# Progressive Palaeontology 2025

Edinburgh

17th June - 20th June

**Abstract Booklet**

# Code of Conduct

It is the expectation of the Palaeontological Association that meeting attendees behave in a courteous, collegial and respectful fashion to each other, volunteers, exhibitors and meeting facility staff. Attendees should respect common sense rules for professional and personal interactions, public behaviour (including behaviour in public electronic communications), common courtesy, respect for private property and respect for intellectual property of presenters. Demeaning, abusive, discriminatory, harassing or threatening behaviour towards other attendees or towards meeting volunteers, exhibitors or facilities staff and security will not be tolerated, either in personal or electronic interactions.

**Digital images and social media**

Do not photograph a poster or record a talk without the author's express permission. While the default assumption is to allow open discussion of presentations on social media, attendees are expected to respect any request by an author to not disseminate the contents of their talk or poster.

**Reporting unacceptable behaviour**

If you are the subject of unacceptable behaviour or have witnessed any such behaviour, you can report it (anonymously if you choose to) via the online reporting form (link below). Anyone experiencing or witnessing behaviour that constitutes an immediate or serious threat to public safety, or a criminal act is expected to contact the appropriate law enforcement agency. Those witnessing a potential criminal act should also take actions necessary to maintain their own personal safety.

## Online Reporting Form

https://www.palass.org/association/reportmember-code-conduct-violation

# Contents



# Introduction

Progressive Palaeontology (ProgPal) is an annual conference organised by students for students, and is supported by the Palaeontological Association. This year we are excited to host ProgPal 2025 in the beautiful city of Edinburgh!

We aim to provide a welcoming, supportive space for early-career researchers to present their work in a conference environment and spend time with their peers from other institutions.

This year's logo was designed by Edinburgh alumnus, Natalia Jagielska. Her design incorporates one of Edinburgh's most iconic landmarks, Edinburgh Castle, at the top of the graphic. Inside the graphic, Scottish fossils can be seen, including sea scorpions from the Pentlands, conodonts and shrimps from Wardie Bay, a mammal and pterosaur from the Isle of Skye, plants and fungi from the Rhynie Chert, and many more.

This truly represents the stunning geological history of Scotland and Edinburgh, and the depth and diversity of its fossils.

# Sponsors

**We are very grateful for the support of the following sponsors**

The Company of Biologists

UK Centre for Astrobiology

The University of Edinburgh
School of Geosciences

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Edinburgh Geological Society

# Meet the committee

**Adam Manning**
2nd year PhD student studying how dinosaur brains change over time.

Fave prehistoric animal: *Regaliaceratops*

Fave place in Edinburgh: Ancient Robot Games

**Milly Mead**
1st year PhD student studying the evolution of the brain and cognition in fossil tetrapods.

Fave prehistoric animal: *Oksoko*

Fave place in Edinburgh: Topping & Co. Booksellers

**Ruaridh Alexander**
3rd year PhD student studying the Ediacaran-Cambrian transition.

Fave prehistoric animal: *Namacalathus*

Fave place in Edinburgh: Flotterstone, Pentland Hills

**Laura Cooper**
4th year PhD student Devonian plants and their mysterious friends.

Fave prehistoric species: *Prototaxites*

Fave place in Edinburgh: The Mansfield Traquair Centre

# Meet the committee

**Issy Walker**
MScR student studying the neurobiology and ecology of ankylosaur dinosaurs.

Fave prehistoric animal: *Parasaurolophus*

Fave place in Edinburgh: Twelve Triangles Bakery

**Jack Davidson**
MScR student studying plesiosaurs and their taphonomic processes.

Fave prehistoric animal: *Triceratops*

Fave place in Edinburgh: Blackford Hills

**Carly Pligersdorffer**
MScR student studying thalattosuchian brains.

Fave prehistoric animal: *Simosuchus clarki*

Fave place in Edinburgh: The National Gallery

**Ross Simpson**
MScR student studying functional diversity in the Ordovician.

Fave prehistoric animal: *Barinasuchus*

Fave place in Edinburgh: Fife

# Meet the committee

**Gemma Laker**
MScR student studying the geochemistry and palaeontology of the Late Ediacaran.

Fave prehistoric animal: *Anomalocaris*

Fave place in Edinburgh: Botanic Gardens

**David Kirson**
MScR student studying perissodactyls from the Early Eocene.

Fave prehistoric animal: *Carnotaurus*

Fave place in Edinburgh: National Museums Scotland

**Chang (Aurora) Liu 刘畅**
MScR student studying the phylogenetics of birds and theropod dinosaurs.

Fave prehistoric animal: *Anchiornis*

Fave place in Edinburgh: Pentland Hills

**Edwin Rodriguez**
3rd year PhD student studying Precambrian organic-walled microfossils (Torridon) and carrying out experimental taphonomy.

Fave prehistoric animal: *Hallucigenia*

Fave place in Edinburgh: Duddingston Loch

# Meet the committee

**Rosa Parkin**
PhD student studying fossil plants.

Fave prehistoric plant: *Lepidodendron*

Fave place in Edinburgh: Arthur's Seat

**Tea Reinert**
PhD student studying the phloem in seed plants.

Fave prehistoric species: *Podozamites*

Fave place in Edinburgh: The Botanics

**Diego Sanchez**
PhD student studying the origin and evolution of spiral phyllotaxy (plant leaf arrangements).

Fave prehistoric plant: *Millerocaulis preosmunda*

Fave place in Edinburgh: Hunter's Bog, Holyrood

# Schedule

**17th June 2025 - Pre-conference event**
**14:00 -** Registration Opens (Nucleus Building, Kings Campus)
**18:30 -** Pre-Conference Event - Great micro-ancestors: the overlooked beginners of life on Earth (Room 6231, James Clarkwell Memorial Building, Kings Campus)

**18th June 2025 - Day 1: Workshops, Poster session and Icebreaker**
**09:00 onwards -** Registration and poster hanging (Nucleus Building, Kings Campus)
**10:00 & 11:00 -** Collections tour
**11:00 & 14:00 -** Workshops (see details in next section)
**15:00 -** Poster session (Nucleus Building foyer, Kings Campus)
**17:00 -** Icebreaker (Outside Nucleus Building)
**19:00 -** End

**19th June 2025 - Day 2 - Presentations and Annual Dinner**
**09:00 -** Opening Remarks (Elm Lecture theatre, Nucleus Building, Kings Campus)
**09:15 -** Keynote speaker, by Tim Rock
**09:45 -** Coffee Break
**10:00 -** Talk session 1
**11:00 -** Coffee break
**11:20 -** Talk session 2
**12:40 -** Lunch and LGBTQ+ Meetup
**13:40 -** Talk session 3
**15:10 -** Coffee break
**15:30 -** Talk session 4
**17:00 -** Auction, awards and closing
**18:00 -** End
**19:00 -** Conference dinner (Montpeliers, Bruntsfield, EH10 4DG)

**20th June 2025 - Day 3 - Field Trip to Barns Ness**
**12:00 -** Coach departs for Barns Ness (Outside Grant Institute, Kings Campus)
**16:00 -** Coach departs Barns Ness to return to Kings Campus.

# Getting around Edinburgh

## Getting to Edinburgh

In line with our goals to reduce our carbon footprint, we encourage delegates to use public transport to attend the conference and get around Edinburgh

**Rail:** Edinburgh's main train station is Edinburgh Waverley. Waverley has good rail connections to the rest of the country. The station is in the middle of the city centre, right next to Princes Street, and there are numerous bus options connecting Waverley and Princes Street to the university and conference venues. Consult The Trainline and National Rail for route advice and ticket prices. For those unaware, railcard discounts of a 1/3rd on many train tickets are available for all those under 30 on purchase of a railcard, see Railcards for more details.

**Coach:** National Express, Megabus and Flixbus all run long-distance coach routes to Edinburgh from various locations. When making your booking, check the drop-off point and where your accommodation and venues are, to ensure you can get to where you need to be afterwards.

**Air:** Edinburgh Airport has daily flights to numerous cities across Europe. It is connected to the city centre via the tram and the bus. The 100 Airlink bus travels directly from the airport to the city centre (stops outside Waverly Station) and return tickets can be bought for £8. Additionally the tram is available which goes through the city centre and continues towards Newhaven. Taxis are also available from the airport.

**Car:** We recommend walking or taking transit to the King's Buildings Campus whenever possible. If you do drive, visitors are able to buy parking permits from the university, but parking spaces on campus can be limited. Street parking around King's Buildings is available, but many streets have a priority parking scheme enforced so finding a spot nearby can be challenging. An important consideration when driving in Edinburgh are Low Emission Zones or LEZ's. The King's Buildings Campus is not located within a LEZ, however you may have to drive through one to get there.
It is important to be aware of LEZ's and if your vehicle is compliant
in order to avoid a penalty-charge.

# Getting around Edinburgh

## Getting to the University

In line with our goals to reduce our carbon footprint, we encourage delegates to use public transport to attend the conference and get around Edinburgh.

The University of Edinburgh is a city university and different departments are distributed around Edinburgh. The ProgPal conference will be taking place at the **King's Building Campus** which is located south of the city centre on West Mains Road.

One of the best ways to get to the King's Buildings Campus is by bus. There is a bus stop inside the campus, and bus stops just outside it on West Mains Road and Mayfield Road. Additionally bus stops on the A701 near Cameron Toll shopping centre are a short walk away from King's Buildings. A link to travel options can be found here.

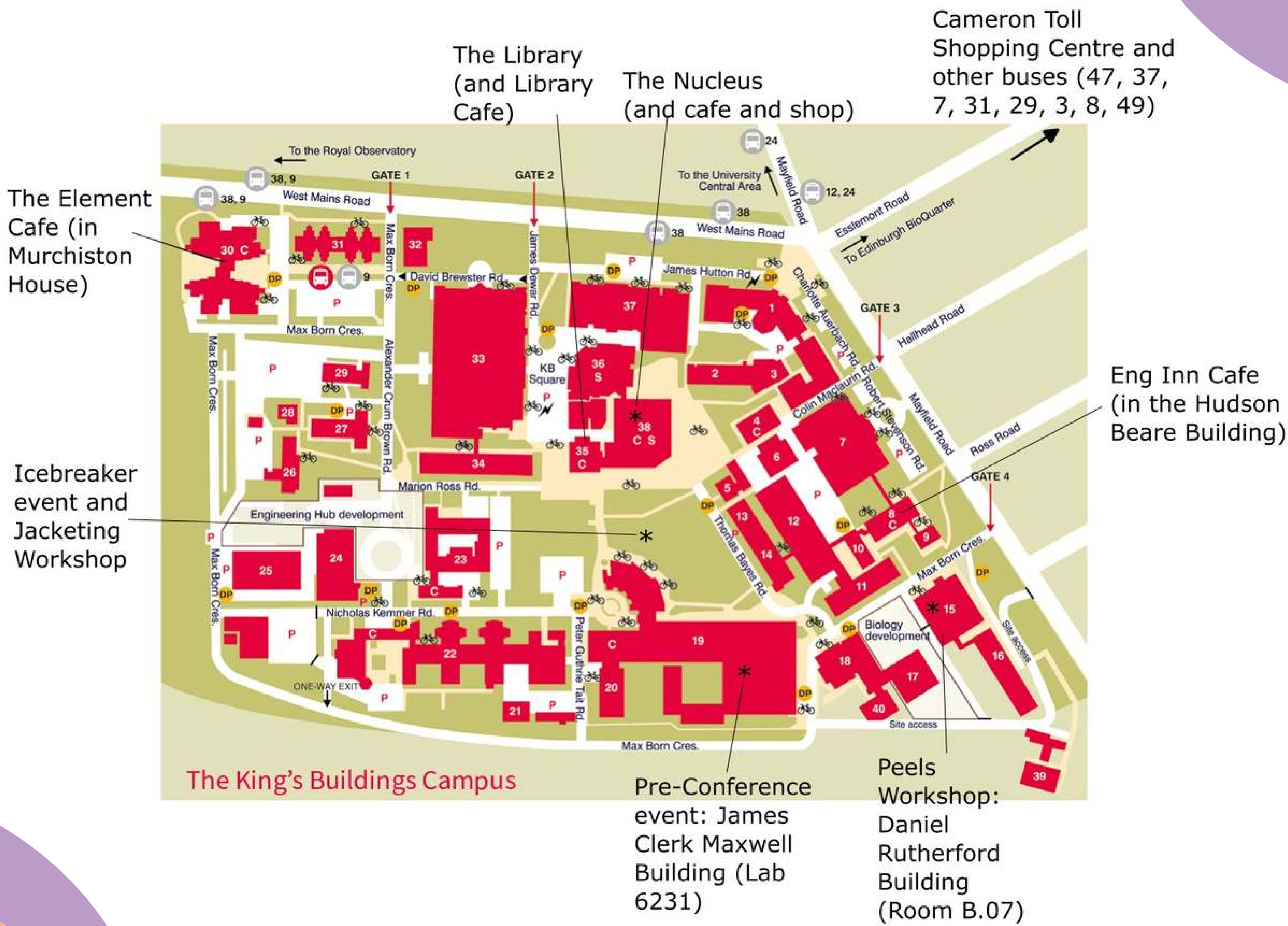
We recommend downloading the **Lothian Buses and Trams** app to plan your journeys and receive regular updates on bus timings.

**Note:** The university shuttle bus will not be in operation during the conference.

King's Buildings are located south of the city centre, with a reasonable decent and uphill climb between it and the city centre. The number 9 Lothian bus will drop you off directly onto campus, and many others will drop you off at nearby Cameron Toll, making travel to and from the city easy.

The main location for the conference is the Nucleus Building, which is located centrally in the King's Buildings campus. The simplest way to get to the event space is to enter through the South-Eastern entrance.

