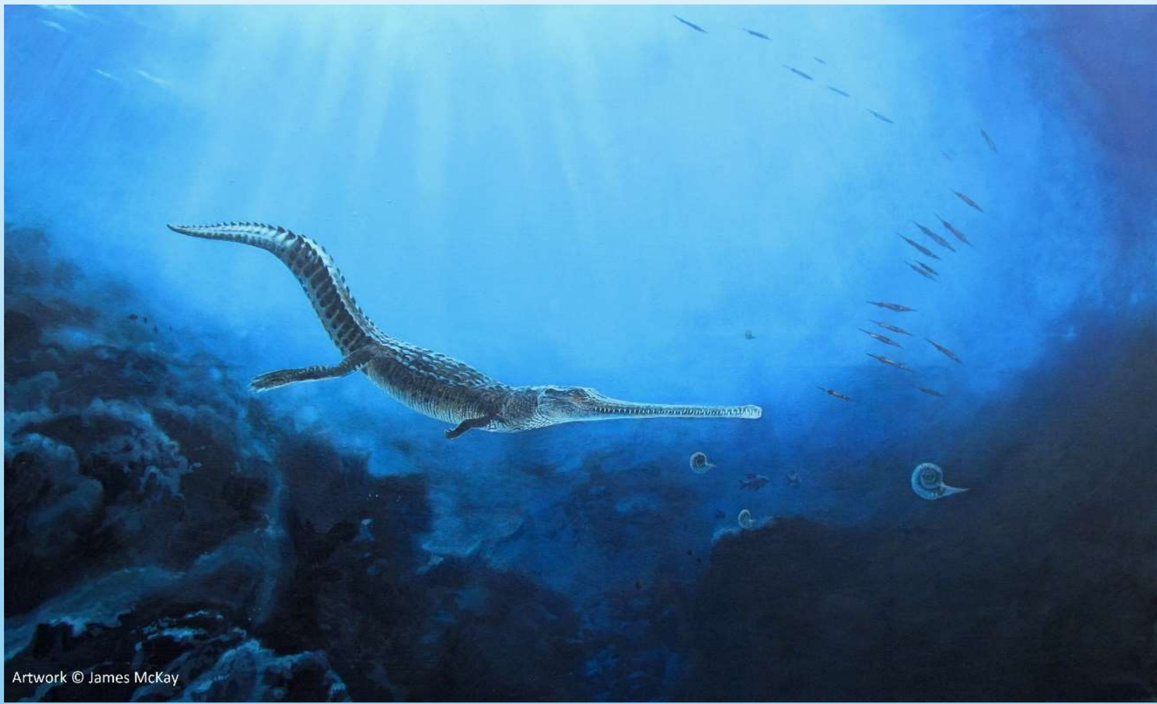

Symposium on Toarcian Palaeobiology

17th – 20th June 2024

Bath

GCG Est. 1974 Geological Curators Group

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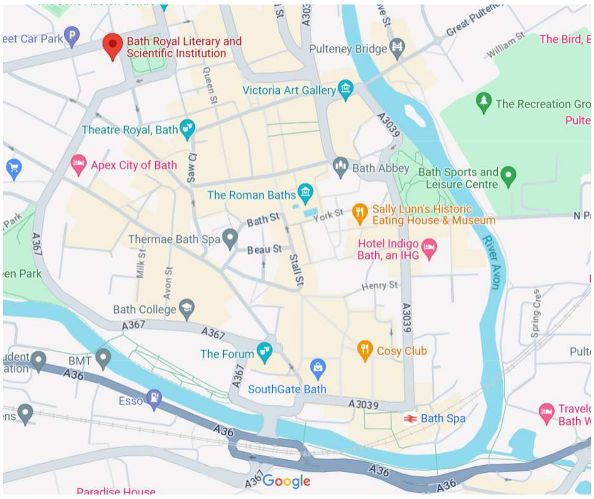
200 Bath Royal Literary & Scientific Institution 1824–2024

WELCOME

Welcome to the Symposium on Toarcian Palaeobiology. We have a full programme of 19 talks, 3 keynote talks, 3 workshops, and 1 poster, spread across three days at the historic Bath Royal Literary and Scientific Institution.



The schedule for the meeting is below.

Please send any questions to Meghan Jenkinson (eemj@leeds.ac.uk)

Meghan Jenkinson, Crispin Little (University of Leeds), Matt Williams (Bath Royal Literary and Scientific Institution, Mark Evans (British Antarctic Survey), and the Geological Curators Group.

SPONSORSHIP AND THANKS

We are grateful to the following sponsors: The Palaeontographical Society and Neo Jurassica

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Thanks are also extended to Simon Harris for his invaluable help with web support, Rob Lowther, Emma Nicholls, and the rest of the Geological Curators Group committee for their ongoing support. Paul Browne and James Hamilton from the Bath Royal Literary and Scientific Institution for their support with event logistics. Charles Peplow who will be providing help during the conference.

We thank James McKay and Alan Haywood for permission to use the teleosauroid image in the banner for this meeting.

And most importantly, thank you to all of you for registering and making this happen!

SCHEDULE

(May be subject to last minute changes)

Monday 17th June		
18:30 – 19:00	Lonsdale Room	Registration
19:00 – 21:00	Lonsdale Room	Icebreaker welcome reception

Tuesday 18th June		
09:00 – 09:30	Elwin Room	Registration & refreshments
09:30 – 09:50	Elwin Room	Opening remarks
09:50 – 10:10	Elwin Room	(Talk 1) **Samuel Cooper** - Cannibalism and more: Dietary ecology in pachycormid fishes from the Toarcian of Europe
10:10 – 10:30	Elwin Room	(Talk 2) **Christina Shears Ozeki** - *Osedax* in the Toarcian? First recorded occurrence of *Osspecus*-shaped borings and other features on ichthyosaurid vertebrae from the Whitby Mudstone Formation, North Yorkshire, UK
10:30 – 11:00	Break	
11:00 – 11:20	Elwin Room	(Talk 3) **Dean Lomax** - Hidden in Plain Sight: A Long-Lost Ichthyosaur from the Strawberry Bank Lagerstätte (Toarcian, Lower Jurassic)
11:20 – 11:40	Elwin Room	(Talk 4) **Erin Maxwell** - Diversity and stratigraphic ranges of fossil vertebrates in the Toarcian Posidonienschiefer Formation (Germany)
11:40 – 12:00	Elwin Room	(Talk 5) **Dean Lomax** - The 'Rutland Sea Dragon': excavation overview, initial findings and future plans
12:00 – 13:00	Lunch (self-foraging)	
13:00 – 14:00	Lonsdale Room	Ammonoid Biochronology Workshop
14:00 – 14:20	Elwin Room	(Talk 6) **Christine Bordean** - Explore the Toarcian at the Sedgwick Museum of Earth Sciences, University of Cambridge
14:20 – 14:40	Elwin Room	(Talk 7) **James Hogg** - How Toarcian fossils led to the opening of a new museum
14:40 – 15:00	Elwin Room	(Talk 8) **Sarah Steele** - Time is the substance I am made from: jet analysis, a waiting game.
15:00 – 15:30	Break	
15:30 – 15:50	Elwin Room	(Talk 9) **Crispin Little** - Benthic macrofossil extinctions and recoveries across the Pliensbachian-Toarcian interval
15:50 – 16:10	Elwin Room	(Talk 10) **Meghan Jenkinson** - Benthic macrofaunal turnover across the late Pliensbachian, and early Toarcian Oceanic Anoxic Event (Lower Jurassic; ~183 million years) in the Llanbedr (Mochras Farm) core.
16:10 – 17:00	Elwin Room	(Keynote speaker) **Emily Swaby** - The fossil insect assemblage associated with the Toarcian (Lower Jurassic) Oceanic Anoxic Event (T-OAE) from Alderton Hill, Gloucestershire, UK

