDS FROM THE WARM MEDITERRANEAN PLIOCENE

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Bivalves form their shells at varying rates throughout the year. Seasonal growth patterns can be identified through sclerochronological analysis, where growth increments represent interval of times in which the organism produces its shell and provide information on environmental conditions during growth, while growth lines identify periods of growth cessation, caused either by physiological processes (e.g., spawning) or abiotic factors, typically temperature. Here we compare micro-growth increments and stable-isotopes ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) of two stenohaline Pectinidae, *Gigantopecten latissimus* and *Pecten jacobaeus*, from mid-Pliocene deposits of Tuscany (Siena Basin, Italy). *G. latissimus*, with large and heavy shells, got extinct around 3.0 Ma ago; *P. jacobaeus* survived Plio-Pleistocene climate cooling and is the largest scallop inhabiting the Mediterranean Sea today. Our aim is to characterize the seasonal growth of the two species and to test if different strategies controlled species extinction or survival. The two Pectinidae show similar seasonal growth patterns, typical of bivalves of subtropical affinity, with higher growth rates during colder months and slower rates during warm periods, with summer cessation. *G. latissimus*, however, shows higher correlation between $\delta^{18}\text{O}$ and growth increments compared to *P. jacobaeus*, suggesting that temperature was a primary factor controlling its growth. Considering that in many subtropical bivalves, summer growth cessation coincides with the spawning period, we hypothesize that a drastic decrease in summer temperature after 3.0 Ma, hampered the reproduction potential of *G. latissimus* contributing to its extinction. The survival of *P. jacobaeus* can be explained instead by a less specialized life strategy. Studies on modern species indicate that it has multiple spawning intervals through the year, making it more adapted to a changing climate.

**MORPHOMETRIC ANALYSES OF THE PLIOCENE OYSTERS FROM BUTTIGLIERA
D’ASTI (ASTI, NW ITALY)**

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The aim of this study is the morphometric analyses of the Pliocene oysters from Buttigliera d’Asti (Asti). The most common oyster species is represented by *Ostrea edulis* Linnaeus, 1758, initially attributed to *Ostrea lamellosa* Brocchi, 1814, stored at “Museo Regionale di Scienze Naturali” of Turin (thanks to Dr. Annalaura Pistarino for the availability of the material). These samples (more than a hundred specimens) come from the outcrop called “Bosco delle Conchiglie”, a locality investigated by Caretto in 1982. The facies exposed at this outcrop is comparable to that described by Caretto himself (1981) for the locality “Becchi” of Castelnuovo Don Bosco (Asti), referred to the Middle-Upper Pliocene. The taxonomic revision is currently in progress; however, a preliminary morphometric study was conducted on the specimens of the collection. The applied parameters are: shell height (H), maximum shell length (W), hinge length (W1), distance between the resilifer area and the upper part of the muscle scar (H1), ventral length (W2), distance between the lower part of the muscle scar and the ventral margin (H2) and opening angle of the muscle scar (α), ratios W/H, W1/H1 and W2/H2. In particular, a database of points, landmarks and outlines has been created, in order to understand the abundance trend of specimens and their morphological development, in relation to the distribution of characters, respect to the left and right valves outlines. As for the samples of the Valle Botto area (Asti), “Riserva Naturale Valle Andona, Valle Botto e Valle Grande”, studied previously, it has been tried to verify if a morphological imprint of typical features for each “subgroups” with the same morphological peculiarity could have occurred. The study is in the preliminary phase, but it promises good utility in the analysis of the most similar specimens attributable to different “subgroups”.

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**NEW ALLODAPOSUCHID REMAINS FROM THE LATE CRETACEOUS OF CATALONIA
(SPAIN): INSIGHTS INTO DERMAL AND POSTCRANIAL SKELETAL ANATOMY**

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The Late Cretaceous of Europe was a pivotal time for the origin and early radiation of Crocodylia, the group containing all extant crocodylians. Notably, the most common crocodyliforms in this period are the allodaposuchids, whose remains are found in Spain, France, and Romania. Allodaposuchidae is a controversial and recently established clade, but its postcranial record is poorly documented. Here, we describe a new allodaposuchid specimen from the Fontllonga-6 fossil site (Àger Basin, NE Spain) in the lower red unit of the Tremp Formation (early-late Maastrichtian). The specimen is represented by teeth, postcranial, and dermal skeleton remains, and is the most complete crocodyliform from the Late Cretaceous of Spain, with over 30% of the skeleton recovered, including more than 70 osteoderms. Although some of the teeth recovered show diagnostic ornamentations for *Allodaposuchus palustris*, a confident taxonomic assignment is challenging due to poor postcranial record of the group. Taphonomic analyses reveal a disarticulated but probably autochthonous accumulation of bones. The specimen exhibits heterodonty, massive vertebrae, a large ribcage, and the recovered osteoderms show diverse morphology and size, providing insight into the position of these elements in the dermal skeleton. The overall morphology of the specimen suggests a bulky body, with a massive pectoral girdle that shows large areas of muscle attachment, and resembles that of *Allodaposuchus hulki*. This new finding sheds light on the poorly documented postcranial morphology of allodaposuchids, providing new insight into the diversity and ecology of crocodyliforms in the Late Cretaceous of Europe.

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DEEPBRYO: A WEB APP FOR BRYOZOAN AI-ASSISTED MORPHOMETRIC CHARACTERIZATION

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The colonial invertebrate phylum Bryozoa has played a fundamental role in classical debates on tempo and mode of morphological evolution. The order Cheilostomatida, in particular, shows a high degree of modularity and division of labor in the colonies: genetically identical, calcified modules develop into a wide array of polymorphs devoted to functions such as feeding, reproduction and defense. Thus, colony-level allocation of resources can be estimated from skeletal features using simple morphometric tools, providing a unique opportunity to study ecological and life-history traits in the fossil record. However, morphometric characterization of bryozoans is notoriously labored. It is usually carried out manually by a dwindling number of taxonomic experts, a process that is low-throughput, costly, and time-consuming to reproduce. Here, we present DeepBryo, a web app for deep learning-based morphometric characterization of cheilostome bryozoans from SEM images. DeepBryo tackles the problem of instance segmentation using state-of-the-art transformer models wrapped in a simple interface. The app detects objects belonging to six classes and outputs 14 morphological shape measurements for each object. The model shows high recall and precision for module-level structures and structure-level measurements are statistically indistinguishable from those obtained via manual annotation. DeepBryo reduces the person-hours necessary to process individual colonies to less than 1% of the time required for manual annotation making morphometric characterization of bryozoans cost-labor and time-efficient. This can greatly increase the scale of macroevolutionary and paleobiological analyses based on this model system. Lastly, with small changes in the source code, the object detection abilities of DeepBryo can be combined with other approaches, e.g., automated landmarking algorithms, and the repository contains all building blocks necessary to adapt the tool to other study systems.

**THE SILICIFIED MOLLUSCS OF PELSA-VAZZOLER (EASTERN DOLOMITES, ITALY) AND
THE LATE MIDDLE TRIASSIC DIVERSIFICATION OF MARINE LIFE**

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The Middle Triassic was a crucial time for the recovery of benthic marine communities after the end-Permian mass extinction. Following an Early Triassic lag phase, a global hyperbolic diversity increase is recorded in the Anisian, connected with the resurgence of large carbonate platforms. In the framework of this diversification, we studied a silicified, upper Ladinian invertebrate fauna recovered from limestones near the Vazzoler lodge, facing Mount Pelsa (Agordino Dolomiti). Facies analysis suggests that the Pelsa-Vazzoler shell beds were transported from a back-reef environment into a moderately-deep intraplatform lagoon. Intercalated fossil assemblages include fishes, plants and insects. The highly diversified marine invertebrate fauna is dominated by benthic molluscs, with subordinate cnidarians, brachiopods, sponges and echinoderms. The taxonomic study revealed 25 bivalve, 51 gastropod and one scaphopod species, for a total richness of 77 species in about 3000 molluscs specimens from seven bulk samples. The vast majority of the species have sizes smaller than 10 mm. The high diversity of gastropods suggests a strong effect of biotic interactions on rates of diversification, relating high richness of small herbivores with new niches made available by producers of carbonate platforms. This new finding fills a knowledge gap between the upper Anisian-lower Ladinian diversity plateau and the exceptional early Late Triassic Lagerstätte of the San Cassiano Formation, also in the Dolomites. The Cassian fauna yields the highest species richness reported from any pre-Cenozoic formation known to science, amounting to a total of 857 species of benthic molluscs recovered in 30 localities. The Pelsa-Vazzoler alpha diversity $S=77$ is comparable to the mean value of 96 species per locality of the famous Cassian 'liberation Lagerstätte', or possibly larger if one considers that the latter are known thanks to almost two centuries of collection effort and taxonomic research.