# Map of Kings Buildings



# Pre-conference event

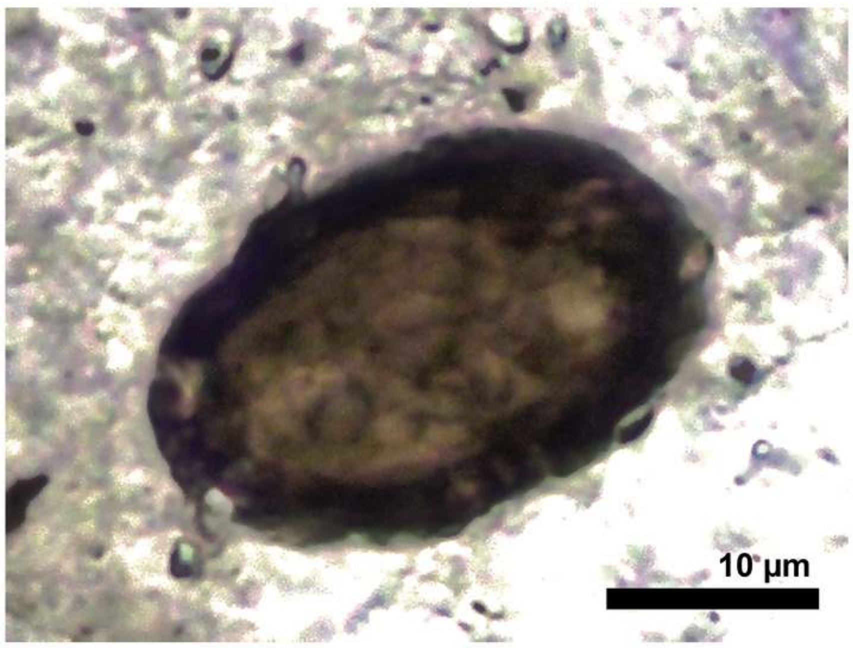
## Great micro-ancestors: the overlooked beginners of life on Earth

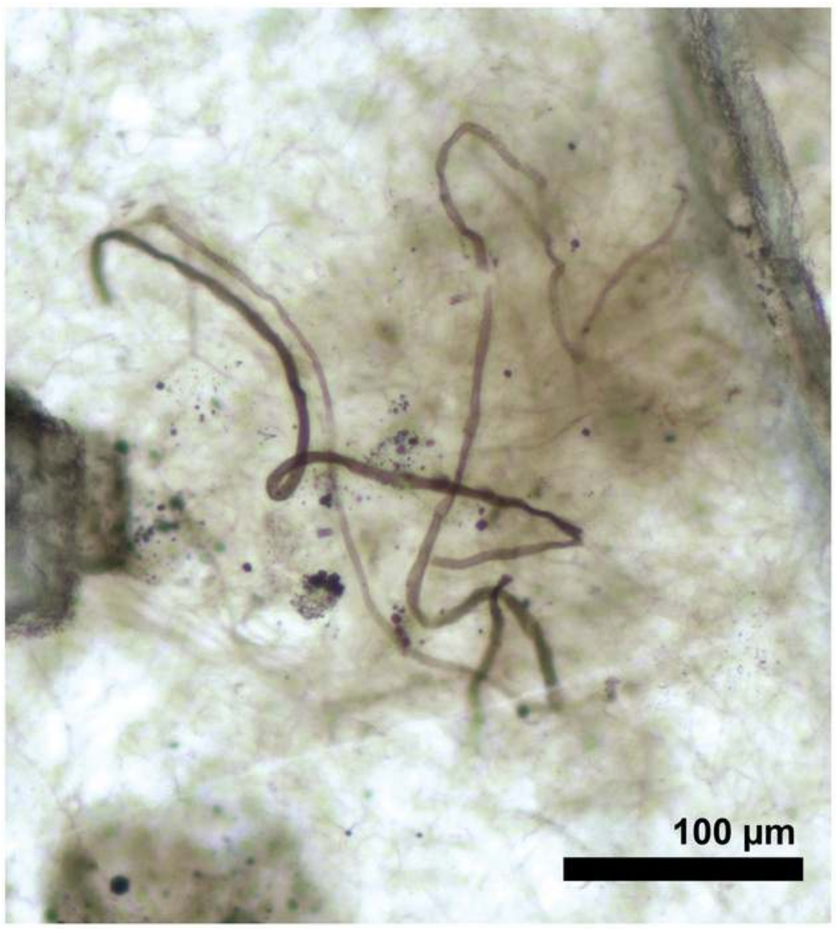
18:30, June 17th. Lab 6231, James Clerk Maxwell Building.

Microbial life dominated Earth for roughly 2 billion years before complex multicellular life appeared, thus representing the vast majority of life's evolutionary history.

Studying ancient microorganisms helps palaeontologists to understand fundamental processes like the development of photosynthesis, the oxygenation of Earth's atmosphere, and the origin of eukaryotic cells. Microfossils also serve as some of the oldest direct evidence of life on Earth.

But how can micropaleontologists contribute to the study of astrobiology, and what is the relationship between fossils and space? The organizers of this event, members of the UK Centre for Astrobiology (UKCA) at the University of Edinburgh (UoE), are delighted to present an evening full of microbial fossils to answer these and more questions!




Fossil holozoan *Bicellum brasieri* from the Torridon Group (above), and fossil filaments *Siphonophycus sp.* from the Draken Formation (right).

# Pre-conference event

**Dr Sean McMahon**

Sean is the Programme Director for UoE's MSc in Astrobiology and Planetary Sciences, UKCA co-director, and Reader in Astrobiology. He studies the co-evolution of life and planetary environments across large spans of space and time, focusing on biosignatures in ancient materials from early Earth, Mars, and beyond.

**Edwin Rodriguez Dzul**

Edwin is a PhD student at the UoE. He is researching the application of experimental taphonomy to microbial eukaryotes, and spectroscopic techniques to ~1-billion-years-old microbial fossils from the Torridon Group. He previously completed his Masters studying the preservation of fossil microbes in the Rhynie Chert.

**Beilei Hua**

Beilei is a PhD student at the UoE. She is undertaking research into the determination of the biogenicity of ambiguous structures. She previously completed her Masters on the application of vibrational spectroscopy to Proterozoic fossils.

**Mylaine Holin**

Mylaine is a PhD student at the UoE, and previously completed her Masters at Sorbonne Université and Université Paris Cité. She is researching the production, modification and destruction of organic molecules by abiotic processes on Mars and in the early solar system.

**Katy Field**

Katy is a PhD student at Dublin City University and a previous student of Edinburgh having done her Masters here. She specialises in Precambrian palaeontology and its applications for understanding how we identify and recognise early life within the fossil record. Soon she will be working on potential fossils that are nearly 3.5 billion years old.

**Hanzhi Qu**

Hanzhi is a visiting PhD student from Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. He received his Bachelor's degree in Geology from China University of Geosciences in 2022. He is now investigating spectroscopic characteristics of Neoproterozoic algae fossils from South China.

# Workshops & Events

**Palaeobotanical Peels Workshop:** This workshop will endeavour to educate attendees about the cellulose acetate peel technique and give them the opportunity to produce their own from Carboniferous plant fossils. Cellulose acetate peels are a widely used technique in palaeobotany to study permineralised fossils in cellular detail. You will also hear how the Molecular Palaeobotany and Evolution Group at Edinburgh has used peels and other preparatory techniques to study Devonian and Carboniferous plants to build an understanding of the early evolution of major plant groups. There will be two sessions with 20 people per session, the first at 11:00 and the second at 14:00. They will be held at The Daniel Rutherford Building (Teaching Lab B.07) on Kings Campus.

**Field Skills - Jacketing Workshop:** This workshop focuses on developing a vital transferable skill for field palaeontology: plaster jacketing. Attendees will receive a short informative talk on the theory, process, and logistics of preparing a specimen for jacketing, using diverse case studies from the UK and abroad. You will learn how to tailor your jacketing to ensure the safety of fossils, followed by a demonstration before having a go yourselves. This will be a fun, hands-on session where you will get to work directly with plaster to jacket mystery (non-fossil) material in small groups, so please come prepared to get a bit messy! There will be two sessions with 20 people per session, the first at 11:00 and the second at 14:00. The sessions will begin in James Clerk Maxwell Building, Lab 6231.

**National Museums Collections Centre Tour:** This tour of the collections centre of National Museums Scotland in Granton will show you a behind-the-scenes look into the research and innovation that occurs in Edinburgh. This tour will be hosted by museum staff that can answer all your questions. Please visit the collections website for an insight into what you can expect from this tour. There will be two sessions with 12 people per session, the first will be at 10:00 and the second at 12:00. The Collections Centre can be found at the north of the city, 242 W Granton Rd, Edinburgh EH5 1J.

**Icebreakers:** We will be hosting an icebreaker event on the evening of Day 1 (June 18$^{th}$) outside the Nucleus Buidling on our lovely green space. The icebreaker event is an opportunity for delegates to network and socialise in an informal event. The icebreaker event will include a pub quiz where both alcoholic and non-alcoholic beverages will be available.

**Auction and Awards:** We will be holding an auction and presenting awards for best poster and best talk at the end of the final talk session before the annual dinner.

**Annual dinner:** The annual dinner will take place on the evening of Day 2 (June 19th) at Montpeliers in Bruntsfield. The dinner will have a set menu which will be made available closer to the date. Please inform us of your dietary requirements so that we can ensure that the restaurant can cater to them.

# Field trip - Barns Ness

This year's field trip will be to Barns Ness, a wonderful fossil locality a short coach journey away from Edinburgh (approx. 45 minutes).

Barns Ness is famous for its Carboniferous limestone outcrops, as well as sandstone, mudstone and coal. There are also plenty of fossils to be discovered, including corals, trace fossils and plant fossis.

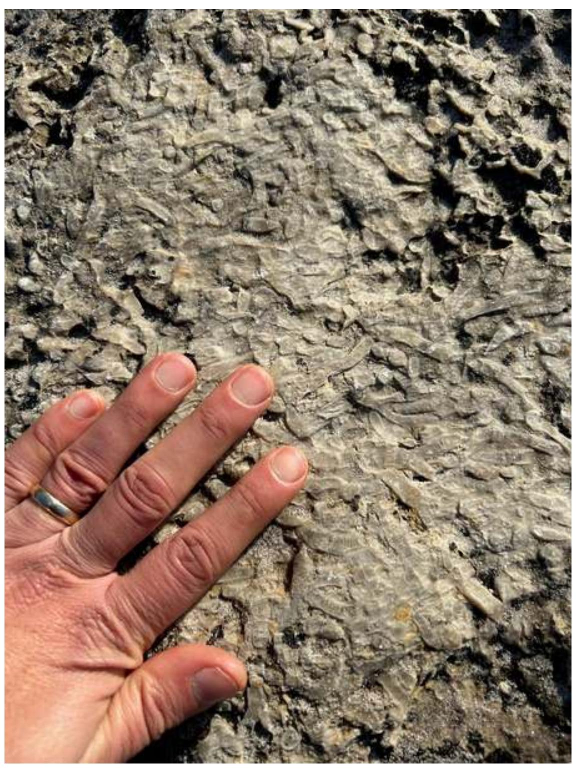
**Barns Ness is a Site of Special Scientific Interest and hammering is forbidden. Loose rocks and fossils will be available to be collected instead.**

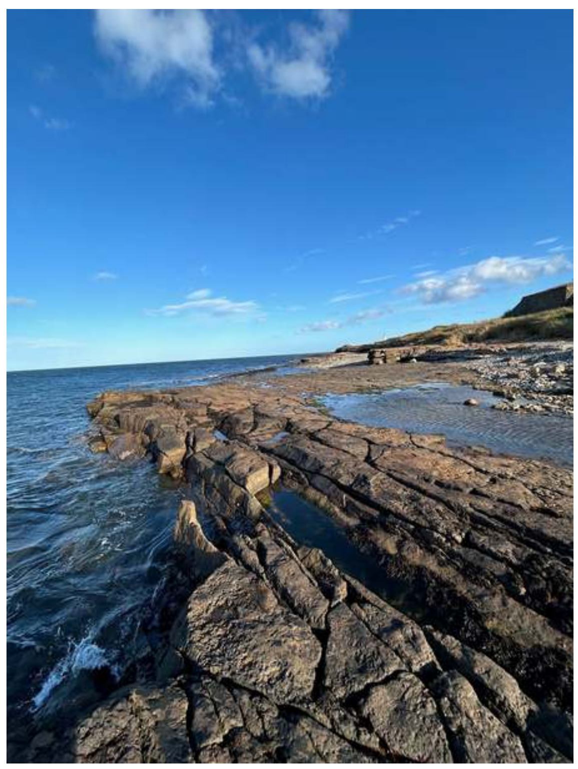
We will be leaving King's Buildings via coach at 12pm outside the Grant Institute. The journey is approximately 45 minutes depending on traffic. At the site, we will be dropped off at the carpark, which has toilet facilities.

There will be no places to eat nearby, so please bring with you any lunch or food items you would like to eat whilst we are there. As with any public site, please be careful not to litter and to bring back any waste with you to be disposed of properly.

We will take a short walk up the beach on mostly flat terrain to visit the fossil sites. This is a rocky shore with low cliffs, and there is the risk of tripping, slipping or falling, especially on wet surfaces. Delegates should wear the appropriate fieldwork gear, including waterproof coats and trousers, and strong walking boots.

We aim to leave the site at ~4pm and be back at the King’s Buildings by 5pm.





*Photos from @SteveBrusatte on X*

# Talk Schedule

**09:00 -** Opening Remarks
**09:15 -** Keynote Talk - Tim Rock
**09:45 -** Coffee break

**Talk Session 1**
**10:00 -** Lightning Talk - Scott Bellotti
**10:10 -** Full Talk - Emily Ball
**10:30 -** Lightning Talk - Julia Seim Grønningsæter
**10:40 -** Full Talk - Princess Aira Buma-at
**11:00 -** Coffee break

**Talk Session 2**
**11:20 -** Full Talk - Alex Colesmith
**11:40 -** Lightning Talk - Ethan Jones
**11:50 -** Full Talk - Maxime Flaunet
**12:10 -** Lightning Talk - Zoe Kinzella
**12:20 -** Full Talk - Lucy Jackson

**12:40 - Lunch**

**Talk Session 3**
**13:40 -** Lightning Talk - Jack Lovegrove
**13:50 -** Full Talk - Yarong Liu
**14:10 -** Lightning Talk - Hebert Bruno Nascimento Campos
**14:20 -** Full Talk - Rebecca Sheng
**14:40 -** Lightning Talk - William Newton
**14:50 -** Full Talk - Yujie Shi
**15:10 - Coffee break**

**Talk Session 4**
**15:30 -** Lightning Talk - Bethany Pittard
**15:40 -** Full Talk - Lara Uttinger
**16:00 -** Lightning Talk - Vanja Simonsen
**16:10 -** Full Talk - Benton Walters
**16:30 -** Lightning Talk - Sasha Ubhi
**16:40 -** Full Talk - Morgan Whitley

**17:00 - Auction & Awards**

**18:00 - End**

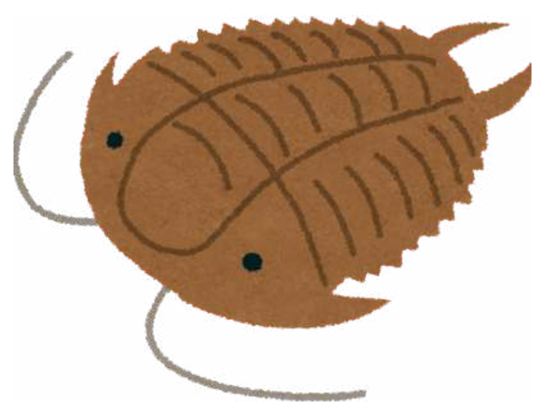
# Keynote Talk

## Adventures in 'complexity space': A multivariate approach for quantifying the evolution of biological complexity.

**Tim Rock**
**University of Bath**

From a single celled LUCA, through the Cambrian and beyond, the maximum complexity of organisms has indisputably increased throughout geological time. An increasing number of evolutionary studies seek to quantify and characterise such complexity change at macroevolutionary scales, often focussing on the proliferation and differentiation of serial homologues within organisms (e.g., bones within limbs; vertebrae within axial columns). Problematically, while numerous operational frameworks have been proposed for doing this, many focus on just one or sometimes multiple conflated aspects of what is really a multidimensional concept. This talk will introduce 'complexity spaces' as an adaptable framework for quantifying the complexity of biological systems (now published in *Royal Society Interface*; doi.org/10.1098/rsif.2024.0558).