Wednesday 19th June		
09:00 – 09:30	Elwin Room	Registration and refreshments
09:30 – 09:50	Elwin Room	(Talk 11) **Elena Cuesta Fidalgo** - The Jurassic Radiation of Averostra (Dinosauria, Theropoda): Early Patagonian Representatives from the Cañadon Asfalto Formation as a lens to assess the effects of the Toarcian crisis.
09:50 – 10:10	Elwin Room	(Talk 12) **Suresh Singh** - The macroevolutionary impacts of predator-prey interactions on the rise of giant carnivorous dinosaurs in the Jurassic.
10:10 – 10:30	Elwin Room	(Talk 13) **Robert Weis** - Outstanding palaeontological discoveries from the 'Schistes bitumineux' (early Toarcian) Lagerstätte of Bascharage, Grand-duchy of Luxembourg
10:30 – 10:55	Break	
10:55 – 11:15	Elwin Room	(Talk 14) **Kevin Page** - Ammonites and Time in the Lower Toarcian (Lower Jurassic): Towards a High Resolution ammonite-based international biochronology for the Jenkyn's – and other – events.
11:15 – 12:00	Elwin Room	(Keynote speaker) **Michela Johnson** - An ecological and ontogenetic exploration into thalattosuchian palaeobiology from the Posidonia Shale Formation, southern Germany
12:00 – 13:00	Lunch (self-foraging)	
13:00 – 14:00	Lonsdale Room	Art workshop
14:00 – 14:20	Elwin Room	(Talk 15) **Connor O'Keeffe** - Global climate disruption in the latest Pliensbachian: a prelude to the T-OAE
14:20 – 14:40	Elwin Room	(Talk 16) **Baran Karapunar** - The timing of extinction peak in bivalves across the Pliensbachian–Toarcian and the palaeoecology of bivalves prior to the extinction
14:40 – 15:00	Elwin Room	(Talk 17) **Alex Dunhill** - Extinction cascades, community collapse, and recovery across a Mesozoic hyperthermal event
15:00 – 15:30	Break	
15:30 – 15:50	Elwin Room	(Talk 18) **Mohamed Benzaggagh** - Toarcian succession and marine macrofauna of the central High Atlas (southeast Morocco)
15:50 – 16:10	Elwin Room	(Talk 19) **Asma Alnaqbi** - Palaeoclimatic and Palaeoenvironmental Insights from the Ferrar Volcanism: A Comprehensive Review of Early Jurassic Palaeobotany in Southernmost Gondwana
16:10 – 16:55	Elwin Room	(Keynote speaker) **Emese Bordy** - Early Jurassic palaeo-biodiversity: African insights from vertebrate ichnology and sedimentology
16:55 – 17:10	Elwin Room	Closing remarks
19:00 onwards	Dinner at The Alchemist at The Empire Hotel	

Thursday 20th June		
10:00 – 16:00	BRSLI	Charles Moore collection workshop

WORKSHOPS

Ammonoid Biochronology Workshop – Hosted by Kevin Page

Tuesday 18th June
13:00 – 14:00

Ammonoids are the primary biostratigraphical guide fossils in the Jurassic, facilitating the detailed correlation of geological successions internationally – often at a very high resolution of 50,000 – 75,000 years. Crucially, as Jurassic ammonite 'zones' can be considered to explicitly represent discrete phases of geological time, they are most correctly referred to as chronozones rather than biozones. But beyond chronozones and subchronozones, it is ammonite-based biohorizons which provide the highest resolution, with often 3-6 being recognised per subchronozone. A biohorizon is effectively an ammonite correlated 'event' representing a defined segment of a continuously evolving ammonite lineage, or a very short-lived migration from another region of a different taxa, the record (i.e. preservation) of which may be related, at least in part, to sedimentary cycles, both orbital and sea-level. However, to correctly apply this available high-resolution biochronology, one must first be able to *correctly* identify the ammonites collected from any section…

The aim of this workshop, therefore, is to introduce participants to the principles and practice of ammonite biochronology starting with how to identify an ammonite – as well as how to appropriate communicate any uncertainties in that determination which may affect your ultimate stratigraphical conclusion (just like any graph showing measurements, for instance of isotope ratios, should show error bars.). The session will be based on a tried-and-tested university practical and will be supported by a large collection of typical ammonite specimens from the Ilminster district of Somerset, close to the 'Strawberry Bank' lagestatten, as well as a range of related documents and aids. Participation in reaching correlative conclusions will be encouraged!

Toarcian Palaeoart Workshop – Hosted by James McKay

Wednesday 19th June
13:00 – 14:00

James McKay is palaeoartist at the University of Leeds. He has illustrated many prehistoric scenes, and his work has been published by the Palaeontological Association and has featured on the cover of Nature. James will be hosting a drop-in workshop where he will be producing live a painting representing different Toarcian environments. He welcomes delegates to feed into the production of this piece and offer insight into their particular field within Toarcian palaeobiology. James hopes to represent as many areas present at the symposium as possible in his piece.

Throughout the meeting, James will also be displaying artwork from an upcoming book depicting the Toarcian of the Yorkshire coast.

Charles Moore Collection Workshop – Hosted by Matt Williams

Thursday 20th June
10:00 – 16:00

Charles Moore (1815 – 1881) was a notable palaeontologist with a broad interest in geology. Despite only being an amateur, Charles had a passion for collecting and amassed huge quantities of scientifically significant material. After his death, the city of Bath, where Charles has lived for a significant period of his life, purchased his collection. Within the material amassed by Charles is a collection of fossils from the Lower Toarcian of Strawberry Bank, Ilminster. This collection is renowned for it's exceptionally preserved fish, ichthyosaurs, and crocodiles from the Fish and Saurian Bed (*falciferum* Zone). Many specimens are preserved in 3-dimensions within nodules and even retain soft tissue. Charles' Upper Lias material from Strawberry Bank also includes many invertebrates such as ammonites, bivalves, and gastropods.

However, the Moore collection of Upper Lias material has received relatively little scientific interest. To celebrate this exceptional collection alongside the bicentenary year of the BRLSI, we are offering delegates the opportunity to spend a full day with the collection to study specimens for themselves and collaborate with newfound colleagues. Material will be brought out of the stores and laid out in the Lonsdale Room for examination. This day will be relatively informal.