ASSESSING RELEVANCE AND VULNERABILITY OF PALAEOLOGICAL SITES: AN ANALYTICAL PROCEDURE

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Every year, hundreds of square kilometres are affected by land development projects that may result in the destruction of everything preserved in the sediments. Geopalaeontological heritage, however, rarely receives the same legislative attention reserved to the archaeological one. Part of the problem seems to be, at least in some contexts, the difficulty to acknowledge fossils as distinct assets from other cultural heritage objects and the lack of expertise among the administrative functionaries. For this purpose, the Earth Science Department of the University of Florence is carrying out a PhD project focused on the evaluation, planning and practical intervention of vulnerable areas of Tuscany using GIS. This study aims to describe and test an objective analytic operational procedure that could allow assessing the relevance of any fossiliferous site and its potential vulnerability in its present state. The estimations were obtained using numerous quantitative and qualitative parameters that could describe the probability of fossil discovery for each site (Pr) and scientific and cultural interest of the locality (In). Further subcategories refine these parameters, improving their definition. Simple equations are used to obtain two main indexes: the Site Relevance (R^*), generally expressed as a percentage, and the Vulnerability index (V). Such indexes are made to be applicable to any type of locality, from those with tracks and indirect evidence to direct fossil-bearing sites. To assess the validity of the methodology we tested the indexes on several localities, different from several features (e.g., site extension, site typology, fossil richness and diversity). The results show that the proposed indexes properly describe and characterize each locality. Such an operational procedure is a simple and objective method allowing palaeontologists and non-expert personnel to categorize localities, and therefore act as a base to plan actions in geopalaeontological heritage management, relative to territorial development and land use.

60 YEARS OF THE ITALIAN PALEONTOLOGICAL SOCIETY THROUGH ITS JOURNAL

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The recent reorganization of the *Bollettino della Società Paleontologica Italiana*, with the setting up of an electronic platform for article submission and the completion of the digital archive, enabled as well to revisit the history of the Italian Paleontological Society. Founded in 1947, the Society was officially established in the form of an Association in 1960 when it became obvious to a group of attendees that there was sufficient interest to form a Society. Simultaneously, the Society decided to publish its own journal, named *Bollettino*, with the specific aim of adhering to “*the desire, expressed many times by the Members, to have a national gymnasium of their own, for scientific activity of a clear paleontological nature*” (Montanaro Gallitelli, 1960). Initially published twice a year, the journal shifted later to three issues a year. The language also evolved from contributions in Italian, German, English, French and Spanish to submissions in Italian and English and, recently, only in English. The earliest annual reviews of the social activity are the most direct way to meet the Society through the years, with descriptions rich in anecdotes of the first large meetings, detailed reports of the weather conditions and curiosities (and mistakes) of the past Presidents. What is even more striking is that the original rules given by the Editor in the first page of the *Bollettino* keep being so deeply alive: “*Whoever the editor is tomorrow, let us ask him/her to be relentless in his/her criticism of the authors, as long as the criticism does not demolish but improves. In this way ... the works will be useful, clear and readable*” (Montanaro Gallitelli, 1960). During the past 60 years, the Society has been alive also through its journal thanks to the many pioneers and scientists who have contributed and disseminated research in all fields of paleontology. This presentation will highlight the changes of a Society that is now celebrating over 75 years of progress.

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**REASSESSMENT OF A PUTATIVE PELTOPLEURID FISH FROM THE SINEMURIAN
(LOWER JURASSIC) OF OSTENO (COMO, ITALY): PRELIMINARY RESULTS**

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Between 1964 and 1980, the Museo di Storia Naturale di Milano conducted a series of excavations in the Sinemurian Osteno Quarry (Lugano Lake, Como, Italy), resulting in the discovery of hundreds of fossils, including exceptionally preserved plants, invertebrates, and about 100 fish specimens (Duffin & Patterson, 1993). Notably, one of the most distinctive fossil fish from this Jurassic site is a specimen (MSNM V659) that consists of part and counterpart of an almost complete actinopterygian, measuring about 90 mm in length. Although briefly described by Duffin & Patterson (1993), its taxonomic attribution is challenging due to the inadequate preservation, which precludes observation of most of the skull traits and offers a limited view of the unpaired fins. Duffin & Patterson (1993) suggested a certain degree of similarity to the genus *Peripeltopleurus*, primarily based on the presence of vertically elongated scales on the body flanks and broad pectoral fins. Recent research on the actinopterygian fauna of Osteno prompts a re-evaluation of its taxonomic position, taking into account that this specimen probably represents the only known Jurassic survivor of the order Peltopleuriformes, hitherto considered as restricted to Middle-Upper Triassic (Xu & Ma, 2016). Summarizing, this study will contribute to a better understanding of the evolution of actinopterygian fishes during the Lower Jurassic and of the possible persistence of the order Peltopleuriformes after the Triassic-Jurassic boundary.

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THE ANALYSIS OF THE FRONTAL SINUS IN THE GENUS *EUCYON*: EVOLUTIONARY AND ECOLOGICAL INSIGHTS

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This study has analyzed the development of the frontal sinus in three different species of genus *Eucyon* (Mammalia, Canidae). The frontal sinuses are cavity of the cranium within the frontal bone, whose origin and evolutionary relevance are still poorly understood and debated even in extant canids. Moreover, no prior study has taken in consideration the analysis of this structure in fossil canids. Using Virtual Paleontology techniques, we reconstructed and analyzed these paranasal cavities aiming to explore the relationship between this structure and their phylogenetic and paleoecological influence, through the description of their development in extant and, especially, fossil species. According to the more widely accepted hypothesis, the function, morphology and size of the frontal sinus are linked to the dietary preferences and biomechanics of feeding. Indeed, their inflated shapes allow dispersing the stresses during hunting and feeding as in durofagous species, e.g., in hyenas where the frontal sinus expands greatly caudally into the sagittal crest toward the occipitals. The study focused mainly on *E. adoxus*, a poorly-known species from the Late Pliocene of Southern France, whose fossil type is particularly well preserved. The study used CT and microCT scans of the fossil and of extant specimens of the genus *Canis*, *Lupulella*, *Lycaon* and *Vulpes* to perform morphological and morphometric comparative analyses. Although this study is still preliminary, a relationship was identified between the fossil species and extant specimens, especially for what concerns the ecological adaptations. Particularly, the frontal sinus of *E. adoxus* has some affinity with that of *Canis simensis*. This hints that the two species might have had similar dietary habits, confirming the evident cranial and dentognathic affinities.

MICROBIAL BIOMINERALIZATIONS IN TIDALLY-INFLUENCED SUBTERRANEAN SETTINGS (ZINZULÙSA CAVE, CASTRO, ITALY)

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The tidally-influenced subterranean settings represent natural geomicrobiological laboratory, not yet explored, that make possible the investigation of new biomineralization processes. The peculiar chemical conditions of these environments derive from the complex mixing of seawater with freshwater and their interactions with the surrounding sediments. In particular, in the Zinzulùsa cave, the marine waters interact with organic deposits and generate hydrogen sulfide as a result of sulfate reduction. This peculiar water chemistry and the oligotrophic and aphotic conditions of this system allow the development of a unique ecosystem in which complex bacterial activities induce rare biomineralization processes. Actually, a diversified microbial community has been demonstrated to develop on the bottom and on the walls of the cave, in particular on centimeter-thick crusts that form at a depth of 3-4 m. The crusts show a variable color from the black of the external surface to the white in the most internal part, passing through different tonality of brown to the medium portion. They are formed of very fine anhedral to sub-euhedral crystals organized in irregular laminations. The thinner black external cover, few microns in thickness, is composed of ferromanganiferous oxides, while the remaining part is formed of Ca-phosphate minerals, mostly carbonate-fluoroapatite, independently from the color and texture. Diffuse spheroidal corpuscles, segmented filaments and amorphous organic matter are mixed with the minerals. The organic nature of ferromanganiferous cover and Ca-fluoroapatite is demonstrated by their high fluorescence under UV-excitation and organic bands in Raman spectra. The overall data point to biomineralization processes, induced by microbial metabolic activities or influenced by organic matter taphonomy, for the deposition of both the component of the crusts.