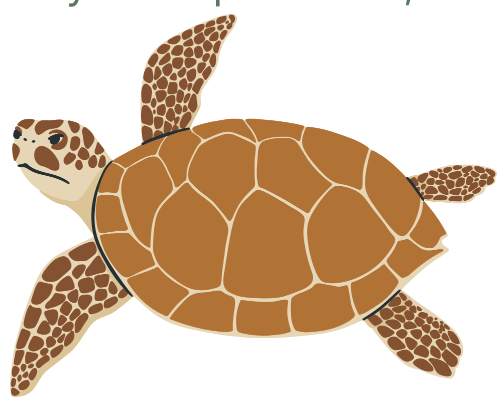
Derived from the relative positions of their constituent parts in morphospace, systems differ in part number, part differentiation and the regularity of this differentiation, allowing us to understand them not just as more or less complex, but also as *differently* complex. We show that this approach can be generalised very widely and provide proofs of concept for two different system types. Firstly, we analyse trilobite body plan complexity through time, in which individuals comprise segments of varying number, form and regularity. Secondly, we quantify the complexity of eusocial ant colonies, treating colonies as superorganisms in which different castes and worker polymorphisms represent homologues of differing number, differentiation and regularity. Finally, this talk will explore the potential wider utility of complexity spaces in palaeontological research, and for understanding the relationships between complexity, function, and biodiversity.



## Assessment of ontogenetic and intraspecific variation in the Campanian baenid turtle *Plesiobaena antiqua* based on computed-tomography guided description of multiple specimens.

**Scott Bellotti - University of Fribourg**

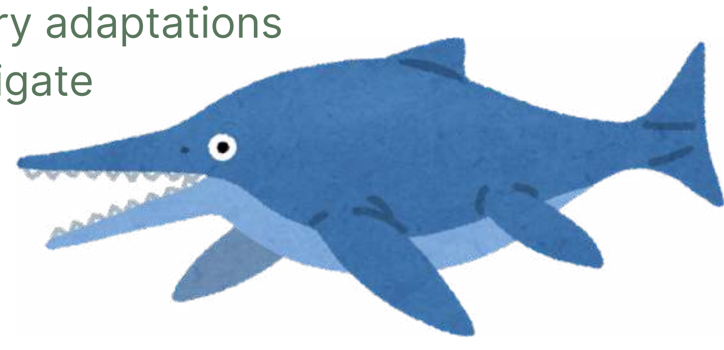
The name Baenidae is used to unite a clade of fresh water paracryptodiran turtles with a fossil record ranging from the Early Cretaceous to the Eocene and is found across North America, with the highest diversity during the Maastrichtian (Late Cretaceous). The baenids are a fascinating group as they represent an important group of continental vertebrates that survived the mass extinction event at the Cretaceous/Paleogene boundary. Among them, *Plesiobaena antiqua* is the most common turtle in the Campanian (Late Cretaceous) Judith River deposits in Canada. The aims of this contribution are first to document and describe the cranial osteology of the Campanian baenid *Plesiobaena antiqua* using for the first time on this species micro-computed tomography scanning technology, with the explicit goal of improving phylogenetic resolution and secondly to identify and describe both ontogenetic and intraspecific variation in *Plesiobaena antiqua* as our sample consists of several specimens with varying sizes. A bone-by-bone analysis of the available material allowed us to notice some ontogenetic related variation: 1) the jugal is progressively included into the orbital margin; 2) the angular height and the robusticity of the mandible increase; 3) the adductor fossa gets more accentuated. Contrary to expectation, the epipterygoid fusion is intraspecifically variable, and does not happen ontogenetically. This project significantly enhances our understanding of baenid turtles, particularly *Plesiobaena antiqua*, by providing new insights into its cranial osteology and into ontogenetic trends in baenids.



## The enigmatic anatomy of *Grippia longirostris*

**Julia Seim Grønningsæter - Natural History Museum**

*Grippia longirostris* was an early Triassic species, belonging to the group Ichthyosaurs–marine reptiles whose history span 157 million years -from Early Triassic to Critaceous times. (Fischer et al. 2016). Their ancestors lived on land, just like the ancestors of whales. However, the known history of cetaceans is not even 50 million years. So far, the fossil record, and/or literature has yet to give proper insight of *Grippia longirostris*´ whole vertebrae column, thus there can only be suggestions regarding the anatomy of it. New material will be measured, documented and analyzed. It is important to gain a broader knowledge of the morphology of *Grippia longirostris*, if the objective is to better understand the evolution and ecology of early Ichthyosaurs (Motani 1998). Once the material has been studied, it might give a better insight into the locomotion of *Grippia longirostris*, and the adaptations it went through in order to thrive in a marine environment. In a rapidly changing nature, understanding necessary adaptations made by successful prehistoric animals, might provide tools to mitigate future challenges like climate change, decreasing populations or extinction. The present study is part of a project at Natural History Museum of Oslo: Evolutionary Convergence of Historical Oceans (ECHO).



### Modelling the marine transgression of the Rhaetian stage Triassic across South West England and South Wales: A 3D GIS driven approach to palaeogeography

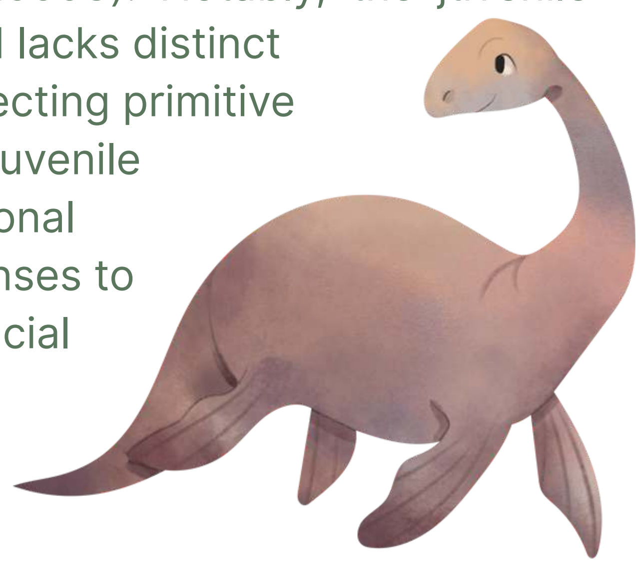
**Ethan Jones - University of Bristol**

The Rhaetian transgression represents a significant transition from a semi-arid terrestrial environment to a shallow, temperate-to-warm marine environment at around 202 million years ago, in the latest Triassic. The transgressive event marks the stratigraphic boundary between the Mercia Mudstone Group and the Penarth Group. The initial marine transgression generated a fragmented chain of islands that were progressively onlapped and buried as relative sea levels increased into the early Jurassic. A sharp and well-defined sequence of stratigraphic formations and members makes it ideal for palaeogeographic reconstruction. Using Geographic Information System (GIS) tools, BGS 1:50000 scale geological maps and Ordnance Survey digital terrain models (DTM) the onlap limits and elevation relative to the palaeo-islands can be reconstructed. Geological map data are supplemented with borehole records and published information on railway cuttings and coastal sections. In a previous project, multiple horizons, including the base of the Rhaetian Transgression, as well as some higher horizons through the Rhaetian were reconstructed and documented progressive stages of flooding. The area covered was around Bristol, and in the current study, this is extended to south Gloucestershire and South Wales to expand understanding of how the distribution of land and sea changed over a geologically rapid flooding event that had major effects on life in the coastal marine and terrestrial settings.

### Plesiosaur fossils from the Pliensbachian (Lower Jurassic) of Bornholm, Denmark

**Zoe Kinzella - Independent**

Plesiosaurians were a globally distributed and successful marine reptile group spanning from the Late Triassic to the end of the Cretaceous. However, Early Jurassic plesiosaur evolution remains poorly understood due to the scarcity of fossils, particularly from the Pliensbachian (192.0 - 184.2 Ma), with only three formally named taxa. Here, I describe five plesiosaur specimens from the Pliensbachian Hasle Formation of Bornholm, Denmark, including a juvenile propodial - the first of its kind discovered in Denmark. These findings contribute to our understanding of plesiosaur evolution and diversity after the Early/Middle Jurassic faunal turnover (approx. 175 Ma). The material consists of isolated remains: a robust, ornamented tooth (NHMD 625447) assigned to Pliosauridae indet., an unfused neural spine (NHMD 625435) possibly from an osteologically immature individual, a neural arch with an unusual shape (NHMD 625357-1), a caudal rib (NHMD 625357-2), and the base of a spinal process (NHMD 625503). Notably, the juvenile propodial (NHMD 625145) is small (117 mm) with rounded edges and lacks distinct epipodial surfaces. Its slight concavity suggests it is a humerus, reflecting primitive Liassic plesiosaur limb morphology. The propodial is one of the few juvenile specimens known from the Lower Jurassic and, alongside the additional material, refines our understanding of plesiosaur evolutionary responses to Early Jurassic environmental changes. These specimens provide crucial insight into plesiosaur life history strategies and contribute to reconstructing the diversity and development of these marine reptiles following the end-Triassic extinction.



## Dinosaur of the round table: a redescription of *Camelotia* highlights its importance to our understanding of sauropod origins

**Jack Lovegrove - University College London**

*Camelotia borealis* was named in 1985, but the holotype material of this taxon was collected nearly a century earlier from Late Triassic marine deposits in Somerset, UK. The description of *C. borealis* separated the partial postcranial skeleton of a sauropodomorph from the two problematic tooth-based taxa, *Avalonianus sanfordi* and *Picrodon herveyi*, it had previously been referred to. *C. borealis* is significant for its large size relative to other Late Triassic sauropodomorphs and its consistent recovery in phylogenetic analyses as being just outside the clade Sauropoda. Our understanding of sauropodomorph taxonomy and anatomy has advanced considerably in recent years making *C. borealis* ripe for re-description. Surface scanning of the material, which is currently split between two museums, has enabled its anatomy to be described in detail. This osteological description, combined with preliminary phylogenetic results, reveals the importance of this taxon for understanding sauropod origins. The biogeographical implications of *C. borealis* are especially significant as our understanding of sauropod origins is otherwise entirely reliant on taxa from the Southern Hemisphere. *C. borealis* is also significant for our understanding of British Late Triassic faunas as it is known from well-dated marine strata, unlike most other British Late Triassic dinosaurs which are known from “fissure fill” deposits with controversial dating. Fossil footprints from Poland suggest that the arrival of *C. borealis* ‘grade’ sauropodomorphs may have occurred across Europe in the Early Rhaetian. This project highlights the importance of re-examining and re-describing overlooked taxa.

## Reassessment of *“Huaxiapterus” benxiensis*: A distinct tapejarid pterosaur from the Jiufotang Formation (Early Cretaceous, China)

**Hebert Bruno Nascimento Campos - Universidade Federal do Ceará**

The pterosaur *“Huaxiapterus” benxiensis*, originally described based on the nearly complete specimen BXGM V0011 from the Jiufotang Formation, has been traditionally regarded as a sinopterine tapejarid. However, a new detailed morphological reassessment reveals that this taxon exhibits a unique suite of features that clearly differentiate it from other Jehol tapejarids such as *Sinopterus dongi* and *Huaxiadraco corollatus*. The frontoparietal crest of “H.” benxiensis is highly distinctive: It is elongate and terminates in a steeply inclined posterior projection, in contrast to the short, blunt-ended crests seen in sinopterines. Additionally, the mandibular symphysis displays a well-developed sagittal ridge along the occlusal surface—an uncommon trait within Sinopterinae but frequently present in derived tapejarines from Gondwana. The dentary crest is blade-like and posteriorly elongated, with a more gradual tapering compared to the vertical termination seen in Tupandactylus navigans. These morphological distinctions, particularly in cranial and mandibular anatomy, support the interpretation of *“Huaxiapterus” benxiensis* as a tapejarine rather than a sinopterine. This reassessment suggests that *“H.” benxiensis* represents the first confirmed occurrence of a tapejarine pterosaur in the Jiufotang Formation, expanding the known paleobiogeographic distribution of the clade and supporting faunal exchange between East Asia and Gondwana during the Early Cretaceous. Our findings underscore the importance of reevaluating existing taxa with updated anatomical criteria to better understand tapejarid diversity and evolutionary patterns.

### Improving the state of ostracoderm taxonomy using quantitative ratio data

**William Newton - University of Manchester**

Today, almost all vertebrates are jawed vertebrates, or gnathostomes. However, in the Ordovician and the Silurian, vertebrate faunas were dominated by heavily armoured, jawless vertebrates known as ostracoderms. As successive clades along the gnathostome stem-lineage, the ostracoderms record the stepwise acquisition of features that define gnathostomes, such as jaws, paired fins, and mineralised skeletons. Unfortunately, the taxonomy of ostracoderms has remained fairly rudimentary since its inception in the early 19th century, holding back understanding of how the gnathostome body plan was assembled. A lot of early taxonomic studies on ostracoderms were predominantly based on qualitative descriptions (i.e. features described as 'short', 'narrow', and 'elongate') and neglected to provide thorough and comparable quantitative data. Nevertheless, improvements are slowly being made, thanks to the increased use of quantitative data, chiefly in the form of ratio data (i.e. a feature's length divided by its width). The first year of my PhD has focussed on describing and establishing the taxonomy of a jawless vertebrate fauna from a so-far-undescribed site in the Welsh Borders, supplementing qualitative descriptions with quantitative ratio data. This approach has ensured that species identification accurately reflects intra- and inter-taxon variation within the site's fauna. The result is a robust taxonomy and an improved framework for investigating further questions regarding ostracoderm phylogeny, ecology, ontogeny, palaeobiogeography, and more.