ABSTRACTS

Arranged in order of first author, presenting author underlined

KEYNOTE SPEAKERS

Early Jurassic palaeo-biodiversity: African insights from vertebrate ichnology and sedimentology

Emese M Bordy[1]

[1] Department of Geological Sciences, University of Cape Town, Cape Town, South Africa
Email: emese.bordy@uct.ac.za

Southern Gondwana witnessed profound geological events in the Early Jurassic, most notably the eruption of the Karoo-Ferrar Large Igneous Province (LIP), which resulted in voluminous continental flood basalts. This multiphase magmatic event is thought to have been pivotal in the late Early Jurassic global environmental perturbations, including mass extinction and palaeoclimate change, e.g., the Toarcian hyperthermal event. While the petrology and geochemistry of the Karoo-Ferrar LIP have been extensively studied, the understanding of continental palaeoenvironmental dynamics during this time remains incomplete.
Field investigations in southern Africa have shed light on the palaeoenvironmental changes coinciding with the onset of Karoo volcanism. The colossal Karoo lava pile contains sandstone interbeds hosting vertebrate footprints among desiccation cracks and ripple marks. These tracks, attributed to bipedal and quadrupedal animals, including theropods, ornithischians, crocodilians, and synapsids, provide insights into the ancient ecosystems. Moreover, facies changes in the sedimentary succession suggest shifts from a dry to a wet desert ecosystem, capable of supporting a diverse biota including gymnospermous trees. The discovery and correct stratigraphic placement of these Early Jurassic fossils challenges previous assumptions about palaeo-biodiversity and overall continental ecosystem complexity.

The integration of vertebrate ichnology with sedimentological and palaeontological studies presents a multidisciplinary approach that is key for reconstructing the dynamics of the fiery landscape in southern Gondwana. These findings not only enhance our knowledge of Gondwanan ecosystem

changes but also contribute to a nuanced understanding of the global implications of LIPs as well as the resilience and adaptation of biota amidst significant environmental upheavals.

An ecological and ontogenetic exploration into thalattosuchian palaeobiology from the Posidonia Shale Formation, southern Germany

Michela M. Johnson[1]

[1]Museum am Löwentor, Staatliches Museum für Naturkunde Stuttgart, 70191, Germany
Email: michela.johnson@smns-bw.de

The Posidonia Shale Formation (Jurassic: Toarcian) of southern Germany has yielded an array of incredibly preserved fossil vertebrates, including fishes, ichthyosaurs, marine crocodylomorphs (thalattosuchians), and plesiosaurs. One of the most well represented clades in this formation is Thalattosuchia (which includes teleosauroids and metriorhynchoids), a group of successful crocodylomorphs that dominated the coastlines during the Early Jurassic. While at least four distinct thalattosuchian species are present in the Posidonia Shale Formation (three teleosauroids and one metriorhynchoid), the most notable and abundant is the teleosauroid *Macrospondylus bollensis*. Individuals of this species range in skull length from 12 cm to over 100 cm, making *Macrospondylus* an ideal taxon for ecological and ontogenetic studies. However, previous studies, which lack the taxonomic, stratigraphic, and ontogenetic control required to understand growth and palaeobiology within a species, have not investigated many aspects of thalattosuchian biology from the Posidonia Shale Formation. This represents a major gap in the understanding of the group's early evolution and ecology. Herein we will explore recent results that shed light on four aspects of thalattosuchian biology: (1) distinctive anatomical features that hint at different lifestyles; (2) hypothesized feeding and functional ecology; (3) growth and ontogeny within *Macrospondylus*, using linear regressions and histological analyses; and (4) certain taphonomic aspects, namely indicators of headfirst seafloor landings emphasized by 3D photogrammetric models. Thalattosuchian crocodylomorphs are shown to display an intriguing diversity, unusual growth, and unique palaeobiology early on in their evolutionary history, ultimately allowing for them to become one of the most successful crocodylomorph groups.

The fossil insect assemblage associated with the Toarcian (Lower Jurassic) Oceanic Anoxic Event (T-OAE) from Alderton Hill, Gloucestershire, UK

Emily J. Swaby[1], Angela L. Coe[1], Jörg Ansorge[2], Andrew J. Ross[3], Bryony A. Caswell[4], Scott A.L. Hayward[5,6], Luke Mander[1], Liadan G. Stevens[7], Aimee McArdle[7]

[1]School of Environment, Earth and Ecosystem Sciences, The Open University, Walton Hall, Milton Keynes, Buckinghamshire, United Kingdom
[2]Institut fur Geologische Wissenschaften, Ernst-Moritz-Arndt-Universität Greifswald, Greifswald, Germany
[3]Department of Natural Sciences, National Museum of Scotland, Chambers Street, Edinburgh, UK
[4]School of Environmental Science, Faculty of Science and Engineering, University of Hull, Hull, United Kingdom
[5]School of Biosciences, University of Birmingham, Birmingham, United Kingdom
[6]Birmingham Institute of Forest Research, University of Birmingham, Birmingham, United Kingdom
[7]Natural History Museum, London, United Kingdom
Email: emily.swaby@open.ac.uk

Extreme global warming and environmental changes associated with the T-OAE (~183 Mya) profoundly impacted marine and terrestrial biota. Despite the exceptionally elevated abundances of

fossil insects from T-OAE strata, only assemblages from Germany and Luxembourg have been studied in detail. Here, we focus on the insect assemblage found in strata recording the T-OAE at Alderton Hill, Gloucestershire, UK, where <15% of specimens have previously been described. We located all known fossil insects (n=370) from Alderton Hill, and used these to create the first comprehensive taxonomic and taphonomic analysis of the entire assemblage. We show that a diverse palaeoentomofaunal assemblage is preserved, comprising 12 orders, 21 families, 23 genera and 21 species. The number of orders is comparable with present-day assemblages from similar latitudes (30-40°N), suggesting that the palaeoentomofauna reflects a life assemblage. The high abundance of Hemiptera (22.1%) and Orthoptera (13.4%) within the Alderton assemblage indicates well-vegetated islands, while floral changes related to the T-OAE may be responsible for hemipteran diversification. The marginally higher proportion of sclerotised taxa compared to present-day insect assemblages possibly indicates adaptation to environmental conditions or taphonomic bias. From the Alderton assemblage, we also describe a new genus and species of cockroach, *Alderblattina simmsi* gen. et sp. nov. (Blattodea: Rhipidoblattinidae), which possesses the first unequivocal occurrence of aposematic colouration, a predator deterrent, in cockroaches. We hypothesise that the extreme environmental conditions associated with the T-OAE drove competition for resources and evolutionary changes in predators, which in turn led to the development of aposematic colouration in insects at this time. The coeval palaeoentomofauna from Strawberry Bank, Somerset is less diverse (9 orders, 12 families, 6 genera, 3 species) and is taphonomically biased. Therefore, the Alderton Hill palaeoentomofauna is interpreted to be the best-preserved and most representative insect assemblage from Toarcian strata in the UK.