BETHLEHEM SUIDS RECONSIDERED: CHRONOLOGICAL AND PALEOBIOGEOGRAPHIC IMPLICATIONS

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The Pliocene is a critical period in the study of faunal exchanges between Africa and Eurasia through the “Levantine Corridor”, a biogeographic crossroad between these continental landmasses. Yet, very few Pliocene fossil localities are known from the region. The site of Bethlehem, excavated during the 1930s and 1940s (Bate, 1934, 1941; Garrod & Bate, 1937), yielded a unique fauna that has been referred to as Villafranchian (Hooijer, 1958). Over the years, the site has been either regarded as Late Pliocene or Early Pleistocene in age. Recent studies on revising the archival documentation and fauna of this unique locality had suggested an earlier age based on the proboscideans and rhinoceros (Rabinovich & Lister, 2017, Pandolfi et al., 2020). Bethlehem suids, which were assigned by Hooijer (1958) to *Sus cf. strozzii*, a species that would be at odds with a Pliocene age, are here reevaluated. Following comparison with relevant Pliocene and Pleistocene suids from Eurasia and Africa, Bethlehem suids are reassigned to *Sus arvernensis*. *Sus arvernensis* is a Pliocene species best represented in faunas correlative of the Triversa Faunal Unit (MN 16a), not firmly documented in the European fossil record after ca. 3 Ma. Thus, the occurrence of *S. arvernensis* is an important biochronologically constraint. The presence of the species, aligned with recent studies, suggests both a mosaic origin of African and Eurasian species and a Pliocene age for the fauna of Bethlehem.

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THE FIRST KUNGURIAN FOSSIL FOREST REVEALS WETLAND CONIFERS TO THRIVE IN PERI-TETHYAN PANGAEA

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Fossil forests in-situ are valuable biological archives for the structure and setting of paleocommunities and the ecology of their organisms. Here, we present the first trees preserved in growth position from the Kungurian (early Permian) Athesian Volcanic Group, N-Italy—one of the most extensive volcanic successions in Europe. The high-resolution documentation of facies architectures and petrography and the paleontological and taphonomic characterization of the fossil content permitted reconstructing the structure, rise and demise of the forest and drawing paleoecological implications. The fossiliferous strata reflect the volcanotectonically controlled base-level rise in a limnic, possibly endorheic wetland basin from a low-relief volcanic landscape. The forest, preserved as calcified stem bases with roots, grew during a short interval of lake-level stasis on a small deltaic sheetflood fan. Less than 5 m tall trees with tabular root systems adapted to the waterlogged substrate built up the forest buried and destroyed by mass flows following rapid submergence. These obrution deposits yield para-autochthonous woody debris providing anatomical evidence of conifers as the major arborescent plants of the fossil forest. Our results not only elucidate the root architecture of Paleozoic conifers. They also document the ecomorphological plasticity of these plants and predate their appearance in wetlands to the early Permian. The evidence of lake perenniality in the studied succession is the youngest known from Europe, indicating late-icehouse aridification in the Euromerican tropics to be much more differentiated in space and time.

***PLIOVIVERROPS FAVENTINUS*, A SMALL MESSINIAN HYAENID FROM ITALY: A
REVISION**

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We present the revision of the fossil hyaenid *Plioviverrops faventinus* (latest Miocene, Cava Monticino, Brisighella, RA), probably the last and most derived species of the genus *Plioviverrops*. After the description of the abundant (and unpublished) cranial and dental material of this species, we focused on the morphological and morphometrical comparison of the species with other carnivores aiming to clarify the ecological role that this hyaenid played in the late Miocene guild. Our results indicate, by size and morphology, the families Herpestidae and Viverridae as the taxa more similar to *P. faventinus*. A range of species of these families was therefore selected to make more targeted comparisons of dental morphologies with *P. faventinus*, looking for the most similar taxa and to infer on the ecological niche occupied by the taxon under study. In further morphometric comparison, in addition to the species used for morphological comparison, several other Carnivora species (belonging to 9 families) were considered in order to have a wider and more complete vision of the morphospace occupied by *Plioviverrops faventinus*, and therefore of its possible ecological role. To perform the former, extant species have been added two other fossil species belonging to the same genus: *Plioviverrops guerini* and *Plioviverrops orbigny*. The results of the analyses do not show a clear exclusive affinity with the examined species of herpestids or with those of viverrids, suggesting that *P. faventinus* occupied an ecological niche that we can assume by and large comparable to that of *Herpestes naso* and *Viverra megaspila*. Concerning the comparative analysis with the fossil species of the genus, *P. faventinus* is more similar to *P. orbigny*. In conclusion, the analyses carried out allow us to hypothesize that *P. faventinus* was a species with a hypocarnivorous diet, based on both invertebrates and small vertebrates, but also on vegetables and other food resources (e.g., eggs).

***PACHYROCUTA*, AN ACTIVE HUNTER OR A SOCIAL SCAVENGER? INSIGHTS FROM
POSTCRANIAL MORPHOLOGY**

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Pachyrocuta brevirostris is one of the most abundantly recorded carnivoran species during the late Early Pleistocene in European large mammal assemblages. During the last decades controversies regarding its feeding behavior arose. Some researchers advocate for a strictly scavenging behavior and a kleptoparasitic relationship with sabertoothed cats, while others hypothesize a feeding behavior more similar to the extant spotted hyena. In one way or the other, all the former inferences were based on the only known putative complete skeleton of this species, a specimen from the Middle Pleistocene Zhoukoudian-1 site in China. Here we present two new partial *Pachyrocuta* skeletons from Upper Valdarno and Vallparadís Section sites, respectively. The postcranial evidence from our samples shows less marked reduction of the distal limb segments compared to previously reported measures, and body proportions more similar to *Parahyaena brunnea* than to the Late Pleistocene *Crocuta spelaea*. Additionally, our body mass estimations show a high degree of variability in body size with a range from 80 to 160 kg, estimated on both cranial and postcranial specimens. Overall, the postcranial evidence of *Pachyrocuta* shows a lower specialization for carcass transport and cursoriality as compared with extant forms. Considering its body mass, the feeding habits of *Pachyrocuta brevirostris* probably differed from that of any extant form, characterized by conspicuous food intake necessarily derived from hunting as well as scavenging.

COCCOLITHOPHORE VARIATIONS IN THE SUBANTARCTIC SOUTH PACIFIC ALONG LATE QUATERNARY GLACIAL-INTERGLACIAL CYCLES

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During IODP Expedition 383 - Dynamics of the Pacific Antarctic Circumpolar Current (Lamy et al., 2019; 2021), three sites were drilled in the Pacific sector of the Southern Ocean in order to explore changes in atmosphere-ocean-cryosphere dynamics on glacial-interglacial cycles. The Southern Ocean is a significant area influencing global ocean circulation and climate. The Antarctic Circumpolar Current (ACC), driven by strong westerly winds, is the world's strongest zonal current system that connects all three major ocean basins of the global ocean. The ACC has an important role on global climate by affecting the global Meridional Overturning Circulation and the stability of Antarctic ice sheets. It is also one of the key players in regulating atmospheric CO₂ concentration, through changes in upwelling strength and related biological productivity, and export of dissolved inorganic carbon. Here we focus on sediment cores retrieved at Sites U1539 (56°09.0655'S, 115°08.038'W, ~1600 NM west of the Strait of Magellan at 4070 m water depth) and U1540 (55°08.467'S, 114°50.515'W, ~1600 NM west of the Strait of Magellan at 3580 m water depth), located in a latitudinal transect of the central South Pacific, across the ACC. We performed quantitative analyses (i.e., coccoliths/gram of sediment estimates) and we used coccolith absolute abundance as a proxy of past carbonate export production. We consider the abundance patterns of selected species as proxies for paleoproductivity changes (e.g., small *Gephyrocapsa*) as well as temperature variations (warmer / colder taxa, e.g., *G. caribbeanica* and *Helicosphaera* spp. / *Coccolithus pelagicus*). Coccolith absolute abundances change dramatically in the studied cores, ranging from high values during interglacials (up to ~1011 coccoliths per gram of sediment during Marine Isotope Stage 11) to extremely low values during glacials, where siliceous microfossils, mainly diatoms and minor silicoflagellates, dominate.