### Utilising the archaeological record to create long-term biodiversity baselines for declining UK bird populations: Enhancing conservation and ecological understanding.

**Bethany Pittard - University College London**

Contemporary change in natural systems is occurring at unprecedented rates and magnitudes. Currently, 40% of birds are in population decline, with 20% of species at risk of extinction. Little availability of long-term avian monitoring data means timescales are relatively short compared to those needed to establish both biodiversity baselines prior to anthropogenic interference, and useful conservation goals. To overcome this, the zooarchaeological and fossil record provides the only empirical data on long-term interactions between biodiversity, climate, and human impacts from the Pleistocene to present.  Here, we present five case studies based on the rich historical and archaeological archives of birds in the UK. (1) the Grey Partridge (Perdix perdix), (2) the Black Grouse (Lyrurus tetrix) and (3) the Curlew (Numenius arquata) are all relatively rare and demonstrate contracted habitats in the UK compared to their archaeological records, and are fast declining particularly on agricultural land. (4) the White-tailed Eagle (Haliaeetus albicilla) and (5) the Common Crane (Grus grus) both have previously experienced extinction UK and populations now reflect an artificial reintroduced distribution and abundance.

## Digesting an ancient ecosystem: Coprolites from the Grippa bonebed, Lower Triassic, Svalbard

**Vanja Simonsen - Natural History Museum Oslo**

Five coprolite morphotypes were identified and described from the marine Grippia bonebed, Vikinghøgda Formation, Lower Triassic, Svalbard. The bonebed consists of disarticulated skeletal material, teeth, and coprolites. 97 coprolites were studied and sorted based on shape and inclusions. Inclusions were studied using thin sections, SEM and micro CT-scanning. The analyses revealed abundant and diverse inclusions such as bone material, fish scales and the first documented evidence of invertebrates in the Grippia bonebed. Invertebrates include sponge spicules, a cephalopod shell fragment and a high abundance of cephalopod arm hooks (onychites). Possible coprolite producers are discussed and include bony fish, chondrichthyans, temnospondyls, ichthyopterygians and archosauromorphs. This study describes a method for finding low-density elements such as onychites in CT-scans and provides a more complete picture of the Early Triassic marine paleoecosystem and food web in the Grippia bonebed from Svalbard.

## Plasticity of benthic foraminifers in the Neogene – linking environment to success

**Sasha Ubhi - University of Bristol**

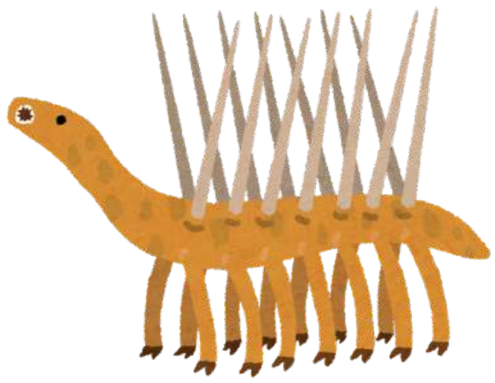
Plasticity plays a significant role in understanding how life persists in the context of environmental change, which will be particularly important in the face of modern-day climate change. Plasticity is the ability of an organism to adapt to environmental stimuli by changing their traits, morphological, developmental or behaviourally. This project focuses on two species of Neogene benthic foraminifera (Oridorsalis umbonatus and Nuttalides umbonifer), exploring their morphological plasticity and fitness changes with the aim to understand: (a) the variability of plasticity and abundance through their development, across geographic and temporal scales; (b) to determine whether plasticity differs in stable versus dynamic environments; and (c) the relation of plasticity to overall fitness to test if plastic traits benefit or hinder organisms survival and adaptability. Foraminifera specimens have been collected from Ocean Drilling cores of the Kerguelen Plateau (Southern Ocean), Walvis Ridge (Atlantic) and the Central Pacific between 0 and 25 Ma at a resolution of 5 Ma. Specimen were picked from washed samples and abundance calculated. CT scans are used to extract morphological characteristics related to fitness. Walvis Ridge samples only contained O. umbonatus while the other two locations have both taxa, suggesting different bottom water masses and environmental conditions. Unexpectedly, several samples did not bear any benthic foraminifera of the two study taxa showing unsuitable environmental conditions. High abundances may be related to food availability at Walvis Ridge.

# ProgPal 2025 Abstracts - Full Talks

## The cost of living: Reconstructing metabolic rates of Eocene fishes from otolith stable isotopes

Emily Ball - University of Southampton

An organism’s metabolic rate is linked to factors like growth rate, life history and activity. Therefore, understanding the metabolic rates of fossils can tell us a lot about how they lived. Fossils can preserve geochemical clues about an organism's metabolic rate, offering new insights into their ecological and physiological traits across deep time. Stable isotope ratios of carbon and oxygen in otoliths (fish ear bones) have been used successfully to infer metabolic rate and experienced temperature respectively in modern fishes. Here we assess the extent to which stable isotope compositions can be used to reconstruct ecophysiological traits of fossil fishes from the Eocene London Clay Formation of the Isle of Sheppey, UK. Otolith-based metabolic rates differed between fossil species, reflecting differences in physiological rates and lifestyles. Inferred metabolic rates recovered from fishes inhabiting warm (25°C) Eocene waters are remarkably similar to metabolic rates recovered from modern relatives in cool temperature settings (13°C). Body trait data associated with metabolic activity, (such as body shape) also shows a strong relationship with δ13C values, providing yet more evidence for the use of δ13C as a proxy for metabolic rate. Geochemical proxies for (palaeo)physiological rates provide direct context-specific evidence for species and population level metabolic physiology through geological time.



## Morphometric and spatial analyses of *Charniodiscus* from the Ediacaran of Newfoundland, Canada

Princess Aira Buma-at - University of Cambridge

Ediacaran macrofossils (580-539 Ma) represent the earliest-known complex animals, revealing critical insight into the evolution of macroscopic life. This study examines Charniodiscus, an upright, sessile, frondose organism that is morphologically simpler than rangeomorphs, enabling the refinement of new quantitative techniques. One of the largest Charniodiscus populations occurs within the Main E Surface community in the UNESCO Mistaken Point Ecological Reserve, Newfoundland. This in situ population can be utilized to explore physical variation across specimens, as well as the spatial distributions of traits within a community. We generated a photogrammetric map of the main E Surface and obtained morphological traits by marking up the branching architecture of 116 Charniodiscus specimens. We used multivariate cluster techniques to identify different morphogroups and to constrain defining physical traits. We then used random labelling analyses to investigate how the spatial patterns of specific characteristics varied across the population, and to identify the spatial patterns of the different morphogroups identified. We find that traits showing distinctive spatial patterns and defined morphogroups are likely to be more ecologically significant than those which vary randomly. Therefore, this novel approach helps elucidate which morphological traits, or combinations of traits, are key drivers of Ediacaran evolutionary dynamics.

## Boneless Wings: the evolution of manual claws in birds

**Alex Colesmith - University of Cambridge**

Tree-climbing and wing claws are both plesiomorphic traits for avialans. Nonetheless, hoatzins (*Opisthocomus hoazin*) are the only modern birds which climb using wing claws, although some other arboreal birds have claws on the wing. This is a long-standing mystery in avian evolution. We used CT scans of intact bird hands to study the distribution of manual unguals, and performed a literature review of fossil crown-birds to inform ancestral nodes. We then created ancestral state reconstructions of avian claw evolution, showing that the most recent neornithine ancestor had two wing-claws. Claws have been lost or reduced over thirty times independently in Neornithes, but rarely regained. Claw loss is strongly associated with altriciality, which is seen primarily in tree-nesting or cliff-nesting birds; claw loss events are associated with transitions to inaccessible nesting. Altriciality causes claw loss by post-displacing wing development relative to hatching, forcing the wings to 'catch up' without fully ossifying or even forming the unguals. Where precocial taxa have lost claws, this is associated with secondary precociality or short wings relative to body size. We introduce the wing:femur ratio as a metric of wing length to body size, and use it to show that precocial clawless taxa have shorter wings and much weaker allometry than clawed precocial taxa do. Heterochrony also causes claw loss in these short-winged taxa. Hoatzin claws are neither atavistic nor regained, but a specialisation for the hoatzin's folivorous lifestyle, unique life history and foregut fermentation.

## Aerodynamic impacts of hindlimb presence, size and posture in the pterosaur flight apparatus

**Maxime Flaunet - Friedrich-Alexander-Universität Erlangen-Nürnberg**

Pterosaurs existed from 220 to 66 million years ago during the Mesozoic era and were the first vertebrates to evolve active flight. Previously, pterosaur wing apparatus investigations have focused on the forelimbs, whilst the role of the hindlimbs (now generally agreed to have contributed to the flight apparatus) has been mainly ignored. This study assesses the contribution and posture of the hindlimbs to active flight by utilizing three wing shape models: the Narrow Wing Model (NWM), excluding the hindlimbs; Standard Wing Model (SWM), and Extended Wing Model (EWM), fully incorporating the hindlimbs into the flight apparatus. Wing panel areas were measured using Imagej software and evaluated for 350 specimens from 175 species within Pterosauria. The dataset was used to calculate aerodynamic properties such as aspect ratio and wing loading. Comparisons between the models reveal wing areas for the SWM and EWM are twice that of the NWM surfaces (2.2—16.8 m2). Aspect ratio decreases from 8.6—23.9 for the NWM to 4.8—10.5 for the SWM, and 3.4—9.1 for the EWM, indicating broader wing profiles and lowering wing loading values (NWM = 15—284.9; SWM = 7.6—129.4; EWM = 6.4—104). To investigate evolutionary changes in the wing profile, these data were placed into a phylogenetic framework revealing clade-specific variation. Taxa with long hind limbs (e.g., Azhdarchoidea) exhibited greater variation compared to those with short-medium length hind limbs (e.g., Rhamphorhynchinae). Overall, this study demonstrates wing profiles are sensitive to hind limb inclusion and posture, impacting our understanding of pterosaur aerial abilities.

## Visualizing rhombiferan echinoderm respiratory structures in 3D

**Lucy Jackson - University of Reading**

Modern echinoderms (e.g., starfish, sea urchins) are a morphologically and ecologically diverse animal phylum, but the fossil record illuminates a wide array of extinct echinoderm body plans that do not closely resemble modern forms. Rhombiferans are one class of extinct echinoderms which are characterized by rhomb-shaped arrangements of respiratory pores on their theca. Our understanding of how these respiratory structures extend into the theca is incomplete, making the function and evolution of respiratory structures across rhombiferans difficult to decipher. We used X-ray micro-CT to visualize, for the first time in three dimensions, the respiratory structures of a hemicosmitoid rhombiferan. The results reveal previously undescribed internal canal systems, inferred to be an internal respiratory distribution network derived from the somatocoel, similar to that possessed by crinoids. These results expand our understanding of the morphology and function of respiratory structures in extinct echinoderms. Ultimately, they may help uncover homology among respiratory structures across the disparate extinct clades, with potential implications for reconstructing their phylogenetic relationships and evolutionary history.

## Ediacaran-Cambrian Ecosystem Turnover: Spatial Evidence from Lamonte trevallis Trace Fossils

**Yarong Liu - Nanjing Institute of Geology and Paleontology, CAS**

Substrate turnover from matground to mixground marks a pivotal transition during the Ediacaran-Cambrian boundary. Fragmentation of microbial mats, creating evolutionary pressures that drove metazoan diversification and depauperation of Ediacaran-type biota, was a result of enhancing ecosystem engineering in the late Ediacaran. To investigate the early bio-environmental interactions, we employed spatial point process analyses and model fitting to examine the spatial patterns of an Ediacaran trace fossil, Lamonte trevallis. This compound trace fossil that found in the Shibantan biota (~551-543Ma), South China, is characterized by horizontal tunnels connected with vertical burrows. Pair correlation functions reveal significant aggregations indicating resource preference under heterogeneous conditions, while mark correlation functions demonstrate segment length autocorrelations, indicating an optimized foraging strategy to minimize time and energy spent in foraging. These targeted and efficient exploitation amplified microbial mat horizontal heterogeneity. The overlaps between shallow and deep vertical burrows aggregation areas reflect congruent resource preference in a narrow temporal window. Good fittings of Thomas Cluster process identify shared resource attractions and the clustering of deep burrows around shallow ones, suggesting probable cascading three-dimensional exploration: shallow burrow systems modified mat substrates facilitating deeper-tier colonization while destabilizing matground. The resultant mutual feedback loop – the escalation of horizontal and vertical anisotropy, which in turn favoring motile organisms – foreshadowed irreversible ecosystem turnover. Our quantitative study demonstrates substrate heterogeneity as both cause and consequence of this evolutionary event, revealing the significance of trace-maker behaviors in Ediacaran – Cambrian ecosystem transition.

# ProgPal 2025 Abstracts - Full Talks

## Preliminary Insights from New End-Devonian Early Tetrapod Material from Greenland

**Rebecca Sheng - Uppsala Universitet**

The tetrapod (limbed vertebrate) stem group appeared during the Devonian, and the earliest known crown tetrapods come from the early Carboniferous. The Hangenberg event, a mass extinction at the Devonian-Carboniferous boundary, affected the diversity of many jawed vertebrate clades. However, its impact on tetrapods is not well understood, largely due to the period of patchy tetrapod fossil record from the end-Devonian into the early Carboniferous known as Romer's Gap. New tetrapod specimens from a bone bed of latest Devonian age from the Stensiö Bjerg Formation of Celsius Bjerg, East Greenland, will cast new light on this event. This locality yields the youngest known multi-species assemblage of Devonian tetrapod fossils. Furthermore, this death assemblage samples multiple aspects of a complex terrestrial ecosystem, with the preservation of coprolites and a variety of ichnofossils in addition to body fossils of tetrapods, arthropods and plants – but thus far no skeletal remains or coprolites of fish. The specimens were imaged using propagation phase-contrast synchrotron microtomography (PPC-SRµCT), performed at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, and then virtually segmented and rendered. Specimens segmented so far represent at least 5 new species, none of which can be assigned to any of the known Devonian early tetrapods from Greenland (Ichthyostega, Acanthostega, Ymeria and Brittagnathus). It is clear that a new and important faunal assemblage is emerging.