TALKS

Palaeoclimatic and Palaeoenvironmental Insights from the Ferrar Volcanism: A Comprehensive Review of Early Jurassic Palaeobotany in Southernmost Gondwana

A. Alnaqbi[1] and N. Alteneiji[1]

[1]Department of Applied Physics and Astronomy, College of Science, University of Sharjah, Sharjah, UAE
Email: asma.alnaqbi@sharjah.ac.ae

Large-scale volcanic activities, such as those in the Ferrar Province (~183 Mya), are significant contributors to the rapid increase of CO2 and other volcanic gases (e.g., water vapor and sulfur dioxide) in the atmosphere. These emissions disrupt the Earth's climate by affecting its warming and cooling processes, impacting global terrestrial ecosystems. Fossil plants and wood are crucial for studying palaeoclimatic and palaeoenvironmental changes associated with volcanism due to their rapid response to environmental shifts. This study presents a comprehensive review of the palaeobotany of Southernmost Gondwana, compiling data from literature and museum collections. It includes a detailed catalogue of approximately 400 botanical species from Antarctica, Australia, New Zealand, and Tasmania, providing new insights into the palaeoclimate and palaeoenvironment of these regions during the Early Jurassic. Notably, this compilation represents the first comprehensive effort to gather data on fossil plants from South Gondwana, primarily focusing on the Triassic and Jurassic periods. To visualize the impact of Ferrar magmatism, graphic illustrations for the Central Transantarctic Regions were generated using data from literature, petrography, and bulk chemical analyses.

Toarcian succession and marine macrofauna of the central High Atlas (southeast Morocco)

M. Benzaggagh[1]

[1]Université Moulay Ismail, Department of Geology, Faculty of Sciences, Meknes, Morocco
Email: benzaggagh@gmail.com

In the central High Atlas, the Toarcian sequence forms significant outcrops of marls and marl-limestones resting on the upper Pliensbachian bedded or massive limestones. In the Amellago area (axial part of the central High Atlas furrow), the Toarcian series (500 m-thick) consists of two formations: Tagoudite (200 m-thick) and Agoudim (300 m-thick). The Tagoudite Formation (lower Toarcian) consists of marls and thin limestone beds, with frequent silico-clastic turbiditic levels and containing rare ammonites of the Polymorphum Zone dominated by the genus *Dactylioceras*; the Agoudim Formation, essentially marly, is rich in its base in ammonites of the Levisoni Zone; its middle part yielded rare ammonites of the Bifrons Zone (middle Toarcian). In the Ait Atmane locality (southern margin of the central High Atlas furrow), the Toarcian series (100 m-thick) consists of marls and silty marl-limestones containing in its lower part (Levisoni Zone) brachiopods, mainly rhynchonellids. Its middle part is also rich in brachiopods (terebratulids and rhynchonellids) and containing bivalves, gastropods and ammonites of the Bifrons and Gradata zones; its upper part (upper Toarcian) is rich in terebratulids.

Paleogeographically, the Pliensbachian-Toarcian boundary is marked throughout the basin by a rapid deepening and lithological change. Thus, the lower Toarcian deposits indicate deep and confined marine environment unfavorable for the life of benthic macrofauna. From the uppermost lower Toarcian and the middle-upper Toarcian, marine environment becomes less and less deep allowing the return of favorable conditions for the life and the proliferation of benthic and nectobenthic macrofauna, particularly on the margins of the basin.

Explore the Toarcian at the Sedgwick Museum of Earth Sciences, University of Cambridge

C. Bordean[1], M. Riley[2]

[1,2]Sedgwick Museum of Earth Sciences, University of Cambridge, Cambridge, UK
Email: [1]cb2023@cantab.ac.uk, [2]mlr44@cam.ac.uk

The Sedgwick Museum collections contain over 1,700 specimens of Toarcian age. The taxonomic breadth of these collections offers something for every Mesozoic researcher: molluscs, brachiopods, worms, decapods, echinoderms, insects, vertebrates, and plants. These organisms are spread across a semi-continuous stratigraphic range, including notable formations such as the Blea Wyke Formation, Bridport Sand, Beacon Limestone, Whitby Mudstone, Marlstone Rock, and Scalpay Sandstone. Such a wealth of data has huge research potential for anyone wishing to reconstruct these ecosystems and track their changes through time. In this presentation, we highlight just a few of the Sedgwick Museum specimens that have featured in prominent studies from the 1880s to the present day. The Museum offers a variety of services to help further your own research. We look forward to working with you to unlock the full potential of this fascinating collection, and to furthering our understanding of the Earth during the Toarcian age.

Cannibalism and more: Dietary ecology in pachycormid fishes from the Toarcian of Europe

[1, 2]**Samuel L. A. Cooper**, [1]Erin E. Maxwell

[1]Museum am Löwentor, Staatliches Museum für Naturkunde Stuttgart, 70191, Germany
[2]Department of Natural Sciences, University of Hohenheim, 70599, Germany
Email: samuel.cooper@smns-bw.de

Pachycormiformes is a Mesozoic clade of stem-teleost actinopterygian fishes famed for their high morphological and ecological disparity. Seemingly coinciding with their first emergence in the fossil record, pachycormids during the Toarcian are already fairly diverse and display various diets and feeding strategies. The dietary ecology of pachycormids has until recently been severely understudied, with new information based predominantly on fossilised gut contents from Konservat Lagerstätte revealing direct evidence for their complex diets and trophic relationships. Early Jurassic representatives of the clade are predominantly teuthophagous; however, the taxonomy of the preferred prey squids varies drastically between different pachycormid species, and includes a variety of belemnoids, loligosepiids, and teudopseids. Minimal overlap in preferred prey taxa between pachycormid species suggests that the clade experienced a high trophic disparity whilst minimalizing interspecific competition for prey during the Toarcian. *Pachycormus macropterus* – the most abundant and widespread of all Toarcian pachycormids – demonstrates a strong dietary ontogeny whereby the juveniles of this taxon were obligate piscivores, whereas the adults are facultatively teuthophagous. Juvenile *Pachycormus* recurringly perpetrated cannibalism (conspecific predation) on smaller individuals of its own species, a behaviour not yet observed elsewhere in the group. A particular example of *Pachycormus* from Holzmaden (southern Germany) preserves a large ammonite inside of the gut, appearing to represent an example of an accidental, likely fatal, ingestion event. Changes in pachycormid diet, diversity, and abundance are additional discussed in the context of the Early Toarcian Oceanic Anoxic Event.

The Jurassic Radiation of Averostra (Dinosauria, Theropoda): Early Patagonian Representatives from the Cañadon Asfalto Formation as a lens to assess the effects of the Toarcian crisis.