Lamy F., Winckler G., Alvarez Zarikian C.A. & Expedition 383 Scientists (2019). Expedition 383 Preliminary Report: Dynamics of the Pacific Antarctic Circumpolar Current. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.383.2019>.

Lamy F., Winckler G., Alvarez Zarikian C.A. & Expedition 383 Scientists (2021). Dynamics of the Pacific Antarctic Circumpolar Current. Proceedings of the International Ocean Discovery Program, 383. <https://doi.org/10.14379/iodp.proc.383>.

**DOUBLE-ARMOURED HERRINGS (CLUPEOMORPHA: ELLIMMICHTHYIFORMES)
FROM THE LOWER CRETACEOUS OF PIETRAROJA (SOUTHERN ITALY)**

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Known since the end of the XVIII century for its exquisitely preserved fossils, the Lower Cretaceous (Albian) Plattenkalk of Pietraroja (BN, southern Italy) is one of the most celebrated Italian palaeontological sites, especially after the discovery of the first complete dinosaur skeleton found and described in Italy, *Scipionyx samniticus*, exquisitely preserving internal organs and other soft tissues. The clupeomorph fishes of the Pietraroja were among the first fishes described for this world-famous Italian Konservat-Lagerstätte. However, a detailed anatomical and phylogenetic study has never been carried out on these fishes in order to clarify their taxonomic status, systematic position, and relationships within the Clupeomorpha. The examined specimens exhibit diagnostic features that clearly support their alignment with the extinct double-armoured herring order Ellimmichthyiformes. Based on the presence of an incomplete series of heart-shaped predorsal scutes, a new combination, *Armigatus elatus* (Costa, 1850), and the new species *Armigatus plinii* Marramà & Carnevale, 2023 are recognized as the oldest representatives of the ellimmichthyiform family Armigatidae, whereas a unique combination of features allows us to recognize most of the specimens as a new representative of the family Paraclupeidae, *Paraclupea pietrarojae* Marramà & Carnevale, 2023. The presence of lower Albian species of *Armigatus* and *Paraclupea* in the Western Tethys extends the temporal and biogeographical range of these widely distributed genera, providing additional information for our understanding of the evolutionary and biogeographical history of the double-armoured herrings.

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NEW PALEONTOLOGICAL RESULTS ON THE EARLY MIDDLE PLEISTOCENE OF NOTARCHIRICO (VENOSA, SOUTHERN ITALY)

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The archaeological and paleontological site of Notarchirico (Venosa Basin, Basilicata, Italy) is a reference locality for the study of the human occupation of Mediterranean Europe during the Middle Pleistocene, the evolutionary trends of the fauna, and paleoenvironmental reconstructions during the Early-Middle Pleistocene Transition. Through the 1930s and 1950s, several archaeological and paleontological deposits were discovered in the Venosa Basin, among these Notarchirico, firstly investigated by Virginia Ginetta Chiappella in 1956. The systematic excavations started during April 1980 and continued until 1995, under the direction of Marcello Piperno, with the support of the Italian Institute of Human Paleontology (IsIPU, Anagni, Latium). The extraordinary richness of the site led to the foundation of the Paleolithic Park of Notarchirico, where part of the archeological and paleontological finds is still preserved *in situ*. After more than twenty years, a new project was resumed, coordinated by Marie-Hélène Moncel (CNRS). The aims of the new project are: i) to redefine the age of the different layers by biostratigraphy and radiometric dates; ii) to investigate the basal part of the succession (levels I-F), that was poorly excavated in the past and recently dated between 695-670 ka through ⁴⁰Ar/³⁹Ar and ESR methods; iii) to study the newly excavated materials; iv) to restudy the previous excavated collection from the Paleolithic Park of Notarchirico (stored at the National Archeological Museum of Venosa “Mario Torelli” and at the Museum of Civilizations, Rome, in addition to the fossils *in situ* exposed). Here, we will present the preliminary paleontological results of the new project in the light of the broader framework of the mammal faunal evolution during the Early-Middle Pleistocene Transition.

**IT'S TIME TO EAT: GREAT WHITE SHARK (*CARCHARODON CARCHARIAS*) BITE MARKS
ON BALAENID (RIGHT WHALE) REMAINS FROM THE PLIOCENE OF TUSCANY
(CENTRAL ITALY)**

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Modern marine waters are inhabited by more than 500 shark species. Among them, the great white shark (*Carcharodon carcharias*) represents the apex predator of the present-day global ocean. Even if *C. carcharias* is well-known as a formidable active predator of marine mammals (pinnipeds and odontocetes), it may also behave as a scavenger. In fact, several anecdotal and scientific documentation exists for white sharks feeding on floating whale carcasses, which are rich in blubber, and consequently, highly energetic. Given the latest Miocene origin of *C. carcharias*, the Plio-Pleistocene marine deposits can preserve evidence of the feeding interaction between white sharks and marine mammals in the form of bite marks on bones and/or teeth embedded into (or closely associated with) marine mammal skeletons. Here, we report on two new examples of white shark-cetacean trophic interaction from the Pliocene of Tuscany (Italy), consisting of two scapulae that are densely incised by serrated shark bite marks, up to several centimeters long. The morphology and regular denticulation of the latter allows for identifying the great white shark as the tracemaker. One scapula, stored in the Museo Geopaleontologico GAMPS of Scandicci (Italy), comes from Monterotondo Marittimo (southern Tuscany), whereas the other is part of the historic collection of Tuscan Pliocene cetaceans of the Museo G. Capellini of Bologna (Italy), but its precise provenance is actually unknown. Based on osteoanatomical considerations, these scapulae can be referred to two distinct species of small balaenids (i.e., right whales). Considering the fragmentary nature of the studied specimens, whether the observed bite marks represent scavenging or active predation could not be assessed. What is remarkable here is the kind of trophic interaction that it witnesses to, which includes members of baleen whale morphotypes that are no longer present in the modern Mediterranean Sea, not even in the rest of the global ocean.

BIVALVE RESPONSE TO PLIO-PLEISTOCENE CLIMATE CHANGE IN THE MEDITERRANEAN SEA

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The Mediterranean Sea is recognized as a hotspot of marine biodiversity. Analyzing its past biodiversity can help in understanding species response to climate change. In this study we built a species level dataset of bivalve occurrences that spans the Zanclean-Calabrian interval, a time characterized by strong climate change, with the shift from subtropical to temperate conditions. Data were gathered from the literature and, after taxonomic and chronostratigraphic revision, include a total of 400 species belonging to 68 families, collected in 138 localities from the Eastern to the Western Mediterranean Sea. We measured changes in species richness and turnover (i.e., proportion of species either gained or lost relative to the total number of species) through time, after dividing the record into four consecutive time bins. Since the number of sites and occurrences was uneven across time, with the lowest values in the Gelasian, we rarefied the data to make them statistically comparable. Our results confirm a loss of biodiversity since 3 Ma, although we find that this phenomenon was less intense and more gradual than previously estimated (loss of 17% of species from the Pliocene to the Pleistocene). We also observed that, although bivalve richness continues to decrease through time, with the loss of warm-water species, the Early Pleistocene has the highest proportion of species appearance. Species loss is counterbalanced by the introduction of boreal guests, especially during the Calabrian, which is the interval of time with the highest turnover (24%). In addition, we divided bivalve species according to different combination of tiering and feeding categories and paleoenvironments. Our results further show that among the most abundant feeding/tiering categories, suspension feeders (both infaunal and epifaunal) lost a higher proportion of species compared to infaunal deposit feeders. Similarly, we found that species loss was higher on the shoreface compared to the shelf.