## Morphological Plasticity in Benthic Foraminifera Across Crisis Intervals: Insights from *Nuttallides truempyi* and *Oridorsalis umbonatus*

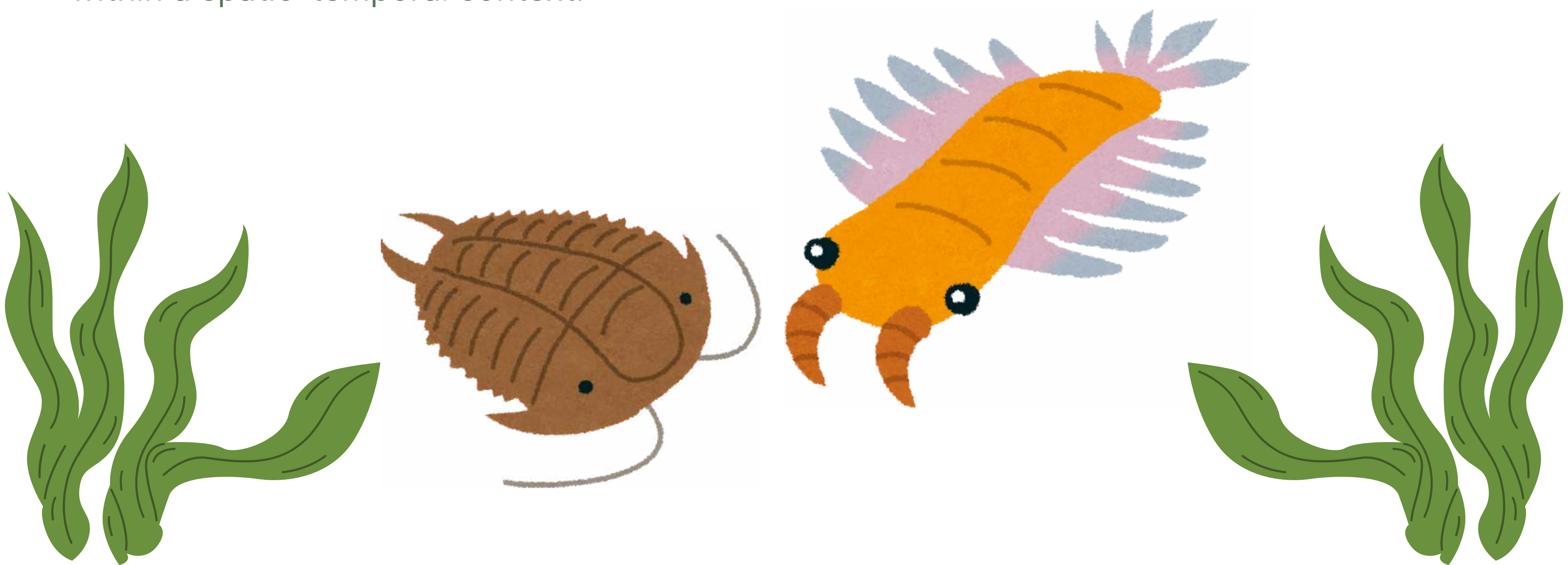
**Yujie Shi - University of Bristol**

Individuals often exhibit morphological changes in response to environmental shifts, particularly during rapid environmental change, termed plasticity. Plasticity is not limited to morphology but can also include changes to behavior and physiology. To quantify whether the rate and amplitudes of warming determine the degree of phenotypic plasticity this study focuses on the morphological plasticity of two benthic foraminifera species — Nuttallides truempyi and Oridorsalis umbonatus. By analyzing Ocean Drilling cores from the Southern Ocean, SE Atlantic, and Central Pacific across the Paleogene, we extract morphological traits using 3D data from micro-CT scanning, including diameter, volume, surface area, and number of chambers. Here we show that the two species underwent similar morphological shifts during two short-term warming events (i.e., PETM and ETM2), characterized by increased plasticity and reduced size at peak stress. These responses are modulated by region-specific responses influenced by nutrient availability and water depth. In contrast, during the prolonged warming period of the EECO, the morphological changes in response to the warm temperatures are not reversed after the end of warming. Long-term warming resulted in the selection of big specimens with few chambers, suggesting selection for rapid growth. By exploring the relationship of volume to number of chambers, we infer adaptive strategies under resource limitation and nutrient uptake efficiency.

## Lost in Space: The Impact of Conflicting Cambrian Palaeogeographic Models on Biodiversity Dynamics Using Small Shelly Fossils as a Case Study

**Lara Uttinger - University of Cambridge**

The Cambrian Period (538.8–485.4 Ma) witnessed rapid diversification and radiation of animals, yet the palaeogeography of this interval, and its role in driving evolutionary dynamics, remains highly debated. Multiple published models drawing on diverse data sources - including palaeobiogeographic data, climate-sensitive lithologies, palaeomagnetic records, and deep mantle structures - present conflicting reconstructions of Cambrian continental positions and connectivity. In contrast to well-established links between palaeogeography and biotic events later in the Phanerozoic, the role of continental configurations in driving the Cambrian Explosion remains underexplored. This study explores the differences between the existing palaeogeographic models and investigates how the latitudinal position of palaeocontinents can influence patterns in the fossil record, using Small Shelly Fossils (SSFs) as a representative dataset. 18 different global and regional palaeogeographic models were compared, evaluating their data foundations and continental distributions. Criteria to assess the relevance of each model for palaeobiological analysis were developed, such as data transparency, spatio-temporal span, accessibility, and reliability. The SSF occurrence dataset was retrieved from the Paleobiology Database to examine diversity patterns across models. The analysis reveals significant discrepancies in latitudinal placements of SSFs between models. These variations critically influence interpretations of macroevolutionary patterns, such as the latitudinal diversity gradient (LDG), within SSFs. The most robust evaluated palaeogeographic model does imply the presence of a LDG. These results demonstrate the need to critically evaluate the choice of available palaeogeographic reconstruction, since the model choice can have profound implications for interpreting biodiversity dynamics within a spatio-temporal context.



### Reconstructing Pterosaur Wing Shape: There's Something Wrong with Our Pterosaurs

**Benton Walters - University of Bristol**

In volant vertebrates, wing shape varies with flight performance, allowing for direct investigation of the form-function relationship. Unfortunately, this is more difficult for pterosaurs due to the fragmentary nature of their remains means. While much is known about pterosaur diversity, ecology and phylogeny, the morphology of the pterosaur wing remains controversial. This leaves published illustrations as the best available resource for examining how shape affects flight performance in pterosaurs. A four-part, theoretical morphospace-based, examination of published wing illustrations reveals that artists' illustrations do a poor job of reproducing viable and functionally diverse flight forms expected of a group as large and long ranging as pterosaurs. To gain insight into pterosaur flight performance, we recreate the planforms of multiple pterosaur species using mesh warping of a consensus wing and subject reconstructed wings to the same series of tests, with direct comparison to previous analyses of pterosaur flight from linear measurements and variation in birds. While this approach produces a more consistent and reliable pterosaur planform, reconstructed wing shapes still occupy a reduced area of morphospace and exhibit lower functional diversity than anticipated from previous studies, performing more like artists' illustrations than living animals. This work demonstrates the necessity of consensus when reconstructing anatomy and the difficulties in drawing inference about the flight of extinct animals from the extant phylogenetic bracket.

### The evolution of tooth form and function in non-avian theropods

**Morgan Whitley - University of Reading**

Teeth are critical for vertebrate feeding, with morphological changes influencing stripping, puncturing, and cutting properties. Theropods evolved a diversity of sizes and niches, making them an ideal clade to explore the relationship between tooth form and function. This project investigated how size, diet, time, and phylogeny influenced theropod tooth form and function. A theoretical morphospace was constructed using tooth outlines from 153 species to generate 250 potential morphologies. Von Mises stress was calculated for the theoretical forms under force applied to the tooth tips—puncturing efficiency—or along the distal edge—cutting efficiency. This provided two heatmaps that were superimposed onto the theoretical morphospace to represent the optimality of tooth forms for niche occupation. The empirical species tooth outlines were projected onto the theoretical morphospace to demonstrate the area occupied. Tooth outlines were then grouped by family, diet, four different body measurements, and geological period. Theoretical tooth forms with increased curvature experienced higher stresses, whereas increased mesiodistal length reduced stress. Empirical tooth forms demonstrated more variation in mesiodistal length compared to curvature and were well adapted for stress resistance in both scenarios. Categorising tooth form by diet and phylogeny revealed significant overlap in morphospace occupation, with the greatest diversity occupied by carnivores and troodontids. Tooth diversity positively correlated with geological period, whereas increasing size constrained teeth to wider, slightly recurved forms. These results demonstrate that stress resistance does not significantly influence two-dimensional form. Therefore, other tooth characteristics—serration density—are more integral for theropod niche occupation.

**Review of the tetrapod assemblage of the Purbeck Limestone Group (Tithonian-Berriasian) of Dorset, southern England.**

**Abdur Raheem Butt - University of Birmingham**

The Purbeck Limestone Group is a lithostratigraphic unit which outcrops along a section of the Jurassic Coast World Heritage Site in Dorset, England, and provides one of the richest known mid-Mesozoic assemblages in the world. Following the first documented excavations by Samuel Beckles in the mid-1850s, the Purbeck has yielded over 60 species of small and large-bodied tetrapods, including frogs, salamanders, turtles, lepidosauromorphs, ichthyosaurs, sauropterygians, crocodylomorphs, pterosaurs, saurischian dinosaurs, ornithischian dinosaurs, and both mammalian and non-mammalian mammaliaforms. Most specimens have historically been collected using screenwashing to extract small teeth, jaws and other skeletal fragments from fossiliferous mudstone and marl horizons. Whilst this has been successful in increasing our understanding of Purbeck tetrapod diversity, it has not yet been applied systematically throughout the formation to examine large-scale patterns of faunal change and community structure. This study provides an updated overview of the geology of the Purbeck Limestone Group, and a detailed review of the tetrapod fauna currently known from the assemblage. For the first time, taxa have been placed within their stratigraphic context in the form of a comprehensive biostratigraphic range chart, which displays the distribution of species from the base of the Lulworth Formation (Tithonian) to the top of the Durlston Formation (Berriasian). Our analysis reaffirms that the Purbeck Limestone Group remains the best site globally to examine tetrapod faunal change during the Jurassic-Cretaceous transition, and reveals new potential vertebrate-rich horizons that will be the primary focus for future sampling efforts in the near future.

**More moa than ever before? New insights from the sparse fossil record of Dinornithiformes**

**Abi Crane - University of Southampton**

The recently extinct moa (Dinornithiformes) of New Zealand represent an unusual tangent in bird evolution; not only did they grow to some of the largest body sizes in all of avian history (and get to those sizes at an unexpectedly slow rate), they are unique among archosaurs for having evolved the complete absence of forelimbs. Other than abundant Holocene specimens, the moa fossil record is very poor. To date, the sole ancient moa specimens come from the Miocene St Bathans fauna, New Zealand’s only substantial pre-Quaternary terrestrial fauna. The evidence of moa presence at this locality is tantalising; despite plentiful eggshell with moa characteristics, there are only a handful of fragments from larger bones which can be assigned to the clade. Here we conduct the first thorough investigation into the moa of St Bathans, utilising the relatively scant fossil evidence to investigate their diversity and biology. Drawing comparisons with the better understood waterfowl fossil assemblage from the locality, we suggest that there existed multiple cryptic moa species at St Bathans and that the species composition varied between fossil sites. Additionally, we describe the two most substantial dinornithiform bone fragments known from the site and conduct their first histological analyses, revealing that these ancient moa had already evolved the clade’s unusually slow growth patterns. Our investigation shows the power of a relatively poor fossil record to provide novel insight into the untold history of a truly unique lineage of birds.

## MODERN ASPECTS IN MIOCENE SUNKEN WOOD COMMUNITY FROM POSĄDZA, POLAND, (CARPATHIAN FOREDEEP)

**Agata Bonk - Institute of Paleontology PAS**

Deep-sea sunken wood in marine environments sustains specialized communities. The most important deep-sea wood colonizers are wood-boring xylophagaid bivalves. They host symbiotic bacteria which decompose cellulose and provide their hosts with nutrition. Xylophagaids produce large amounts of fecal pellets, which blanket the surrounding sediment enriching it in sulfide. Their activity creates favorable conditions for organisms adapted to chemosynthesis-based environments. The oldest sunken wood communities are known from the Middle Jurassic, and are non-actualistic. These communities do not contain any xylophagaid bivalves, and are mainly composed of wood epifauna, which are absent from sunken wood communities today. Late Cretaceous and younger sunken wood communities, which more actualistic in composition, are built around xylophagaid bivalves. However, the fossil record of marine sunken wood communities is poor, and details on early actualistic occurrences are relatively unknown. We hereby present a Middle Miocene sunken wood-associated fauna from Posądza 10-S shallow borehole near Kraków, Poland, Carpathian Foredeep. The studied sample comes from an isolated level within an outer shelf Pecten-Spiralis Beds (38 m bsl, Serrevallian) and is rich in terrestrial plant material. It contains microfossils of ostracod *Xylocythere*, known previously from other sunken wood samples from the Carpathian Foredeep, and is accompanied by a minute species of a heterobranch gastropod *Xyloskenea*, and by an undetermined small xylophagaid bivalves. The identification of three cornerstone taxa in Posądza indicates that by the Middle Miocene, some sunken wood communities acquired a clear “modern aspect”: they were composed of small-sized representatives of groups typical for such communities today.