E. Cuesta[1,2], D. Pol[3], O. W. M. Rauhut[1,4]

[1] Department für Geo- und Umweltwissenschaften und GeoBioCenter, Ludwig-Maximilians-Universität, Münich, Germany.
[2]Museo Paleontológico Egidio Feruglio, Trelew, Argentina.
[3]CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas), Buenos Aires, Argentina.
[4] SNSB – Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany
Email: elena.cuestaf@gmail.com

Averostra represents the main clade of theropod dinosaurs, but the interrelationships of its early members and the relationships between the major subclades are still debated. The clade underwent a rapid radiation from the Early to Late Jurassic, with the Pliensbachian-Toarcian extinction event likely being one of the major causes for this explosive evolution. However, the scarcity and the highly fragmented nature of the fossil record from this period pose challenges in assessing the effects of this event on the diversity of terrestrial groups. The Cañadón Asfalto Formation (Chubut, Argentina), dated by high-precision U-Pb geochronology as Toarcian, is an important window to study the terrestrial faunal assemblage and its evolutionary history in the aftermath of the Jenkyns event. Theropods are represented by several averostran taxa in this unit, including *Piatnitzkysaurus,*

Condorraptor, *Eoabelisaurus*, and *Asfaltovenator*, which are among the oldest averostran theropods known. Here, we present a preliminary osteological description and phylogenetic analyses for the most complete taxa, *Eoabelisaurus* and *Asfaltovenator*. The phylogenetic results reveal that *Eoabelisaurus* probable represents a non-abelisaurid abelisauroid within Ceratosauria, and *Asfaltovenator* is recovered as an early branching allosauroid within Tetanurae, with both taxa showing a complex combination of plesiomorphic and apomorphic characters. Their position as basal members of their respective clades, their combination of characters, and the mapping of evolutionary changes in these Toarcian taxa underscore their potential to help unravel the phylogenetic history during Averostran radiation and to comprehensively assess the impact of the Pliensbachian-Toarcian extinction on this radiation.

Extinction cascades, community collapse, and recovery across a Mesozoic hyperthermal event

Alexander M. Dunhill[1], Karolina Zarzyczny[1,2,3,4], Jack O. Shaw[5], Jed W. Atkinson[1], Crispin T.S. Little[1,4] and Andrew P. Beckerman[6]

[1]School of Earth and Environment, University of Leeds, Leeds, UK.
[2]School of Biology, University of Leeds, Leeds, UK.
[3]School of Ocean and Earth Science, University of Southampton, Southampton, UK
[4]Department of Life Sciences, Natural History Museum, London, UK
[5]Santa Fe Institute, Santa Fe, USA.
[6]School of Biosciences, University of Sheffield, Sheffield, UK
Email: a.dunhill@leeds.ac.uk

Mass extinctions are considered the quintessential example of a "Court Jester" driver of macroevolution, whereby abiotic pressures drive a suite of extinctions leading to huge ecosystem changes across geological timescales. Most research on mass extinctions ignore species interactions and the structure of the community, limiting inference about who, when and why species go extinct, and how "Red Queen" processes that link speciation rates to extinction rates affect the recovery of biodiversity, structure and function after mass extinction. Here, we apply network reconstruction, secondary extinction modelling and community structure analysis to the Early Toarcian (Lower Jurassic) Extinction Event and recovery. We find that primary extinctions targeted towards infaunal guilds, which caused secondary extinction cascades to higher trophic levels, reproduced the empirical post-extinction community most accurately. We find that the extinction event caused a switch from a diverse, stable community with high levels of functional redundancy to a less diverse, more densely connected, and less stable community of generalists. Finally, we found that the recovery of some elements of community structure and function precede recovery of diversity. Full ecosystem recovery to pre-extinction levels took ~7 million years at which point we see evidence, in the later Toarcian, of dramatically increased vertical structure linked to the Mesozoic Marine Revolution and modern marine ecosystem structure.

Toarcian Fossils; How Fossilised Remains Inspired a Museum

[1]**J. Hogg**

[1]Department of Earth Sciences, Yorkshire Natural History Museum, Sheffield, United Kingdom
Email: jhogg@jhogg.net

The Yorkshire Natural History Museum in Sheffield was founded in 2022. A new public museum, the institution was founded to act as a resource in the north of England for research in the disciplines of the Earth and Life Sciences and to provide Natural History education to the public. The research collection of the organisation is continuously growing, forming a strong repository for insight into the natural sciences. But how did such an institution emerge into society? All organisation endeavours require inspiration, and at the heart of the foundation of the Yorkshire Natural History Museum was Toarcian fossils. Specifically, those that inspired its founder, myself. To fully understand the impact these fossilised remains had, I look into the socioeconomic impact of the fossil trade arising from the eroding cliffs of the Yorkshire Coast, the societal demand for public repositories for specimens of palaeontological importance and the human perception of life in the Toarcian. I reflect on my own experiences and the impact of surrounding society. I find that the choices I made relating to encounters with Toarcian fossils cumulated into a museum in tangency with my ideals for such an institution. The significance of this is certainly the foundation of a museum, but arguably what I find is more important is the implication of how a single *Dactylioceras* commune can inspire pathways into the science of palaeontology and lead to greater understanding of prehistoric Earth.

Benthic macrofaunal turnover across the late Pliensbachian, and early Toarcian Oceanic Anoxic Event (Lower Jurassic; ~183 million years) in the Llanbedr (Mochras Farm) core.

[1]**Meghan Jenkinson**, [1]Crispin T.S. Little, [1]Baran Karapunar

[1]School of Earth and Environment, University of Leeds, Leeds, UK
Email: eemj@leeds.ac.uk

Benthic species turnover correlating with the early Toarcian negative carbon isotope excursion (NCIE) and onset of black shale deposition is well constrained in the Cleveland Basin (Yorkshire). However, little equivalent data is known from elsewhere in the UK. The Llanbedr (Mochras Farm) core (Cardigan Bay Basin, North Wales) provides a continuous, expanded section throughout the entire Pliensbachian-Toarcian interval. Notably laminated black shales are absent in the Toarcian.

The most species rich interval across the Pliensbachian-Toarcian is the lower *spinatum* Zone, which correlates with a minor NCIE seen at Mochras. Bivalves and brachiopods reach their highest diversity in this interval, but infauna is scarce, with epifauna dominating the assemblage. Overall diversity then declines at the positive carbon isotope excursion in the *tenuicostatum* Zone, where bivalves completely disappear, leaving an assemblage composed of the gastropod *Ceolostylina* sp. and the shallow infaunal brachiopod *Lingularia longovicensis*. Diversity improves at the onset of the NCIE in the *exaratum* Subzone (*serpentinum* Zone), with gastropods reaching their highest diversity. The assemblage comprises semi-infaunal aporrhaid gastropods, epifaunal *Pseudomytiloides dubius*, shallow infaunal *Pteromya*, deep infaunal *Goniomya,* and small bivalves (likely juveniles). Small pyritised burrows are also common. This suggests that at Mochras redox conditions during the Toarcian 'Oceanic Anoxic Event' differed from those in the Cleveland Basin, both in terms of timings and intensity, suggesting that conditions were at worse dysoxic, rather than principally anoxic. The NCIE does not correlate to an extinction event here.

The timing of extinction peak in bivalves across the Pliensbachian–Toarcian and the palaeoecology of bivalves prior to the extinction

B. Karapunar[1]

[1]School of Earth and Environment, University of Leeds, Woodhouse Lane, Leeds, LS2 9JT United Kingdom.
Email: B.Karapunar@leeds.ac.uk

There is a debate whether the extinction event occurred at the Pliensbachian-Toarcian boundary or coincided with the Toarcian Oceanic Anoxic Event, or the extinction was multi-episodic. A compilation of 112 bivalve species from the Pliensbachian Amaltheenton Formation and the Toarcian Posidonienschiefer Formation suggests that bivalves in the epicontinental sea deposits in Germany experienced the highest extinction at the Pliensbachian-Toarcian boundary. In Toarcian, the diversity stayed low and the extinction magnitude during the TOAE was not as high. This suggests diachronic extinction peaks across different locations/latitudes, but the estimates might be biased by the research effort put in the study of Pliensbachian taxa. Analysis of species range data of 352 bivalve species from northwestern Tethys (Hettangian–Aalenian) shows that the regional diversity peaked in late Pliensbachian, and extinction rates peaked in late Pliensbachian and early Toarcian.