ENDOCRANIAL PNEUMATIZATION OF *URSUS SPELAEUS* AND IMPLICATIONS IN THE BITE FORCE

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The cave bear (*Ursus spelaeus*) is one of the best known extinct carnivorans of the Middle-Late Pleistocene ecosystems of Eurasia. The cave bear lineage (*U. deningeri* - *U. spelaeus*) and that of the extant brown bear diverged approximately 1.2 million years ago from the common ancestor *U. etruscus*, while approximately 24,000 years ago *U. spelaeus* became extinct together with other representatives of the Pleistocene megafauna. Numerous hypotheses have been proposed about the ecology and diet of *U. spelaeus*. Early morphological studies suggested that the cave bear was likely specialized on processing tough and/or abrasive foods, while later microwear studies indicated that it was omnivorous and may have consumed more bone than *U. arctos*. Moreover, CT based simulations see the frontal sinuses as a biomechanical trade-off in mastication and as an adaptation to long hibernation periods. What emerges is still an open debate regarding an increasingly complex interpretation of the paleobiology of *U. spelaeus*. Here, we present the preliminary results on the morphology of the inner cranial pneumatizations of *U. spelaeus*, interpreted as flexible structures designed to dissipate shear stresses during the bite. Through CT scans and digital reconstructions, we compare the cranial pneumatizations between *U. spelaeus* and other extant and fossil taxa, to highlight similarities and differences in the structures adapted to dissipate the stresses caused by the bite muscle contractions. These interpretations, together with other evidence in literature, could be useful in better understanding the potential of the biting force in *U. spelaeus*, in order to contribute to shedding light on its paleobiology.

SYNCHROTRON TOMOGRAPHY PROVIDES NOVEL INSIGHTS INTO THE DENTAL ANATOMY OF *ACYNODON ADRIATICUS* (EUSUCHIA, HYLAECHAMPSIDAE)

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The Villaggio del Pescatore quarry (Duino-Aurisina, Trieste, Italy) has produced an exceptionally preserved, multitaxic fossil assemblage dated to the earliest Campanian. An ongoing research project focusing on the site vertebrate diversity led to a comprehensive revision of the material assigned to the small hylaeochampsid *Acynodon adriaticus*. As specimens are preserved in limestone there are major limits in mechanical preparation, whereas chemical dissolution of the matrix has been largely employed in the past. To reduce further risks related to preparation processes, key specimens have been the target of μ -Ct scanning (void resolution of 28 μ m) at the Elettra Synchrotron facility in Trieste. We here present preliminary results of μ -Ct tomographies of MCSNT 57248, type specimen of *A. adriaticus*, which include a complete and articulated skull with the complete cervical series. Data allowed to unfold the complete dentition of this taxon revealing a previously unknown heterodonty, with large molariform dentary teeth. Living sauropsids with similar teeth morphology are durophagous predators consuming hard-shelled mollusks. Some extinct taxa with analogous traits, such as placodonts and globidensine mosasaurs, seem to confirm the same predatory specialization. We propose benthic mollusk foraging (i.e., bivalves and gastropods) as a potential explanation for the heterodonty, peculiarly flattened skull and splanchnocranium anatomy of *A. adriaticus*. Technical issues regarding specimen size and placement emerged during the acquisition, and despite the high-energy tomographic approach, high-density limestone matrix and partial diagenetic deformation led to low-contrast final imagery, preventing precise recognition of any other anatomical structures apart from the contrasting teeth enamel. Despite technical challenges, digital paleontology remains a key aspect of future researches on vertebrate and invertebrate fossils from the Villaggio del Pescatore site.

CAMBRIAN BIPARTITE ANIMALS REVEAL A LOST CHAPTER IN CHORDATE HISTORY

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Chordates are among the most disparate and ecologically significant animal phyla, but our understanding of their earliest evolution is hampered by a lack of convincing intermediates between canonical early chordates, like *Pikaia* (Conway Morris & Caron, 2012), and other deuterostomes. In consequence, current understanding of the origins of chordates is built largely on the developmental biology and interrelationships of their derived living representatives (Lowe et al., 2015). Vetulicolians and vetulocystids are enigmatic Cambrian bilaterians with a distinctive bipartite body plan, variously interpreted as stem-group deuterostomes, tunicates, echinoderms, or ecdysozoans (Shu et al., 2004; Aldridge et al., 2007). We present new exceptionally preserved vetulicolians and vetulocystids from the Sirius Passet and Chengjiang Lagerstätten (Cambrian, Series 2), informing the most complete phylogenetic test of early deuterostome interrelationships to date. Contrary to previous studies we resolve these “bipartite animals” as paraphyletic, and part of a grade of stem-group chordates including the problematic bilaterian *Yunnanozoon*. These results shed light on the morphology of the last deuterostome common ancestor and challenge the current consensus on the polarity of character acquisition in Chordata, casting doubt on popular enteropneust- and amphioxus-based models of its ancestral body plan (Lowe et al., 2015). Instead, in accord with classical evolutionary-developmental hypotheses (Romer, 1972), our findings chart an early phase of chordate evolution defined by the gradual integration of the pharyngeal region with a segmented tail, revealing a “lost chapter” in the history of our phylum.

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**FIRST MEDITERRANEAN RECORD OF THE DELPHINIDAN GENUS *KENTRIODON* FROM
A NEW LOWER MIOCENE ODONTOCETE LOCALITY AT FELTRE (NORTHEASTERN
ITALY)**

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Fossil odontocetes from the “Belluno Molasse” (Friulian-Venetian basin, northeastern Italy) have been mainly studied and described by Giorgio Dal Piaz in the early 20th century. These historic finds originate from outcrops in the neighborhood of Belluno where the Lower Miocene Libano Sandstone was quarried. This odontocete assemblage depicts a costal-marine (or even estuarine) fauna that includes seemingly endemic lineages such as Dalpiazinidae and Eoplatanistidae. The odontocete remains from the Belluno area are crucial to understand the diversity and richness of marine vertebrate communities in the Early Miocene, a key moment for the evolutionary radiation of many odontocete lineages. New odontocete remains have recently been found by one of the authors (P.V.) in the Colle della Croce quarry (Feltre, Belluno Province). The strata cropping out therein belong to the aforementioned Libano Sandstone (represented by a distal, fine-grained facies) and to the overlying Bolago Marl, both dating back to the Early Miocene. Most of the odontocetes from the Colle della Croce quarry (including the specimen here examined) originate from the Bolago strata, which we have preliminarily dated to the Burdigalian by means of nannoplankton biostratigraphy. In the present work, we focus on a partial cranium including associated ear bones (right petrosal, stapes, malleus and right tympanic bulla). This specimen was recovered from the Bolago Marl strata of Colle della Croce quarry and is housed at “Museo Civico Archeologico” in Feltre. Osteoanatomical considerations and comparisons with other early-branching delphinidans kentriodontid genera allow to assign the cranium and ear bones to the kentriodontid genus *Kentriodon*. This is the first record of *Kentriodon* in the Mediterranean Basin – one that fills a palaeobiogeographical gap in the distribution of this genus, which was widespread globally during the Early and Middle Miocene.