## The Hidden Complexity of Cetacean Teeth through Deep Time

**Alexander James - University of Exeter**

Cetaceans, including whales, dolphins and kin, have dominated marine ecosystems since the Oligocene. Throughout their evolution, cetacean teeth, specifically at the rostral half of the jaw, have been crucial to prey capture. Though key to their success, previous assessments of stem-cetaceans (archaeocetes) and crown cetaceans (neocetes) have not comprehensively analysed their anterior tooth shape, and thus ecological signals in dental morphology may have been overlooked. This study aims to fill this knowledge gap by quantifying the diversity of dental morphologies among extant and fossil whales. I sampled an array of living and extinct cetacean tooth shapes from images of 3D scans. I analysed the diversity of these tooth shapes in a morphospace via an Elliptical Fourier Analysis of their teeth in anterior and labiolingual axes. My results show that cetacean tooth shape has changed drastically since the transition from archaeocetes, to Paleogene stem-neocetes, to more derived neocetes in the Neogene and Holocene. Specifically, crown cetacean teeth have become less ziphodont over time, taking on a range of shapes typified by increased bluntness, labiolingual recurvature, or both, contrasting ziphodont dentitions of stem cetaceans and other marine tetrapods. The nature of these novel tooth shapes in cetaceans likely facilitated a shift towards dietary generalism over time, allowing different lineages to feed non-exclusively on smaller prey and harder, shelled prey. Further analysis of relative isotope ratios in cetacean teeth, and stress simulations on different dental ecotypes, will help illuminate these changes.

**A predator-prey arms race in the Mesozoic oceans?**
**Annabel Nicholls - University of Leeds**

The marine ecological regime shift from sessile, epifaunal benthic assemblages in the Palaeozoic to the Mesozoic involving more motile and structured/tiered communities, similar to those we see today, is often associated with the Mesozoic Marine Revolution (MMR). The MMR refers to a hypothesised escalation event of increased predation pressure stimulating benthic prey to evolve different escape strategies such as increased motility, infaunalisation or increased shell thickness/ornamentation. However, the timeline and the taxa involved with the MMR is often debated within the literature. Here, I aim to quantify and evaluate the evolutionary rates and biodiversity patterns of benthic invertebrates associated with the MMR and whether any bursts of diversification occurred at similar or different stages within the Mesozoic Era. I will conduct this by using Paleobiology Database data from the Permian-Neogene and plot raw and subsampled diversity for each group, which will calculate origination and extinction rates using raw proportional, boundary crossers and gap filler methods. As a result, this project will help highlight the nature and timing of the MMR and provide a more in-depth fresh perspective on one of the most significant evolutionary patterns in the marine environment.

**Palaeoecology and Functional Morphology of the Cambrian Arthropod *Trapezilites minimus***
**Ayari Yanagihara - University of Leicester**

*Trapezilites minimus* (Phosphatocopina, Pancrustacea), an extinct bivalved arthropod from the Upper Cambrian Alum Shale Formation in southern Sweden and discussed its palaeoecological adaptations. Exceptionally preserved soft-body specimens were examined using Scanning Electron Microscopy (SEM) to clarify morphological features and ecological significances. SEM analysis demonstrated that *T. minimus* possessed robust second antennae indicative of strong swimming capabilities. Its small, stereoscopic eyes suggested limited visual acuity, implying it was unlikely an active predator. Four pairs of elongated limbs covered in setae, adapted primarily for paddling rather than walking. Simulations of shell reflectance studies across ultraviolet to visible wavelengths showed consistently low reflectance (less than 8%), suggesting that the transparent shell was less conspicuous to predators in the hypoxic see habitat and may have been used for defensive purposes. Allometric analysis of *T. minimus* and comparative ostracod species revealed isometric growth, primarily in shell length and internal shell surface area, indicating moderate metabolic requirements. These findings suggest *T. minimus* had a detritus-based diet typical of ostracods, requiring modest nutritional intake and oxygen consumption. Conversely, one ostracod species demonstrated negative allometry, potentially due to ecological constraints or evolutionary pressures. The detailed examination of *T. minimus* provides valuable insights into the ecological strategies and adaptive features of early arthropods, contributing to a broader understanding of Cambrian marine ecosystems. This research highlights the scientific significance of exceptionally well-preserved fossils in reconstructing palaeoecological interactions and evolutionary patterns in ancient marine environments.

## Exceptional preservation shedding light on the origin of teleosts at a time of environmental turmoil

**Benedict Emerson - University of Bristol**

Today, teleosts are the most diverse group of vertebrates comprising over 30,000 species. They originated and diversified initially rather gradually through the Triassic and Jurassic, and understanding early teleosts from these times contributes to knowledge of their key innovations and background environmental conditions. I am studying Saurostomus, an early teleost from multiple localities coinciding with the Toarcian Ocean Anoxic Event (OAE, 183 Ma). The Toarcian OAE was a time of environmental turmoil marked by global warming and ocean anoxia and euxinia, conditions that killed much of life but also contributed to exceptional preservation of these organisms. *Saurostomus* is a pachycormid, preserved in three dimensions. Pachycormidae is an extinct family of stem teleosts, known for later, huge taxa such as *Leedsichthys*, one of the largest fish to ever live. The sample of specimens include exceptionally preserved, three-dimensional skeletons and skulls from Strawberry Bank in Somerset, a new locality in Gloucestershire, and Holzmaden in Germany. We are exploring a variety of methods to extract maximum anatomical information, including photogrammetry and CT scanning. Recent cladistic analyses of Pachycormiformes shows 3 groups: macrophagous predators, transitional suspension-feeders, which includes *Saurostomus*, and the suspension-feeders such as *Leedsichthys*. *Saurostomus* being a member of this transitional pre-suspension-feeder group, and prior to the origin of the large filter-feeders, so determining its anatomy in more detail will contribute to understanding of how some of these early teleosts achieved such extraordinary adaptations and success in the Mesozoic. Later work will focus on function and ecology.

## Reconstructing the plumage and colouration of *Jeholornis*

**Beth Wilkinson - University of Bristol**

Historically, the colouration of extinct organisms was thought to be something of only speculation, to be left unanswered. However, over the past decade the field of palaeo colour has emerged, revealing insights into what these animals truly looked like, and what can be inferred about their ecology and behaviour. *Jeholornis*, an avialan taxa, is well known from the Jehol biota of China, but with previous specimens having poor feather preservation, their plumage could not be fully understood, and colouration could not be determined. An undescribed exceptionally preserved specimen of *Jeholornis* has come to light, allowing for plumage to be better understood. The exceptional fossil has preserved melanosomes, keratinous nanostructures containing pigment that produces feather colouration. Here, we aim to reconstruct the colouration of *Jeholornis* through analysis the melanosomes found in the feathers and add insights into the plumage. Preliminary analysis of SEM samples taken from the undescribed *Jeholornis* specimen conclude that the plumage of *Jeholornis* was mostly iridescent, akin to *Microraptor* but with striking ginger coverts. These research revelations allow the ability to infer potential behaviours and ecology, to better understand Jeholornis as an animal and how it fits into the evolutionary transition between dinosaurs and birds.

**Fitness Landscape Roughness Promotes Morphological Disparity**
**Charles Bates - University of Oxford**

Understanding the origin of morphological variation is a fundamental question in evolutionary biology. While several recent studies have quantified Kingdom-level patterns in morphological disparity, none have tested the myriad processes that have been proposed to underpin them. One such proposal, presented in Marshall (2006), is that the burst in morphological disparity seen during the Cambrian Explosion can be explained by a roughening of the animal fitness landscape. We use TREvoSim, an individual-based eco-evolutionary simulator to test this idea, and to investigate relationships between fitness landscape roughness and morphological disparity more broadly: in TREvoSim simulations, the fitness of digital organisms (binary character strings) is assessed against a number of environments. The more environments, the more fitness peaks and, therefore, the rougher the fitness landscape. We quantify the exploration of morphospace in simulations initiated with different numbers of environments and compare the resultant morphological disparity. With higher numbers of environments, end-of-simulation populations have higher mean pairwise distances between character strings, and thus greater morphological disparity. These simulations do not explore real-world mechanisms for altering the fitness landscape (e.g., secular environmental change or the evolution of novel phenotypes and behaviours) but do suggest that the evolution of morphological variety is an emergent property of a roughening fitness landscape, and therefore that the roughening of a fitness landscape is a viable mechanism for saltational jumps in the evolution of morphological disparity, including the Cambrian Explosion.

**A Phylogenetic Supermatrix elucidates the Systematics and Biogeography of Allosauroid theropods**
**Charles Scherer - Univeristy College London**

Allosauroidea was a cosmopolitan clade of tetanuran theropod dinosaurs, including taxa such as the eponymous Allosaurus, the enigmatic metriacanthosaurids and the gigantic carcharodontosaurids. Allosaurs had a long, successful evolutionary history ranging from the Early Jurassic to the Late Cretaceous. The evolutionary relationships of allosauroids have been the subject of numerous studies over the last 25 years with the majority of studies finding carcharodontosaurids to be closer to Allosaurus than to metriacanthosaurids. However, recent work has found support for a close affinity between Metriacanthosauridae and Carcharodontosauridae, contained within the clade Carcharodontosauriformes. This hypothesis has significant consequences for the biogeographical and evolutionary history of Allosauroidea and therefore warrants further investigation. Here, we use a morphological supermatrix approach to produce a new, comprehensive phylogenetic dataset for Allosauroidea (387 Characters; 42 taxa) to test these evolutionary hypotheses. All analyses find robust support for the Carcharodontosauriformes hypothesis; recover new relationships among Metriacanthosauridae and support two lineages of derived carcharodontosaurids, endemic to North Africa and South America, respectively. As a result, we consider the detailed biogeographic history of allosauroids. We show that widespread dispersal and continental separation of lineages during the Cretaceous likely shaped the evolutionary history and contributed to the great diversity demonstrated by the clade. This study highlights the significance of using a comprehensive phylogenetic character-taxon matrix which is focused solely on the group under study, rather than relying on widely comprehensive analyses which include taxonomic units outside of the ingroup in question, which may inadvertently affect the phylogenetic relationships of the studied group.

**Investigating the origin and evolution of the suborbital arch in parrots**
**Callum Hill - University of Hull**

Parrots (Psittaciformes) are notable among birds for possessing highly kinetic skulls, novel facial musculature, and high bite forces, accommodated by a unique skeletal architecture. Unlike most birds, many parrots appear to have a well-defined and often highly ossified structure of bone around the orbit: the suborbital arch. The expression of the suborbital arch varies dramatically, being absent in some individuals, or forming a complete and robust ring in others. While previous work has investigated the relationship between the suborbital arch and the presence of the novel pseudomasseter muscle, little has been done to establish the evolutionary history of this structure; in particular, why it evolved, and how its expression influences the mechanical performance of the skull. Using data collected from both ex vivo specimens and museum collections, I examined the arch condition of 180 species of parrots, covering most of psittaciformes. An ancestral state reconstruction was performed using these arch conditions, and confirmed previous suggestions that the suborbital archway evolved several times independently. Within the Psittacidae, several groups appear to have lost the archway, and there is generally more diversity of suborbital arch expression. Surprisingly, I also found that the condition of the suborbital arch varies at both genus and species level. This could be due to ontogeny, as the archway may ossify with age. A potential suggestion for the function could be for a novel muscle anchor point, or to further strengthen the orbit and skull, which I will investigate with finite element modelling.

**The last of the pareiasaurs; the spiny-headed *Elginia***
**Catherine Butterworth - University of Bristol**

Pareiasaurs were medium to large-sized herbivorous parareptiles from the mid to late Permian, characterised by heavy dermal armouring and unique cheek ornamentations. Despite being widespread and abundant, they went extinct 252 million years ago in the Permian-Triassic extinction event. One of the last of their clade was *Elginia mirabilis*, which was discovered in 1892 in the Cutties Hillock Sandstone, Elgin, Scotland. The holotype was a jawless skull, preserved as a rock mould that was later filled in with plaster; currently held in the British Geological Society, Edinburgh. Since its first description in 1893, new specimens have been found and these can supplement knowledge of its anatomy, including knowledge of the postcranial skeleton. The *Elginia* fossils are natural moulds in the rock, so CT scanning is not as helpful as photogrammetry on the moulds and solid casts, and this was the source of our 3D models. Our phylogenetic analysis confirmed *E. mirabilis* as a derived pareiasaur, its closest relation being *E. wuyongae* from China. By the latest Permian, pareiasaurs had diversified worldwide, and ranged from the 1-tonne Scutosaurus in Russia to the much smaller *Elginia* and relatives. *Elginia* is famous for its remarkable array of cranial protrusions, but their function is uncertain, whether used mainly in display or defence. However, drawing comparisons across predator tactics across the Permian and changes in Pareiasaur armouring we suggest that *Elginia's* increased spinosity and dermal armour could have been a beneficial defence strategy against late Permian predators.

## Bizarre pear-shaped sea urchins in Cretaceous Chalk Sea: Evolutionary pattern, process, and driver

**Chia-Hsin Hsu - University of Southampton**

The Infulaster-Hagenowia lineage is one of the most bizarre echinoids and a classic example of anagenesis, making it crucial for understanding the mechanisms of speciation and evolution. Their gradually shrinking size and elongating rostrums, which extend from the apical part of the test, were interpreted as adaptations to predator avoidance based on functional morphology. However, methodological limitations made the supporting evidence weak. Here, we revisit their trait evolution using paleoTS, a novel maximum likelihood-based statistical modeling method, to quantitatively reevaluate their evolutionary pattern, process, and potential drivers. All available specimens from the British Cretaceous chalk formations housed in the Natural History Museum were measured using calipers to refine trait values, including test width and rostrum length. Preliminary results support a pattern of size reduction (N=35, time bins=14) and rostrum elongation (N=13, time bins=8). Among nine candidate evolutionary process models, size change was best fit by the directional change model, while rostrum elongation followed the unbiased random walk model. Although covariate-tracking models, which account for potential drivers, were not included as candidates in our preliminary analyses, our results demonstrate the feasibility of applying within-lineage trait evolutionary models to fossil echinoderms, implying their high potential in testing traditional hypotheses.

## Sr/Ca and Ba/Ca trace-elemental ratios from tooth enamel provide insight into the trophic and dietary ecology of latest-Cretaceous mosasaurs (Squamata: Mosasauridae)

**Christian Voiculescu-Holvad - GeoCenter Møns Klint, Denmark**

Mosasaurs are diverse, predatory lizards which dominated marine environments during the Late Cretaceous (~100–66 Ma), and underwent dramatic radiation during the latest Cretaceous (Campanian–Maastrichtian: 83.6–66 Ma). Although the taxonomic richness of end-Cretaceous mosasaurs has been extensively studied, their ecological diversity remains poorly documented, despite being relevant to understanding ecosystem collapse and recovery in the wake of the Cretaceous-Palaeogene (K/Pg) mass extinction event. To this aim, we analysed an assemblage of mosasaur fossils from the Maastrichtian white chalk deposits of Denmark, representing one of the stratigraphically youngest mosasaur faunas globally. Laser ablation-inductively coupled plasma-mass spectrometry was used to investigate the geochemistry of mosasaur tooth enamel samples. Specifically, we examined how strontium/calcium and barium/calcium trace-elemental ratios vary across the Danish mosasaur assemblage. Ecological investigations of modern marine ecosystems have revealed this approach to be a reliable proxy of trophic partitioning, as calcium is “bio-purified” relative to strontium and barium in biological systems, and increases in each successive trophic level. Our analyses represents one of the first applications of this methodology to elucidating food-web dynamics in deep time, and reveals considerable dietary and trophic partitioning in terminal Cretaceous mosasaurs. A wide distribution of Sr/Ca and Ba/Ca values in the Danish White Chalk mosasaurs indicates the presence of both macrophagous apex predators, as well as specialist meso-predators in lower trophic levels. This study therefore establishes that both high taxonomic and ecological diversity persisted in Mosasauridae up until their abrupt extinction at the K/Pg boundary.