New studies revealed the earliest members of the carnivorous bivalve family Cuspidariidae and the chemosymbiotic Thyatirid, and the earliest evidence of sexual dimorphism in bivalves in the upper Pliensbachian deposits. Although both Cuspidariidae and Thyasiridae survived, the species and genera of these families disappeared at the Pliensbachian-Toarcian boundary. The sexually dimorphic genus *Nicaniella* survived from the extinction events. One of the most abundant bivalve *Harpax spinosus*, a secondary soft-bottom dweller, became extinct in the early Toarcian. The predators drilling on bivalves were highly specialized and showed strong selectivity of drill site and prey taxon in the Pliensbachian. This type of predator-prey interaction disrupted at the Pliensbachian-Toarcian extinction, perhaps due to the extinction of the predator.

Benthic macrofossil extinctions and recoveries across the Pliensbachian-Toarcian interval

Crispin T.S. Little[1]

[1]School of Earth and Environment, University of Leeds, Leeds, UK
Email: earctsl@leeds.ac.uk

In the Cleveland Basin of Yorkshire, UK, benthic extinction was coincident with the onset of the deposition of laminated, organic-rich mudstones at the top of Toarcian Tenuicostatum Zone, so reduced oxygenation appears to be the main kill mechanism involved (the Toarcian 'Oceanic Anoxic Event'). There was no obvious extinction event at the Pliensbachian-Toarcian boundary in the benthos, although there was a turnover in ammonite families. Benthic diversity remained low in the Serpentinum Zone allowing for specialist low-oxygen tolerant communities to dominate. Recovery properly commenced once sea floor ventilation began to improve and was first expressed by an expanded ecological tiering structure. Recovery progressed slowly thereafter with the possible return to oxygen restricted environments. As sea levels fell and sand-dominated deposition occurred again within the basin, the recovery accelerated with ecological and species richness reattaining, and furthermore exceeding, pre-extinction levels. Full recovery occurred, at the latest, ca. 7 Myr after the extinction. This pattern of benthic extinction and recovery was similar in other NW European basins where early Toarcian laminated, organic-rich mudstones occurred, for example in North and SW

Germany. In contrast, sections in SW Europe and Morocco record very different patterns of extinction and recovery. Here, TOC values in the early Toarcian rocks are low and rapid warming, rather than reduced oxygenation may have been the main environmental factor involved. Whilst geochemical data is abundant for Pliensbachian-Toarcian rocks with an increasingly global extent, palaeontological data is mostly confided to Europe and North Africa, something that needs rectification in future research.

Hidden in Plain Sight: A Long-Lost Ichthyosaur from the Strawberry Bank Lagerstätte (Toarcian, Lower Jurassic)

[1,2]**Dean R. Lomax** and [3]Judy A. Massare

[1]Palaeobiology Research Group, School of Earth Sciences, University of Bristol, Life Sciences Building, Tyndall Avenue, Bristol BS8 1TQ, UK
[2]Department of Earth and Environmental Sciences, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK
[3]Earth Sciences Department, State University of NY at Brockport, NY 14420, USA
Email: dean.lomax@manchester.ac.uk

A practically complete ichthyosaur skeleton from the scientifically significant Charles Moore (1815-1881) collection has long been assumed to come from the Lower Lias (Lower Jurassic) of Somerset, England. Presently, it is one of the numerous well-preserved skeletons currently on loan to the Amgueddfa Cymru-National Museum of Wales. It had been identified and briefly described as probably a juvenile *Leptonectes tenuirostris*. In 2019, a study suggested that it came from the Upper Lias Strawberry Bank Lagerstätte, but it was inconclusive. The specimen was originally on display in the mid-1800s as part of a public museum at the Bath Royal Literary and Scientific Institution. It was mounted on the wall with more than 20 skeletons of Lower Lias ichthyosaurs, so it is not surprising that it was subsequently stored with them. Recent work on the Charles Moore collection has confirmed that this specimen is from the Strawberry Bank Lagerstätte, the most complete marine reptile-from the locality; it also has the best-preserved skull of any ichthyosaur from there. As this site is no longer accessible, this rediscovery offers new opportunities to examine an almost complete ichthyosaur skeleton from a unique location.

Diversity and stratigraphic ranges of fossil vertebrates in the Toarcian Posidonienschiefer Formation (Germany)

Erin E. Maxwell[1], Martin Ebert, Michela M. Johnson[1], Sebastian Stumpf[2], Peggy Vincent[3], & Samuel L. A. Cooper[1]

[1]Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany
[2]Department of Palaeontology, University of Vienna, Vienna, Austria
[3]Centre de Recherche en Paléontologie – Paris, UMR 7207 CNRS-MNHN-SU, Muséum national d'Histoire naturelle, Paris, France
Email: erin.maxwell@smns-bw.de

Fossil vertebrates from the early Toarcian Posidonienschiefer Formation of southwestern Germany have been collected and studied for over 150 years but have not been comprehensively reviewed as a fauna in almost half a century. This geological unit is considered to be a classic fossil Lagerstätte,

and the focus of recent research, based on exceptionally preserved material, has been on the palaeobiology of individual species. Although strong variation in faunal composition between beds was noted over 100 years ago, overarching characteristics of the diversity and stratigraphic distribution of species remain poorly understood. Here, we review the fauna in an updated taxonomic context, and examine factors influencing species abundance in a semi-quantitative framework.

Species abundance data for a subset of vertebrate taxa was collated and then scaled, to account for differences in (1) collecting and preparation effort, (2) taxon body size, and (3) skeletal completeness required for species-level taxonomic assignment. Data were then visualized using a principal components analysis. Despite a plethora of underlying biases, this approach highlighted four characteristic faunas, the separation and taxonomic composition of which appears to be controlled primarily by water depth and bottom water oxygenation. A potentially separate fifth group of taxa is characterized by broad stratigraphic ranges, but a preference for less stratified water column conditions. These data can help predict taxonomic composition, extinction, and extirpation susceptibility in other Mesozoic marine vertebrate faunas, and can also be expanded to understand vertebrate trophic network structure in Mesozoic epicontinental seas.