DECONSTRUCTING THE CLASSICAL LATE MIOCENE FAUNAL ASSEMBLAGES OF THE TUSCO-SARDINIAN PALEOBIOPROVINCE

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Over the past decades numerous studies have been aiming to reconstruct the evolution and faunal succession of endemic mammals from the Late Neogene of the Tyrrhenian area in the Tusco-Sardinian paleobioprovince. In particular, four fossil vertebrate-bearing faunal assemblages, V0 through V3, have been recognized along the Upper Miocene sedimentary succession at the Baccinello-Cinigiano Basin. The V0 to V2 faunal assemblages belong to an endemic faunal complex, the so called “*Oreopithecus*-Zone Faunas [OZF]”, with a high level of endemism, low taxonomic diversity, and a tendency for the development of hypsodonty. The V3 faunal assemblage instead includes continental taxa with Eurasian affinities such as the genera *Hippotherium* and *Procapreolus* and the species *Pliorhinus megarhinus*. The localities belonging to the V1 and V2 faunal assemblages are rather similar in composition, but the V2 fauna includes new immigrants such as *Parapodemus* sp. II, *Eumaichoerus etruscus*, as well as, most probably, *Indarctos anthracitis*, suggesting a temporary reconnection with Europe. Furthermore, the V2 fauna shows new species resulting from the in situ evolutionary transformation of locally endemic forms. New data resulted from the revision of the mammal remains from the Tusco-Sardinian paleobioprovince suggests that some assemblages could be intermediate between the classical V1 and V2 assemblages from Tuscany, but also suggests the existence of separated areas within the Tusco-Sardinian Paleobioprovince. A new paleogeographic and biochronological framework is proposed herein for the Tusco-Sardinian archipelago, hypothesizing a fragmentation of the area into several domains, with sporadic reconnections, and the establishment of different faunal assemblages.

MIDDLE PLEISTOCENE TO HOLOCENE OSTRACOD ASSEMBLAGES FROM THE CORINTH GULF

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Ostracods have a great potential for ecological monitoring and palaeoecological analyses in highly variable environments, especially in transitions between freshwater-brackish and brackish-marine habitats. They are an excellent proxy for the palaeoenvironmental reconstruction of a setting that connects and disconnects to the global oceans, being the only aquatic proxy that could occur continuously in environments with a large difference in chemical-physical parameters. Within the International Ocean Discovery Program (IODP) Expedition 381 in the Gulf of Corinth, ostracods assemblages have been studied from two sediment cores sampled in two different sectors: M0078 in the center of the Corinth Gulf and M0080 in the eastern part of the gulf, in the Gulf of Alkyonides. The two cores have quite a different sedimentation rate, that affects the diversity and richness of the ostracod assemblages. The comparison between the ostracod fauna in the two cores has allowed the identification two different kind of assemblages: 1) Mediterranean marine (*Cytheropteron* spp.; *Henryhowella* spp.; *Aurila* spp.; *Cytherois* spp.); 2) Brackish with Black Sea influences (*Amnicythere* spp.; *Tuberoloxoconcha* spp.; Candonidae). These assemblages indicate a complex history of sea level changes that changed the drainage and depth of the Corinth Gulf during the last 200 ky. The analysis of the ostracod assemblages has allowed to reconstruct a detailed history of the glacial and interglacial cycles since the late Middle Pleistocene.

**THE OUTSTANDING *DAMA*-LIKE DEER SAMPLE FROM VALLPARADÍS ESTACIÓ
(IBERIAN PENINSULA, EARLY PLEISTOCENE)**

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The Vallparadís composite section (VCS) includes the two paleontological sites of Cal Guardiola (CGR) and Vallparadís Estació (EVT), located in the western and eastern banks of the Torrent de Vallparadís, respectively (Terrassa, Catalonia, NE Iberian Peninsula). The whole VCS records a timespan from the late Early to the earliest Middle Pleistocene (ca. 1.1–0.6 Ma). From its layers, more than 30,000 vertebrate remains were recovered, making VCS one of the richest Pleistocene paleontological sites in Europe. In this current work, we present the preliminary study of the small cervid sample from Early Pleistocene EVT layers, consisting of both craniodental and postcranial remains for a total of more than 400 specimens. Amongst the remains, noteworthy is the exceptional presence of three complete antlers, as well as postcranial elements preserved in anatomical connection. Both quantitative and qualitative comparisons suggest the attribution of the sample to a Plio-Pleistocene *Dama*-like deer. More specifically, the morphology of the EVT antlers fits that of those from CGR analyzed previously, and both samples resemble those from the latest Villafranchian and Epivillafranchian sites of Capena, Pietrafitta, Collecureti (Italy), Le Vallonnet (France), and Untermassfeld (Germany). These records have been attributed to different taxa that can be grouped into the cluster of *Pseudodama farnetensis-vallonnetensis*. Further analyses of the VCS material, which is one of the largest fossil collections of this group of cervids in Europe, will expand our knowledge and shed further light on the geographic and chronological distribution of the group, as well as its phylogenetic relationships and taxonomic status.

MICROBIALLY MEDIATED CA-CARBONATE PRECIPITATION IN TUFA FLUVIAL SYSTEM: AN INNOVATIVE APPROACH TO DEVELOP A NEW GENERATION OF SUSTAINABLE BIO-INSPIRED MATERIALS

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For many decades fossil and recent microbial mediated carbonates, that include the oldest evidence of life on Earth (stromatolites), were the focus of numerous studies. Recently these bio-sedimentary systems inspired an innovative approach to produce sustainable biomaterials, to reduce the harmful impact on the natural environment due to industrial activities, such as microbially induced Ca-carbonate precipitate (MICP). MICP has been studied for many applications including environmental remediation, production of construction material, cations removal in wastewater, and carbon sequestration. With the aim to develop a bio-cement for increasing the geotechnical properties of a common multimineral sand, a more sustainable process of MICP was tested introducing the sand in the water flow of a tufa-forming river with active microbial Ca-carbonate deposition. The tufa deposits are covered by a lithifying biofilm composed of a microbial community including autotrophic and heterotrophic bacteria, algae, viruses, and extracellular polymeric substances. Biominerals forming the tufa deposit replace the organic substrates starting with an amorphous phase rich in Ca, Si, and other cations, followed by massive precipitation of fibrous to polyhedral Ca-carbonate crystals and subordinately lamellar/fibrous Mg-clay crystals. During the 16 weeks of the experiment, the biofilm colonized rapidly all the surface of the sand grains, which were gradually encrusted by neoformed Ca-carbonate biominerals showing the same crystal structures and composition of those forming the tufa deposit. Moreover, the sand showed a progressive increase of the internal friction angle from 28.6° to 35.4°, with a trend very similar to MICP lab experiments that used a single bacterial species. This suggests that is possible to use natural Ca-carbonate biominerals, induced by natural microbial communities, for engineering applications with very sustainable procedures.

***IN-VIVO* 3D RECONSTRUCTION AND FIRST VOLUMETRIC BODY MASS ESTIMATE OF
THE OLDEST KAROO PAREIASAUR *BRADYSAURUS BAINI***

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In this contribution we present the first volumetric body mass estimate and a new *in-vivo* reconstruction of the most basal pareiasaurs, *Bradysaurus baini*. First appearing during the Guadalupian Epoch, pareiasaurs were among the world's first large terrestrial tetrapods, being widespread across Pangea in the Lopingian when they formed a significant part of the large herbivore guild. Like many such key groups of early tetrapods, little is known about the palaeobiology of the oldest pareiasaurs, the Bradysauria, from the Lower Beaufort Group of the Karoo Basin of South Africa. Starting from 3D photogrammetric models of two mounted skeletons from the Iziko South African Museum in Cape Town (SAM-PK-5624) and the Field Museum of Natural History in Chicago (FMNH UC 1533), we have digitally reconstructed the *in-vivo* appearance of *Bradysaurus baini*, obtaining a range of possible volumes. We then applied different known densities of living tissues to these volumes and compared the results with those obtained using classical regression methods based on measurements of long bones. Considering the larger adult *Bradysaurus* specimen, our volumetric body mass estimates range from a minimum of 851.4 kg to a maximum of 1,276.5 kg, with an overall mean body mass of 1,022 kg, approximately the body weight of a large domestic cow. This study provides evidence for the evolution of body masses exceeding one ton in adult specimens of upper Paleozoic tetrapods, offering insight into one of the earliest instances of large body size among herbivores as they expanded into new trophic niches within terrestrial ecosystems. Once again, the comparison with classical body mass estimation methods revealed how the use of regression formulas for large sprawling extinct taxa tends to result in a significant overestimation of body mass. Continued reliance on such methods will consequently mislead studies on paleoecology, physiology, and macroevolution.

IMPOSSIBLE FOSSILS: CAN SOFT TISSUES FOSSILIZE IN VOLCANICLASTIC SETTINGS?