**A 3-D reconstruction of the pelvic musculature of *Riojasuchus tenuisceps* (Archosauria: Ornithosuchidae)**

**Connor Munro-Flanagan - Royal Veterinary College**

*Riojasuchus tenuisceps* was an ornithosuchid pseudosuchian archosaur from the Late Triassic of Argentina. Several aspects of its anatomy, including a “crocodile reversed” ankle joint, shortened gracile forelimbs and a lesser trochanter on the femur (shared with dinosauriformes) leave it mired in controversy regarding its locomotor function. To help answer questions regarding the animal’s life habit and ecology, a 3-D model of the pelvic musculature of *R. tenuisceps* was created, utilising a 3-D whole-body skeletal reconstruction of R. tenuisceps created by Von Baczko et al. (2024).

**A New Species of Middle Jurassic Conifer Cone from the North-West of Scotland**

**Destinie Lambert - University of Birmingham**

Despite conifers encompassing an ancient seed plant lineage with a rich fossil history spanning more than 300Myr, there is a significant amount of uncertainty surrounding their phylogenetic relationships and the origins of the modern families. A Middle Jurassic seed cone from Bearreraig Bay, Isle of Skye, NW Scotland, provides insight into the diagnostic characteristics of a new genus and species and potential reproductive strategies.

The seed cone fragments were CT-scanned, and the subsequent image stacks were segmented to produce high-resolution 3D reconstructions of the internal and external anatomy of the cone. Further analyses will include the cone being prepared for acetate peels and phylogenetic analysis.

The new specimen is an ellipsoidal ovulate cone with five to six helically arranged bract-scale complexes, with each bract being over twice the size of its affiliated scale. The scales display two apical lobes with a pocket-forming tissue covering the base of up to seven seeds. Individual seeds have two large wings and are inverted on the adaxial surface of the ovuliferous scale. The bract exterior is parenchymatous and encompasses two to three rows of small resin canals.

The new cone broadens the fossil record for anatomically preserved ovulate cones from the Lower Aalenian to Lower Bajocian stages of the Jurassic, alongside displaying distinct characteristics shared within multiple conifer families. This research further solidifies the scientific importance of sites such as Bearreraig Bay and the opportunities they provide for understanding the contentious phylogenetic relationships of Jurassic conifers, including the origin of the modern families.

**Environmental and biotic drivers of herbivorous theropod biogeography**
**Eren Tasimov - Friedrich-Alexander-Universität Erlangen-Nürnberg**

By the Early Cretaceous (145–100.5 Mya), some non-avian theropod dinosaurs, like the coelurosaurian clades Therizinosauria, Ornithomimosauria and Oviraptorosauria, had adopted herbivorous or omnivorous diets, in contrast to their otherwise meat-eating relatives. What caused this dietary shift and the subsequent diversification of herbivorous theropods remains poorly understood. Prevailing hypotheses state that they were responding to environmental changes, both in the climate and floral composition of their ecosystems. Utilizing comprehensive dinosaur occurrence data from the Palaeobiology Database (PBDB) and an informal, time-calibrated supertree of theropod species extracted from the literature, integrated with palaeoclimatic reconstructions from a general circulation model (HadCM3L), we investigated the patterns of herbivorous theropod diversity and distribution together with their relationship to palaeoclimate during the Middle Jurassic to Late Cretaceous. Our results indicate that herbivorous theropods were constrained in their palaeoclimatic niche compared to other dinosaurs, preferring lower mean annual temperatures and higher seasonal variability. This suggests that global temperatures played a key role in constraining their biogeographic patterns. Phylogenetic comparative analyses revealed that carnivorous coelurosaurs, in contrast to non-coelurosaurs, also displayed similar palaeoclimate preferences. This supports the hypothesis that common traits between all coelurosaurian clades allowed the major herbivorous theropod groups to adapt to cooler habitats, thus leading to their observed global distributions. Ongoing work is investigating potential patterns of niche partitioning between thyreophoran dinosaurs (armoured ornithischian herbivores) and herbivorous theropods during the Early Cretaceous, which indicate that food resource availability was another key driver of herbivorous theropod distributions.

**Using Finite Element Analysis to Investigate Combat Behavior in *Triceratops***
**Eric Ames - University of Bristol**

Ceratopsid dinosaurs like *Triceratops* are distinguished by their diverse of cranial ornaments, primarily the large parieto-squamosal frill and facial horns. Hypotheses for the primary function of these horns and frills include antipredator defense, interspecific recognition, socio-sexual display, and intraspecific combat. For *Triceratops* in particular, injuries to the squamosal sections of the frill demonstrate compelling evidence of intraspecific combat, with the belligerents locking together their meter long supraorbital horns analogous to modern ruminants. However, the nature of this combat remains undetermined, due to an absence of biomechanical data. To address this, we utilized Finite Element Analysis (FEA) to model biomechanical performance under simulated fighting behaviours. To do this, we first produced a 3D, retrodeformed surface model of a *Triceratops horridus* skull in Blender based on surface scans from a specimen on display in Barcelona's CosmoCaixa museum. This data was then used to produce sixteen finite-element models, each simulating performance under specific hypothesized fighting 'styles' (e.g., 'stabbing', 'wrestling', and 'ramming'). FEA was then completed in Abaqus, quantifying stresses, strains, and deformations resulting from these different fighting 'styles'. Comparison of results suggests that *Triceratops* horns may have accommodated stresses resulting from specific, and possibly unique, intraspecific combat 'styles', which indicate complex fighting behaviours. Future work will investigate biomechanical trends in the horns of a wider range of taxa to evaluate the hypothesis that diversity of horn shapes was driven by different intraspecific behaviours in Ceratopsia.

**The Marine Necrobiome: The Microbiology of Decay and Fossilisation**
**Felicity Marlanda Roberts - University of Manchester**

Several hypotheses surrounding exceptional soft tissue fossilisation such as 'Burgess Shale-type Preservation' and Ediacaran 'death masks' invoke roles for microorganisms as both agents of decay and potential mediators of fossilisation. The microbial 'necrobiome' is poorly characterised from a non-anthropogenic perspective, with most studies performed in a forensic context on human cadavers and pigs. Additionally, the identity, succession, and variability of microbial decomposers in marine settings remains largely unresolved. This experiment followed the decomposition of the marine invertebrate, *Munida rugosa*, over 121 days, in two conditions: natural estuarine mud and artificial seawater. 16S rRNA gene sequencing was performed at early, mid and late stages of decomposition to fully characterise necrobiome succession. Initial communities were dominated by host-associated bacteria, which were rapidly replaced by environmental taxa and opportunistic anaerobes. In mud, early enrichment of fermentative and facultatively anaerobic populations (e.g. *Bacteroides, Clostridium, Prolixibacter*) was followed by the emergence of sulphur-cycling communities and several archaea. The artificial seawater necrobiome developed more slowly and shifted towards a predominantly fermentative composition. Several genera, including *Vibrio*, *Tepidibacter*, and *Peptoclostridium*, were conserved across both conditions. Temporal patterns revealed stage-specific shifts in microbial guilds and taxonomic convergence during early to mid-stage decomposition, suggesting functional redundancy in necrobiotic processes. Despite constraint by the taxonomic limits of 16S rRNA sequencing and an absence of transcriptomic profiling, this study provides a time-resolved characterisation of a marine invertebrate necrobiome in sediment and sediment-free conditions. These results may inform models of microbially-mediated taphonomic processes.

**A younger age for the alleged oldest dinosaurs based on novel dicynodont data from Tanzania**
**Hady George - University of Bristol**

The rise of dinosaurs represents a key event in vertebrate evolution, and laid the foundation for terrestrial faunas for most of the Mesozoic. An accurate understanding of the origins of dinosaurs in the Triassic has been the aim of a great deal of research in the last few decades. Often at the centre of this are the dinosauriform *Nyasasaurus* and the silesaur *Asilisaurus*, both of which have been argued to represent the oldest dinosaurs. They are from the Manda Beds of Tanzania, which has been correlated to Anisian (Middle Triassic) age units based on faunal similarities identified in the 1960s-80s. Since then, a plethora of Triassic tetrapod vertebrates have been discovered from numerous Gondwanan sites, but differences and similarities in fauna between many units have yet to be re-examined. We test the Anisian-age hypothesis for the Manda Beds through a survey of published taxa supplemented by osteological and phylogenetic analysis of unpublished dicynodont material from the unit. We identify the dicynodont material as a novel species of the otherwise South American *Dinodontosaurus*, and find that the fauna of the Manda Beds is much more similar to South American units that are Ladinian-Carnian (end Middle-Upper Triassic) than any Anisian units. We conclude that no dinosauriforms/dinosaurs can be identified from the Anisian. Beyond recalibrating the earliest node of the dinosaur phylogenetic tree, our work suggests that the search for the oldest dinosaurs does not need to be restricted to the Manda Beds, and could be achieved in coeval units elsewhere.

**Changing deep ocean fish populations across the Paleocene-Eocene Thermal Maximum.**
**Jacob Godfrey - University of Birmingham**

The Paleocene-Eocene Thermal Maximum (PETM) was the most recent global warming event in the Earth's history, occurring ~56 million years ago. Globally, oceans rapidly warmed by 5-8 degrees Celsius within a few thousand years. Increasing concentrations of atmospheric carbon means more carbon is dissolved in the ocean resulting in rapid ocean acidification. The increased ocean temperature reduces the solubility of oxygen, resulting in reduced oxygen concentrations globally. While there were significant environmental changes, the PETM isn't marked by a mass extinction event. Despite this there was a large extinction of benthic foraminifera, with 35-40% of species going extinct, because foraminifera have a calcium carbonate shell which is dissolved by the newly acidic oceans. A lack of mass extinction of fish leads to the hypothesis that there will be observable change in the dominant morphotypes as the populations adapt to the new environment. The PETM is important to study as it is an analogue for modern anthropogenic warming. The primary aim of this project was to generate new ichthyolith records from Hole U1514C in the high-latitude Indian Ocean to track morphological, productivity and diversity changes across the PETM. This was done by assessing functional morphology, ichthyolith quantity and range charts from across the PETM at the site. Analyses are done using Nonmetric Multi-Dimensional Scaling (NMDS) because the characteristics are not fully numerical. While the variations are yet to be analysed, it is likely that the main morphological grouping will come from triangular teeth and conical teeth.

**Bird-like orbits originated in maniraptoriform dinosaurs**
**James Nathan Tang - University of Aberdeen**

Modern birds have markedly different skulls compared to their theropod dinosaur ancestors. The relatively large and circular eyes of extant birds are of note, as they are a key sensory organ implicated in adaptations for flight and changes to brain anatomy. However, given much of the avian body plan was acquired piecemeal over the theropod-bird transition, we expect to see classically 'avian' orbit features appearing in bird-like maniraptoriform dinosaurs. To test this, we measured orbit and skull length in 25 Mesozoic and 37 extant avian taxa and compared them with measurements from other theropods. We also traced the orbit shape of the studied species and analysed them with 2D geometric morphometric methods and in a phylogenetic context. We find that most Mesozoic avians have similar orbit sizes, both absolutely and relatively, to closely related maniraptoriforms. Likewise, most Mesozoic birds have circular orbit shapes analogous to other maniraptoriforms. However, Mesozoic avians with elongate skulls that lack a temporal fenestra substantially diverge in orbit size and shape from typical maniraptoriforms. Modern birds exhibit greater diversity in orbit size than Mesozoic birds but have similar orbit shapes. These findings highlight phylogenetic biases in skull evolution through the dinosaur-bird transition and imply a role for sensory exaptations in the evolution of flight.

**The Rib Riddle - Microanatomical and Histological Features Observed in Ribs of Late Jurassic Ichthyosaurs Leave More Questions Than Answers**
**Jørgen Krøglid - Natural History Museum Oslo**

The ichthyosaurs, secondarily aquatic animals from the Mesozoic Era, exhibit numerous analogous features to modern cetaceans and are a well-known example of convergent evolution. While been known for over 200 years, studies of their histology remain limited. In general, ichthyosaurian histology reveals a spongy internal structure with a lack of a thick cortex, making skeletochronology challenging due to the absence of compact bone. Previous studies have identified growth markers in ichthyosaur gastralia and relatively thick cortices in the ribs of Jurassic ichthyosaurs. Due to differences in sampling locations in rib studies, it is difficult to evaluate previous research in a comparative context. This study samples material from proximal, middle, and distal locations, to gain a better overview of the ribs' histology. Ribs and gastralia from previously undescribed Jurassic ichthyosaurs were sampled with the aim to observe distinct and reliable growth markers that could be used in skeletochronology. Overall compactness was measured using BoneProfileR to obtain objective values that could be used in comparative analysis with cetaceans. The histological results show no indication of reliable growth markers, but a feature never seen or described in previous studies was observed in one of the specimens, where parallel-fibered matrix is oriented perpendicularly to the ribs' costal boundary. Comparative analysis of overall compactness reveals that both ribs exhibit relatively high compactness compared to other ichthyosaurs and cetaceans. The biological significance of these findings remains unclear at this time, and further research is needed to better understand the implications of the observed results.