Global climate disruption in the latest Pliensbachian: a prelude to the T-OAE

Connor S. O'Keeffe[1], L. Schwark[2], I. D. Bull[3], H. L. Whelton[3], F. L. Gill[1], C. T. S. Little[1]

[1]School of Earth and Environment, University of Leeds, Leeds, UK
[2] Institute of Geosciences, Christian-Albrecht University, Kiel, Germany
[3] Organic Geochemistry Unit, School of Chemistry, Bristol, UK
Email: COKeeffe1@hotmail.co.uk

The Pliensbachian-Toarcian boundary was characterised by localised anoxia in shallow marine environments, and by an extinction event in marine organisms. It is widely believed – based on negative isotopic excursions in bulk organic carbon – that the boundary was marked by a brief hyperthermal event, driven by global climate change. The Pliensbachian-Toarcian boundary preceded the longer lasting Toarcian Oceanic Anoxic Event (T-OAE), and the marine mass extinction that accompanied it, by around a million years. Compound-specific isotopic analyses of black shale sequences deposited during the T-OAE, which circumvent potential interference from local carbon cycling on bulk isotopic records, have confirmed its association with a disruption to the global carbon cycle. However, there is a paucity of similar proxy records from the latest Pliensbachian. We present complementary isotopic records of short and long chain n-alkanes, derived from the Upper Pliensbachian of the Cleveland Basin (Yorkshire), which display coeval isotopic depletion. These records were evaluated through a thin black shale – the Lower Sulphur Band – which is a possible stratigraphic marker for the Pliensbachian-Toarcian boundary in this region. We argue that the simultaneous isotopic depletions observed, in both marine and terrestrial organic matter, imply the occurrence of a disruption to the global exchangeable carbon reservoir in the latest Pliensbachian, and therefore, a hyperthermal event. We further suggest that the sequestration of carbon in marine organic matter during this event limited the capability of the earth system to buffer carbon cycle disruption, and thereby exacerbated the impact of the subsequent T-OAE.

Ammonites and Time in the Lower Toarcian (Lower Jurassic): Towards a High Resolution ammonite-based international biochronology for the Jenkyn's – and other – events.

[1,2]**Kevin N. Page**, [3,4]Emma Cieslak-Jones

[1]Honorary Senior Research Fellow, Camborne School of Mines (University of Exeter), Penryn Campus, Penryn, Cornwall TR10 9FE, UK
[2]Geodiversity & Heritage, Thornedges, Crediton, Devon, EX17 4BR, UK.
[3]University of Lille, France
[4]Em Gems (https://www.youtube.com/c/emgems)
Email: kevinnpage@gmail.com

The latest Pliensbachian and Early Toarcian (Early Jurassic) are famous for one of the most pronounced phases of global warming in the Phanerozoic, known as the Jenkyn's Event. Although the event is typically linked to widespread marine anoxia and extinctions, beyond simply a general chronological coincidence, how many of these observations are genuinely synchronous? Only the application of a refined high-resolution biochronology, such as that available using ammonite biohorizons with a potential correlative resolution of around 50,000 years or less, can help answer this question. Correlations between northern (i.e. Subboreal in a bioprovincial sense) and Sub-Mediterranean and southern Mediterranean areas in Europe (and adjacent areas), using ammonites, however, remain poor due to a frequent lack of understanding of 'southern' faunas by authors in northern areas and *vice versa* for authors in southern areas. This issue is particularly problematical for the Jenkyn's Event interval, not least as northern and southern areas typically use different zonal schemes, despite some key species being common to all. Recent intensive sampling of new sections near Ilminster in Somerset and existing sections on the Dorset coast between Seatown and Eype (Submediterranean Province; all SW England), however, combined with a study of historical collections from NW England (Subboreal Province) are facilitating the consolidation of single chronozonal framework for the entire region, with provincial differences reflected by better integrated biohorizonal schemes. With such a chronology in place, it will finally be possible to make statements about the relative, even ultimately the absolute, chronology of Early Toarcian 'events'.

Osedax in the Toarcian? First recorded occurrence of *Osspecus*-shaped borings and other features on ichthyosaurid vertebrae from the Whitby Mudstone Formation, North Yorkshire, UK

[1]**Christina Shears Ozeki**, [1]Hiroshige Matsuoka

[1]Division of Earth and Planetary Sciences, Kyoto University, Kyoto, Japan
Email: christina.ozeki@gmail.com

Osedax is a bone-boring siboglinid worm discovered in 2002 colonising a grey whale carcass (known as a whalefall), off the coast of California. *Osedax* are known to utilise decomposing whalefalls on the seafloor during the second decompositional stage (Enrichment-Opportunistic). Possessing a 'root' system, which secretes an acidic substance they bore into bones and teeth, to reach the nutrients inside, which are then absorbed via a symbiotic relationship with bacteria.

Cenozoic whalefalls and Cretaceous reptilefalls have also been identified with bioerosional traces resembling *Osedax* borings, these traces have been given the ichnotaxon *Osspecus*. Current molecular clock calculations indicate the mid Cretaceous to be the earliest possible appearance of *Osedax*.

We present bioerosional evidence of the likely existence of *Osedax* during the Toarcian, in the form of *Osspecus* borings on ichthyosaurid vertebrae from the Whitby Mudstone Formation, North Yorkshire.

The bioerosion and other features in the form of microborings, bacterial mats, surface erosion, molluscs, teeth and faecal pellets, were observed via thin sections and stubs using petrological and scanning electron microscopes, EDS analysis was also conducted.

The microborings range in size from 0.15 - 0.95 mm (depth) and 0.10 - 0.85 mm (width) and have been classified in line with other similar studies. They are radial, radially lobate and deeply lobate-shaped, which attributes them to *Osedax*, suggesting a need to recalibrate the current evolutionary model for the siboglinid.

The microborings and other features exhibited on the vertebrae suggest that reptilefalls underwent similar decompositional processes in the Jurassic, as seen on whalefalls today.

The macroevolutionary impacts of predator-prey interactions on the rise of giant carnivorous dinosaurs in the Jurassic.

Suresh A. Singh[1] & Michael J. Benton[1]

[1]Department of Earth Sciences, University of Bristol, Bristol, United Kingdom
Email: sureshsingh.palaeo@gmail.com

Dinosaurs grew to unprecedented sizes during their reign as the dominant large tetrapods on land through much of the Mesozoic era. Indeed, theropod and sauropod dinosaurs gave rise to the largest-known terrestrial carnivores and herbivores, respectively. Larger body sizes are generally energetically costly and impair adaptive flexibility through environmental upheavals. Yet, there appears to have been sustained selective pressure for gigantism across non-avian dinosaurs. The evolutionary drivers of these extreme sizes remain uncertain, but it has been suggested that they stem from an evolutionary arms race between predators and their prey. Antagonistic predator-prey relationships are a strong driver of behaviours that can ultimately drive evolutionary change in both parties, but their influence on macroevolution remains underexplored due to the difficulties of viewing such interactions through the lens of an incomplete and low-resolution fossil record. Using new Bayesian inference modelling and phylogenetic comparative methods, we explore theropod diversification dynamics alongside patterns of morphological change to investigate the potential impacts of predator-prey interactions with sauropodomorph dinosaurs on the early evolution of large sizes in both clades across the Late Triassic and Jurassic (237-145 Ma). We identify the Norian and Pliensbachian-Toarcian as key intervals of theropod and sauropodomorph diversification but find little evidence for potential coevolution until the end of the Early Jurassic. The Toarcian saw an acute shift in theropod jaw and body size evolution that reflects growing adaptation to megacarnivory, which coincided with the proliferation of larger sauropods. Our results suggest escalating predator-prey pressures among dinosaurs linked to the Jenkyns Event.

Time is the substance I am made from: jet analysis, a waiting game.