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The study of fossilised soft tissues (e.g., skin and internal organs) offer a unique opportunity to understand the biology and behaviour of ancient animals. Fossil vertebrates with evidence of soft tissues are usually found preserved in fine-grained lacustrine and/or marine sediments and rarely these are preserved in primary volcanic or volcanoclastic settings. The Italian fossil record yielded two diverse specimens found in such unusual settings: the Permian protosaur *Tridentinosaurus antiquus* (Athesian Volcanic Complex, Trento Province) and the Late Pleistocene griffon vulture *Gyps fulvus* (Colli Albani volcanic complex, Rome). *T. antiquus* shows a dark-coloured body outline suggestive of organically preserved skin. *G. fulvus* exhibits part of the plumage of one of the wings, with feathers three-dimensionally preserved. These “impossible fossils” are of great paleontological importance and have been recently (re)studied using novel approaches to solve their taphonomy. Here the use of a suite of methods spanning from electron microscopy, infrared and Raman spectroscopy unveils new insights into the origin of the soft tissues in both specimens. In *T. antiquus* no original soft tissues are preserved and the dark-coloured body outline has been identified to be a forgery. In the case of the plumage of *G. fulvus*, the feathers are original and mineralized via aluminosilification, a newly discovered mode of preservation for feathers. Further, the presence of mineralized melanosomes (melanin-rich organelles) and keratin fibers suggest that the feather structures were mineralized early during diagenesis. The combination of these two studies highlights the power of the emerging field of applied palaeontology to resolve complex taphonomic enigmas and expand our understanding of soft tissue preservation in relatively unexplored geological settings.

BIOGENIC CONTENT OF SURFACE CORES FROM DEEP-SHELF BOTTOMS CLOSE TO THE CORALLIGENOUS OFF MARZAMEMI (SE SICILY, IONIAN SEA): PRELIMINARY DATA

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Four sediment cores collected offshore Marzamemi (Gulf of Noto, SE Sicily, Ionian Sea) were studied in the frame of the project “CRESCIBLUREEF – Grown in the Blue: new technologies for knowledge and conservation of Mediterranean reefs”. In this area, coralligenous build-ups occur in a wide shallow bathymetric range of 30 to 42 m and in a deep one between 86 and 92 m, whereas isolated structures are scattered at intermediate depths. Three cores were collected in the latter area, in closely spaced sites between 59 and 81 m water depth, in a mosaic of coralligenous build-ups raising from a gently dipping coarse detritic bottom, which often hosts diffuse maerl factories and is locally interspersed with zones characterized by muddy sedimentation. A fourth core originated from a wide but slightly incised channel roughly perpendicular to the coastline. Cores and their bioclastic content have been analysed to investigate the recent depositional history in these areas adjacent to the coralligenous bioconstructions, and especially to understand the possible influence of the build-ups (if any) in contributing bioclastic material to neighboring sedimentation. Preliminary analyses of these cores ranging from 60 to 100 cm in length, and still to be dated, allowed us to document: 1) a persistence of maerl (facies of the Biocoenosis of Coastal Detritic Bottoms: DC) production in the whole area though some lateral and temporal variations; 2) the widespread occurrence of the Biocoenosis of the Offshore Detritic Bottoms (DL, largely indicated by fresh-looking molluscs) and its transitions mainly to the DC Biocoenosis; 3) local evidence of high hydrodynamic energy and of early diagenesis; 4) marked differences in the preservation state of the bioclasts between and within samples. The neighbor occurrence of the coralligenous seems hardly detectable through both a few species and the peculiar morphology of selected taxa.

MAE: MUSEO ARCHEOLOGICO ERNICO - A BRAND-NEW MUSEUM IN ANAGNI IS BORN

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The Museo Archeologico Ernico (MAE) is a brand-new civic museum opening in the municipality of Anagni (Frosinone, Latium, central Italy), with the scientific supervision of the Department of Earth Sciences and the Polo Museale of Sapienza University of Rome, and the financial support of the Municipality of Anagni and BancAnagni. Anagni is mostly known for its medieval past, but this territory yielded evidence of a much more ancient archaeological and paleontological history. The part of the MAE exhibition currently opened is mainly focused on these aspects, telling and placing the story of Anagni and its prehistoric archaeological and paleontological heritage in the general context of the natural history of the territory and human evolution. Two sites play a prominent role in this regard, Coste San Giacomo (2.2 Ma) and Fontana Ranuccio (0.4 Ma), offering unique windows on the Pleistocene terrestrial ecosystems of Mediterranean Europe. Both sites are precisely radiometrically dated and associated with multiple lines of paleontological and, in the case of Fontana Ranuccio, archaeological evidence. For instance, the concurrent presence at Coste San Giacomo of small and large mammals is of great biochronological and paleoenvironmental value, being almost unique among European sites of similar chronology. At Fontana Ranuccio, alongside the diverse fauna, human presence is attested by four teeth and abundant lithic and bone tools. The high scientific value of these two sites is reflected in the Italian biochronological scale of large terrestrial mammals, where Coste San Giacomo and Fontana Ranuccio are chosen as Faunal Unit for the middle Villafranchian and Galerian biochrons, respectively. Paleoenvironmental reconstructions and immersive video-mapping experiences, based on updated scientific evidence and produced with artistic expertise, accompany the visitors of MAE in a journey to the past of Anagni and its territory.

LEPTOBOS AND BISON LIMB PROPORTIONS AND BODY MASS CHANGES IN RESPONSE TO ENVIRONMENTAL TRANSITIONS DURING THE PLEISTOCENE

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Large ungulate limb bones are often used as palaeoenvironmental predictors due to their plasticity in adapting to habitat changes and their abundance in the fossil record. It is often sustained that ungulates with cursorial behaviour undergo to an elongation of the distal limb elements in open environments, whereas larger taxa do not experience this allometric pattern. The triggering factors of this characteristic are still matter of debate. In this study we analyse the limb proportions and body mass of several samples of *Leptobos* and *Bison*, the commonest large bovids of the Western Palaeartic Pleistocene, related with the inferred palaeoenvironments through a timespan covering the last 2.58 Ma. The results show a general trend toward an increased metapodial robusticity from the Early Pleistocene onwards, following the progressive harshening of the climatic conditions and the opening of the habitats. At the same time, it is observed a constant trend toward gigantism, paired with increased radius size, starting from the earliest Pleistocene, and reaching a peak during the late Middle Pleistocene, before recording an opposite trend (i.e., body size reduction) from the Late Pleistocene on. In *Bison*, due to the long history and wide geographic distribution, some fluctuations in size and limb proportions are observed. This study shows that relatively slender forms of *Bison* are always found in more humid, closed habitats, often related with warm interglacial phases, whereas the stouter members of this clade are typical of the open, steppe/prairie-like habitats of the glacial stages. At the same time, the body mass estimations suggest that *Bison* living in open arid habitats were generally smaller than those living in wooded, humid habitats. In our opinion, these oscillations were most probably determined by a complex combination of factors including: ecogeographical patterns, trophic conditions, inter-intraspecific competition, and predatory pressure.

**REDISCOVERING THE FOSSIL COLLECTION FROM THE LATE EARLY PLEISTOCENE
SITE OF PIRRO NORD (FOGGIA, SOUTHERN ITALY) AT THE BARI UNIVERSITY**

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Since its discovery in 1969, Pirro Nord (Foggia, southern Italy) represents an important window on the Early Pleistocene terrestrial ecosystems of the northern Mediterranean. The discovery of the site is related to quarry activities started in the second half of 1960s, which exposed a number of karst fissures within the same karst network. In the early 1970s, geo-paleontologists from Leiden Museum (The Netherlands) and Bari University (Italy) collected many vertebrate bones that were stored at the Department of Earth and Geoenvironmental Sciences (Bari University). Starting from 1980s up to now, further geo-paleontological surveys were conducted by the Florence, Sapienza, Turin and Ferrara Universities. In 2006, the discovery of stone tools made the Pirro Nord site one of the earliest in Europe with evidence of human presence. Because of its great biochronological value, the Pirro Nord faunal assemblage was chosen as representative of the homonymous Faunal Unit of the late Villafranchian biochron in the Italian biochronological scale of large terrestrial mammals. The fossils stored at the Department of Earth and Geoenvironmental Sciences of the University of Bari remained boxed until October 2021, when they were “rediscovered” and are now under analysis. Seven wooden crates, almost all still sealed, revealed hundreds of skeletal and dental remains from Pirro Nord. At a preliminary analysis, the content consists of numerous remains of herbivorous mammals such as equids, bovids, cervids, proboscideans, rhinoceroses, but above all carnivorans such as saber-toothed cats, bears, giant hyenas, canids, other felids and mustelids. Rodents and lagomorphs are also represented, as well as other vertebrates, among which a beautifully preserved tortoise carapace. The study of the historical collection is in progress and will provide new data on such an interesting site, pivotal to a better understanding of the late Early Pleistocene terrestrial ecosystems of Mediterranean Europe.