[1]**Sarah Caldwell Steele**, [2]Richard R. Hark

[1]Department of Archaeology, Durham University, Durham, UK
[2] Institute for the Preservation of Cultural Heritage, Yale University, New Haven, Connecticut, USA
Email: sarah.c.steele@durham.ac.uk

Jets are recognised to have physiochemical characteristics that are geologically special and anomalous, and that these qualities have resulted in past populations assigning magical properties to them. Despite long-term human utilisation, there is no geological consensus as to how wood is jetonised, no technique for the identification of jet gemmologically, moreover, no established method to attribute country of origin for jets. Lacking the necessary geological data, archaeologists as end users of such information, are presently unable to interpret the full socio-symbolic significance of jet. In the case of culturally important materials, attribution of country of origin is crucial to understanding artefact biographies. The presence of artefacts presumed to be constructed of Spanish jet, yet discovered in Colonial Jamestown has previously been used to identify the earliest English settlers as Catholics. A novel combination of jet practitioner knowledge and scientific techniques including pyrolysis gas chromatography mass spectrometry, laser-induced breakdown spectroscopy, and stable isotope analysis of these artefacts and a suite of modern jet samples with known provenance may however allow for an alternative narrative, as if proven scientifically to be made from Whitby jet then the Jamestown jet artefacts can be considered a material manifestation of English folkloric practices and beliefs crossing the Atlantic with the early settlers.

Outstanding palaeontological discoveries from the 'Schistes bitumineux' (early Toarcian) Lagerstätte of Bascharage, Grand-duchy of Luxembourg

Robert Weis[1], Ben Thuy, Dominique Delsate

[1] Palaeontological department, National Museum of Natural History Luxembourg, Luxembourg-City, Grand-duchy of Luxembourg.
Email: robert.weis@mnhn.lu

The Bascharage area in southwestern Luxembourg is known for almost a century for its well-preserved Toarcian-aged fossils of marine and terrestrial origin. The outcropping 'Schistes bitumineux' formation is chronologically and lithologically equivalent to some well-known European Lagerstätten such as the Holzmaden Posidonienschiefer (South-West Germany), the Grimmen and Dobbertin insect beds (Northern Germany) or the Strawberry Bank (United Kingdom). Recent excavations by a team of the Natural History Museum Luxembourg established a detailed stratigraphic framework of the series and provides important palaeo-ecological and geochemical data for the interpretation of the numerous fossils that have been unearthed by citizen scientists and local fossil collectors during the last three decades. The most spectacular and scientifically important discoveries comprise (1) the marine vertebrates, including a new taxon of plesiosaur (*Microcleidus melusinae*), a three-dimensional skull of *Temnodontosaurus zetlandicus*, two new genera of bony fish (*Haasichthys* and *Luxembourgichthys*); (2) terrestrial fauna and flora, comprising several new taxa of insects; (3) cephalopod mollusks, including a new genus and species of a vampyromorph coleoid (*Simoniteuthis michaelyi*). Furthermore, recently published papers discuss predator-prey relationships based on findings of pachycormid fish with gastral remains of teuthids on one hand and a teuthid specimen with preserved fish prey.

POSTERS

Bivalve-barnacle pseudoplanktonic colonisation of wood from the Toarcian, Lower Jurassic, Strawberry Bank Lagerstätte, Somerset UK

Crispin T.S. Little[1,2], Andy Gale[3,4], Matt Williams[5], Øyvind Hammer[6], Vincent Fernandez[7]

[1]School of Earth and Environment, University of Leeds, Leeds, UK
[2]Life Sciences Department, Natural History Museum, London, Cromwell Road, London SW7 5BD, UK
[3]School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Building, Burnaby Road, Portsmouth PO1 3QL, UK
[4]Earth Sciences Department, Natural History Museum, London, Cromwell Road, London SW7 5BD, UK
[5]Bath Royal Literary and Scientific Institution, 16-18 Queen Square, Bath BA1 2HN, UK
[6]Natural History Museum, University of Oslo, Postboks 1172, Blindern, 0318 Oslo, Norway
[7]European Synchrotron Radiation Facility, 71 Avenue des Martyrs, 38000 Grenoble, France
Email: earctsl@leeds.ac.uk

Pseudoplankton are organisms that are adapted for a mode of life attached to floating objects. In modern oceans common examples are lepadid barnacles, which attach themselves to man-made and natural objects, especially wood logs. In the fossil record, pseudoplankton examples are commonly found in black shales, such as the lower Toarcian Posidonia Shale Formation of Germany. Here there are occasional large logs of fossil wood covered in specimens of the inoceramid bivalve *Pseudomytiloides dubius*, with or without specimens of the pentacrinitid crinoid *Seirocrinus subangularis*. Another example of pseudoplankton from the Posidonia Shale is the occurrence of the numerous disarticulated specimens of the phosphatic-shelled eolepadid barnacle *Toarcolepas mutans* associated with a piece of fossil wood, which constitutes the oldest example of pseudoplanktonic barnacles in the fossil record. Here we report a limestone concretion from the lower Toarcian Strawberry Bank Lagerstätte that preserves a piece of fossil wood with a pseudoplanktonic colony comprising at least a hundred specimens of *T. mutans* that attached onto a layer of *P. dubius* bivalves, that had already attached onto the wood. This is one of very few examples of temporal succession for pseudoplankton in the Toarcian and is also unusual in being preserved in a mixed carbonate-siliciclastic facies, rather than a black shale. The occurrence of *T. mutans* in the Strawberry Bank Lagerstätte concretion represents the second record of the species and also the equal oldest example of pseudoplanktonic barnacles in the fossil record.

UPCOMING EVENTS

The History of Geological Discovery in Polar Regions
16-17th July
Cambridge

Day 1 (16th) is a day conference at the British Antarctic Survey Headquarters, with papers on geological discovery in both north and south polar regions.
Day 2 (17th) will include visits to polar archives of geological material at the Sedgwick Museum, and Scott Polar Research Institute.

GCG and HOGG member fee = £30 conference + £5 Visits day. It is possible to register for the conference day only. Conference day (16th) includes refreshments/buffet lunch & soft drinks and abstracts booklet. No refreshments can be provided on 17th as the visits are mostly self-led.

The meeting aims to explore aspects of geological discoveries in the polar regions from the 19th and 20th centuries. It is planned to arrange participation for both days or one day only. Participants will be responsible for their own travel and accommodation arrangements.

Registration is open now - https://www.geocurator.org/events/169-history-of-polar-geological-exploration

The History of Geological Discovery in Polar Regions

16-17th July 2024

A joint meeting of the **History of Geology Group** and the **Geological Curators Group**

Symposium on Palaeontological Preparation and Conservation
11th September
Southampton University

Call for abstracts

Please send abstracts of <250 words plus one image to sppc@geocurator by 30th July 2024. Abstracts will be considered on any topic of earth science conservation or preparation – including all work undertaken to prepare geological material for research, teaching, storage, display, etc. Please state if your abstract is for a poster of platform presentation. We are planning to have a virtual element for people who cannot attend in person.

GCG Winter Seminar and AGM
11th-13th November 2024
Oxford University Museum of Natural History

The Winter Seminar and AGM, in GCG's 50th year, will take place at Oxford University Museum of Natural History. Further information will be announced soon via our events page, newsletter and jiscmail, along with the theme, call for abstracts, and how to register.

Museum of Natural History
University of Oxford

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