**COMBINING PALAEOECOLOGICAL AND PALAONEUROLOGICAL ANALYSES TO
DISENTANGLE CERVID EVOLUTIONARY HISTORY IN RELATION TO CLIMATE
CHANGES: THE CASE STUDY OF THE EARLY PLEISTOCENE DEER FROM PIRRO NORD
(ITALIAN PENINSULA)**

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Research on the evolutionary history of medium-sized deer from the Villafranchian has focused largely on the taxonomy and biochronology of these cervids which resulted in several systematic revisions with material being ascribed to both fossil (*Pseudodama*, *Metacervoceros*) and modern genera (*Rusa*, *Axis*, *Dama*, *Cervus*). This group evolved during a phase of major changes in the global climate system with the onset of the Quaternary glaciations that characterized the Late Pliocene-Early Pleistocene transition. Here we attempt to explore the evolutionary history of these deer by combining palaeoecological and palaeoneurological analyses, a novel approach to investigate how this group could have evolved in relation to climatic shifts. As case study we selected the fossil material of the enigmatic middle-sized deer from the Early Pleistocene locality of Pirro Nord (Apricena, southeastern Italy). We integrate dietary proxies from dental wear and stable isotopes analysis with morphological data from the virtual endocast of a well-preserved male specimen comparing it with those of modern *Dama dama* (fallow deer), *Cervus elaphus* (red deer) and *Axis axis* (chital). The endocast of the Pirro Nord specimen seems to display a closer affinity to those of modern *Dama dama* than to *Cervus elaphus* or *Axis axis*. Dental mesowear patterns point to a long-term mixed diet for the Pirro Nord deer, while dental microwear patterns record a leaning towards a grazing behaviour. The range of the stable isotope $\delta^{13}\text{C}$ ratios implies that it foraged on abrasive water-stressed C3 vegetation in warm woodland and semi-open habitats, a result consistent with both the dental wear analysis and other palaeoenvironmental reconstructions of the site.

COLLEZIONI STORICHE: PROBLEMATICHE E STRATEGIE PER LA VALORIZZAZIONE E COMUNICAZIONE NEL CASO DELLA COLLEZIONE GEORG GASSER (1857-1931)

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Nella sfera del patrimonio museale scientifico, le collezioni storiche possono avere dei limiti per la moderna ricerca per la scarsa disponibilità di informazioni, legata a diverse variabili, come la modalità di acquisizione e registrazione dei dati al momento della raccolta e/o gli eventi intercorsi nel tempo prima della definitiva inventariazione. Eppure, nonostante queste problematiche non trascurabili, le collezioni storiche possiedono ancora oggi un valore nella conservazione, fornendo un valido contributo nel ricostruire e integrare la memoria scientifica e divenendo, in alcuni casi, l'unica risorsa per lo studio di determinate aree, laddove queste non siano più accessibili o esistenti. È questa una delle idee alla base del progetto del Museo di scienze naturali dell'Alto Adige sul recupero, catalogazione e inventariazione della collezione paleontologica "Georg Gasser", parte del nucleo originario dello stesso museo. Nato a Rentsch, nel 1857, Gasser collezionò nel corso della sua vita una ricca raccolta di reperti naturalistici e archeologici, realizzando nella propria abitazione un'esposizione permanente, accessibile al pubblico. Di questa raccolta, la parte paleontologica sopravvissuta fino a noi, è costituita da circa 3500 reperti di cui il 10% è materiale paleobotanico e il 90% paleozoologico. Attraverso l'inventariazione e la digitalizzazione della collezione il progetto ha avuto l'obiettivo di caratterizzare la raccolta dal punto di vista tassonomico, nonché di stabilire, dove possibile, la provenienza geografica e stratigrafica dei campioni. I dati ottenuti, integrati dall'analisi dei documenti scritti, forniscono un interessante strumento di storytelling sulla visione del collezionista e l'impronta data dal contesto geopolitico del tempo. Inoltre le informazioni registrate sono risultate utili per avvicinare il grande pubblico alla paleontologia anche attraverso strumenti di comunicazione diversi come la realizzazione ad hoc di una mostra interattiva.

RECONSTRUCTION OF DEPOSITIONAL ENVIRONMENTS IN THE KUNGURIAN MEGACALDERA OF THE ATHESIAN VOLCANIC GROUP: A MULTI-PROXY APPROACH

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In N-Italy, between the provinces of Trento and Bolzano, is located one of the reference areas to study the late Cisuralian tropical terrestrial ecosystems. The explosive activity of the Athesian Volcanic Group (~289–274 Ma) formed a long-lived megacaldera that preserves fossiliferous sedimentary formations – intercalated between the volcanic units – that were deposited during periods of reduced volcanic activity or quiescence. We applied lithofacies, palynological, and carbon stable isotope analyses on two Kungurian successions of the Guncina Formation to reconstruct the depositional environments and the plant communities in the megacaldera. In that phase, at least one shallow water body with an irregular shape was present within the megacaldera. The diverse sporomorph assemblages indicate that the caldera was colonised predominantly by xeromorphic-hygromorphic plants, such as seed ferns and conifers. In contrast, lycophytes and ferns were rare and restricted to the margin of the water bodies. Although the $\delta^{13}\text{C}_{\text{org}}$ values are comparable with those of other Cisuralian continental successions, the stable carbon isotope records evidence for a small variability, which correlates significantly with the abundance of xeromorphic elements. Based on our palynological and chemostratigraphic data, we reconstructed semiarid to arid climate conditions, typical of the mid-late Cisuralian in tropical areas, without major climatic shifts. The presence of perennial water bodies and local environmental conditions gave origin to an occasionally high abundance of spore plants.

SILICIFIED SHELLS AS ARCHIVES OF GEOCHEMICAL PROXIES: THE HIDDEN POTENTIAL OF A DIAGENETIC PROCESS

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Silicification is a diagenetic process consisting of the replacement of original carbonate hard tissues through the concurrent carbonate dissolution and silica precipitation. This process has a strong potential for enhancing the preservation of fossil specimens, with the silica accurately moulding the external morphology. However, very little is known about silicification, its timing and trigger mechanisms. To date, high-quality silicified specimens have been used almost exclusively in systematics studies, with their potential as geochemical archives yet to be evaluated. Here, we investigate the structural and chemical preservation of Permian brachiopods with different degrees of silicification. SEM analysis of shell microstructure of specimens from the Kungurian of Oman showed that despite heavy silicification, large portions of the original calcite microstructures were still preserved underneath silica-replaced external mould. To assess the chemical preservation, we used a novel approach applying in situ laser ablation boron isotope ($\delta^{11}\text{B}$) analyses on a specimen of *Callytharella websteri*. With this technique, the $\delta^{11}\text{B}$ and [B] of shell structures of choice can be measured at a scale $<100\ \mu\text{m}$ and directly linked to the SEM images. Boron is an ideal element for examining the chemical preservation: $\delta^{11}\text{B}$ variability in modern and well-preserved Permian brachiopods is relatively well-constrained, and due to the large mass difference between B stable isotopes (^{10}B and ^{11}B) and its high geochemical reactivity, B is significantly fractionated during diagenesis and between different mineral phases. Our results show that $\delta^{11}\text{B}$ in the preserved microstructures of the silicified specimen is consistent with values measured in well-preserved shells, demonstrating that the silicification of the external shell portions may act as a protective sheath for the innermost microstructures, thus making partially silicified specimens a valuable geochemical archive.