**An exceptionally preserved Middle Miocene lacustrine ecosystem**
**Josh Turner - University of Cambridge**

The Miocene Clarkia lacustrine deposit in northern Idaho, USA is famous for its exceptionally preserved fossil leaves, although the site also has well-preserved biomarkers, fungi, diatoms, insects, fish, and mollusks. The recent discovery of exceptionally well-preserved small carbonaceous fossils (SCFs) from Clarkia offers further insight into the functioning of the Clarkia lake ecosystem. A low manipulation acid extraction technique developed for analysis of Cambrian SCFs has yielded abundant and well-preserved fossils from Clarkia, including a diversity of aquatic crustaceans and larval insects. The occurrence of these exceptionally preserved SCFs, combined with the previously established Clarkia fossil record, allows us an unprecedented window into the functioning of a Middle Miocene lacustrine ecosystem. Significantly, Clarkia was recently dated to 15.78 Ma, placing at the peak of the Middle Miocene Climate Optimum (MMCO, 16.9–14.7 Ma), a greenhouse interval marked by higher global average temperatures (~5°C warmer than pre-industrial average) and moderately higher atmospheric $CO_2$ concentrations (~500-600ppm). The Middle Miocene climate would have been similar to the IPCC's near-future climate scenarios Representative Concentration Pathways (RCP) 4.5 to 6.0. As such, the MMCO is one of the closest analogues in the geologic record for near-future climate change and Clarkia offers an exceptionally preserved window into a lake ecosystem in a warmer world.

**The size-temperature relationship in *Ctenothrissa* (Ctenothrissiformes) and *Macropoma* (Coelacanthiformes) in the Late Cretaceous Chalk Sea**
**Kaia Spence - University College London**

Climate change is causing increased ocean temperature in modern seas. Whilst fish size is predicted to decrease in response, collecting data to test temperature-size relationships is challenging due to the time required and sampling difficulties. Here, two genera from the UK Chalk which survived climate change during the Cenomanian-Turonian Boundary Event, ~94Ma, were studied. *Ctenothrissa* (Actinopterygii: Ctenothrissiformes) was chosen due to the quantity of well-preserved specimens in the Natural History Museum, London (NHMUK) collections. *Macropoma* (Sarcopterygii: Coelacanthiformes) was chosen as the Family Latimeriidae comprises extant species, potentially providing more direct insights into the impact of climate change on living coelacanths. Specimens were sufficiently well preserved to permit the direct measurement or confident inference of standardised length measurements. The sample consisted of >78 *Ctenothrissa* and >67 *Macropoma* specimens. Ocean temperature was estimated via oxygen isotope analysis of the bulk chalk matrix surrounding 40 specimens, using standard techniques and assumptions. Preliminary results appear to show no significant correlation between oxygen isotope values and length, at either genus or species level, suggesting temperature is not a major control on size in these genera. One interesting result, however, is that *Ctenothrissa* appear to tolerate a broader temperature range than *Macropoma*, with *Macropoma* only present in the UK Chalk Sea during the warmest intervals (sea surface temperatures >24-25°C). This study has shown that at least some Late Cretaceous fish did not become smaller with increasing temperatures. Temperature-size analyses in the fossil record may improve understanding of modern day responses to climate change in fish.

**Changing reef composition as response to positive carbon isotope excursions in the Lower Silurian of Gotland (Sweden)**
**Lars Tischer - FAU Erlangen**

The Silurian was long thought to be a period of stable conditions and warm climate, but numerous recent studies show major perturbations in the global carbon cycle. Some of the highest positive carbon isotope excursions (CIEs) in the entire Phanerozoic have been measured from the Silurian, and these periods are associated with global anoxic events, climate and sea level changes and biological events such as extinction events and teratological malformations. These excursions are also linked to enhanced reef formation, showing the development of large reef complexes and carbonate platforms during these intervals. Despite many different models of the Silurian CIEs, the exact drivers for the events and consequences are still debated. This study investigates one of the reef complexes from Gotland (Sweden) during the Ireviken CIE, the second strongest excursion in the Silurian, and examines how the environment and the biotic composition of the reef were affected by the changing conditions during the carbon isotope excursion. Microfacies analyses together with $\delta$13C measurements of samples from the reef and the surrounding sediments across the Ireviken CIE indicate a shallowing upward trend and changing environment from a distal shelf facies to a shallow-water stromatolite facies. In addition, point count quantifications of 26 samples reveal changes in the reef composition from a coral-stromatoporoid reef in the early phase of the CIE to microbial-dominated reefs with abundant bryozoans in the later phase of the CIE, indicating high nutrient and shallow water conditions, which fits to the observations of other Paleozoic CIEs.

**Natal coat colouration in mammals**
**Lauren Gellately - University of Bristol**

Natal coat colouration in mammals may play a key role in survival and development, yet its ecological significance remains poorly understood. My study examines the functional drivers of natal coat colouration in the orders Artiodactyla, Carnivora, Eulipotyphla and Primates through four key hypotheses. First, I test whether natal coats signal mothers to provide enhanced care, predicting that distinct coats will lead to increased maternal investment, resulting in shorter dependency periods or greater body weight at weaning. Second, I explore whether natal coats provide camouflage against predation, hypothesizing that vulnerable offspring or those left alone for extended periods will exhibit patterned coats to blend with their environment. Third, I assess the influence of climate on natal coat colouration, predicting that lighter coats will be more common in warmer environments and darker coats in colder regions due to thermoregulatory advantages. Finally, I examine whether white natal coats in snowy climates enhance camouflage through background matching and reduce predation risk. To test these hypotheses, I will analyse phylogenetic and ecological data using RevBayes to assess correlations between discrete traits, the hOUwie package in R for correlations between discrete and continuous traits, and the phytools package in R for ancestral state estimations. This research will provide new insights into the adaptive significance of natal coat colouration and its role in mammalian evolutionary ecology.

**Conflict in the Fossil Record: Common Ground for Paleontology and Social Anthropology**
**Madeline-Claire (Leni) Charbonnaeu - University of Oslo**

This poster will give an overview of ongoing research associated with the ERC-funded project Amber Worlds: A Geological Anthropology for the Anthropocene (AMBER). This presentation will exhibit findings from our attempts to merge social-anthropological frameworks with paleontological insights through emphasis on 3 key research questions: 1. How are geopolitics inscribed into the geological record? How do specimens travel within and outside of conflict zones, and how do factors such as war and sanctions interface with the political economy of deep-time research? This poster will share insights from our field sites in Burma (Myanmar), Lebanon, and Mexico alongside considerations of how these aspects may be integrated into science communication more broadly. 2. How can social-anthropological perspectives contribute to ethical frameworks regarding the sourcing and use of specimens? Building on collaborations with diverse researchers and institutions (and with specific attention to the case of Burmese amber), this poster will share preliminary findings regarding the incorporation of ethnographic methodologies into ongoing ethics debates within the paleontological community – particularly those concerning the acquisition and use of research materials. 3. How can paleontological insights be deployed towards contemporary socio-environmental concerns? This aspect focuses specifically on my research into experimental taphonomy and the prospects for taphonomic frameworks in conflict zones – where questions of deposition, preservation, and decay of toxic materials are of critical concern. This poster builds upon ongoing interactions with the Paleontological Association and many of its constitutive members.

**The longest delay: the slow recovery from the Hangenberg mass extinction**
**Lila Blake - University of Leeds**

The global Hangenberg Crisis, close to the Devonian-Carboniferous boundary (~359 Ma), represents one of the major extinction events of the Phanerozoic, with greater than 50% marine invertebrate genera loss. The subsequent recovery and radiation of marine life after the Hangenberg Crisis was exceptionally slow; marine biodiversity remained at low levels for greater than 20 million years, potentially making this the longest aftermath of any biotic crisis of the Phanerozoic. Previous works have linked delayed recovery after mass extinctions to repeated environmental stresses. The Early Carboniferous is characterised by large perturbations to both Earth's climate system and ocean redox state, including recurrent glacial events and widespread ocean anoxia during the mid-Tournaisian, that may have impeded recovery during this time. However, the ultimate cause(s) of this prolonged, post-Hangenberg recovery remains unclear. Here, we aim to investigate the factors controlling taxon diversity patterns across the Tournaisian, the interval directly following the Hangenberg Crisis. This will be done by combining detailed studies of diversity trends and biogeographic patterns in marine communities with palaeoenvironmental analyses, specifically seafloor oxygen levels. Preliminary results indicate a possible cosmopolitanism event in the Tournaisian, suggesting widespread taxonomic dispersal and increased taxonomic similarity as a result of unusual/harsh environmental conditions. However, heterogenous spatial sampling may bias observed biogeographic patterns across this interval. Overall, this project hopes to provide further insight into one of the most fundamental, broad-scale ecological questions: what controls global biodiversity?

**The Comparative Biomechanics and Hydrodynamics of Jurassic Marine Reptiles**
**Lucy Holmes - University of Birmingham**

The Jurassic period is renowned for its rich fossil record, including a diverse selection of marine reptiles, such as plesiosaurians, ichthyosaurs and marine crocodylomorphs. These groups showcased a variety of feeding strategies that enabled them to dominate Jurassic oceans. Extensive research into Jurassic marine reptile phylogeny and anatomy has been conducted previously, however, their feeding biomechanics are much less understood. Understanding the biomechanics and hydrodynamics of these groups, and how these variables interact, is imperative to our understanding of their hunting, feeding and swimming behaviours. Previous research hypothesised that species with a broader skull and larger mandibular muscles would have a smaller maximum gape, but a stronger bite force. However, this would be achieved at the cost of increased water resistance, and therefore slower movement. This hypothesis was tested by investigating the biting biomechanics and hydrodynamics of twelve species of Jurassic marine reptiles, within five phylogenetic groups, and two extant crocodilian species for validation. First, 3D models of their skulls were created, then the main feeding muscle groups were reconstructed. These reconstructions were then used to perform gape analysis using Blender and Python. Finally, the hydrodynamic performance of these species' heads using, mandible and skull surface area data, was calculated using ImageJ. Perliminary results indicate that species with wider skulls, such as the plesiosaur Cryptoclidus, displayed a smaller maximum gape, as well as increased drag, which quantitatively validates the previous.

**Analysis of mouse and echidna soft palate development highlights changes to the pterygoid complex during the evolution of suckling**
**Luke Barlow - King's College London**

Nurturing young with milk is a defining feature of mammals. Therian mammals give birth to live young that nurse from a teat until they are developed enough to feed on their own. In contrast, the egg-laying mammals (monotremes) lack nipples, so the hatchlings lap the milk as it is secreted from specialised patches on the mother's abdomen. To suckle effectively, therian mammals must be able to form two seals. The anterior seal is formed by the tongue against the teat, and muscles of the soft palate and tongue form the posterior seal. The tensor veli palatini (TVP) is absent in monotremes, indicating that the ability to stiffen the soft palate was lost or never developed. Soft palates in therian mammals lie between a structure called the hamulus, which forms within the medial pterygoid, and provides anchorage for the TVP. A synovial bursa develops between the two to reduce friction. To analyse the effect of muscle force on the developing pterygoid, the CACNA1S mutant mouse line was studied. These mice have regular muscles that cannot contract. These mutants did not develop a bursa, indicating that mechanical force is required for normal bursa development. Echidna neonates and juveniles also lack the hamulus and bursa, and the lateral and medial pterygoid processes (ectopterygoid), were unfused. Therefore, musculoskeletal interactions play a crucial role in the development of the soft palate and pterygoid and would have been key for the evolution of suckling.

**Pinnid Distribution and Palaeoenvironmental Insights from the Blue Lias Formation, Lyme Regis**
**Marie Sofia Sebaratnam - University College London**

Lyme Regis, located on the Dorset coast, represents a significant part of the UK Jurassic Coast. Within the exposed Hettangian cliffs of the Blue Lias Formation, lay beds of pinnid bivalves preserved in live position. Although seen in both the pre-planorbis and planorbis zones, the majority of published literature fails to recognise their presence. In this study, macro- and micro- palaeontology were combined to investigate potential palaeoenvironmental links to pinnid distribution and size. 30 stratigraphic samples were taken between beds H19 and H54, with Pinnidae present in 13. The pinnid beds were predominantly limestone amongst other bivalves and ammonites, however some were also observed to be in mudstone. Notably, between H23 and H17, oysters and ammonites were present, while pinnids were entirely absent. These observations sparked further investigation. The beds were subjected to palynological processing and palynofacies analysis to determine the percentage abundance of terrestrial and marine palynomorphs. This was then paired with morphological data collected from individual pinnids, inclusive of height and length. Although linear regression models were indicative of a weak negative correlation between marine palynomorph abundance and pinnid height and length, the correlation was statistically insignificant ($p>0.05$). Nevertheless, this does not negate from the possibility that there may be an underlying reason for the absence of Pinnidae in certain beds, even when other marine mollusc taxa are absent. This study paves the way for future research to investigate other potential factors influencing marine distribution along the Jurassic Coast, such as ecological interactions or hydrodynamic conditions.

### Insights into the locomotor modes of giant extinct kangaroos from vertebral morphology
**Megan Jones - University of Manchester**

Extinct kangaroos, prior to the Australian Pleistocene megafaunal extinctions, reached much greater body sizes than we see today. Their large size, sometimes exceeding twice the weight of the heaviest extant kangaroo, raises the question of what gaits these giant kangaroos used. Were they able to hop? Could they use a pentapedal slow gait, like today's largest kangaroos? Research to date has focused on hindlimb morphology, but the spinal column also has biomechanical significance in locomotion. Here, we perform 3D geometric morphometric analyses of the vertebrae of extant (n=67) and extinct (n=41) kangaroos, to test how vertebral morphology varies by locomotor mode among living species, and compare it to the megafaunal species. We find that among living species, arboreal kangaroos display divergent morphologies throughout the spinal column; meanwhile, pentapedal species are primarily distinguished from more generalist kangaroos in the proximal tail region. We also find that the megafaunal kangaroos frequently possess morphological innovations in their vertebrae unlike any seen today. The trunk vertebrae of the short-faced sthenurines are particularly unique, with large metapophyses and reduced transverse processes in the lumbar vertebrae possibly suggesting increased resistance to ventral bending. Meanwhile, their proximal tail vertebrae are markedly different to those seen in today's large, pentapedal hoppers; instead, they more closely resemble the tails of the arboreal kangaroos, the only extant group known to occasionally use bipedal striding at low speeds. This potentially supports the findings of prior studies, which suggest that the sthenurines may have adopted bipedal striding.

### Kinematics of Cambrian apex predators: insights into the grasping ability of two radiodonts from three-dimensional modelling
**Mingjing Zhang- University of Exeter**

Radiodonts are an iconic predator in Cambrian marine distinguished by a pair of frontal appendages with multiple shapes. Different morphology of frontal appendages has been suggested to indicate specialization to different feeding functions such as grasping, crushing and filtering. However, these ecological groupings are coarse given the range of radiodont frontal appendage morphologies. I utilized three-dimension modelling of appendages to analyze grasping ability in two well-known radiodonts *Anomalocaris canadensis* and *Amplectobelua symbrachiata* and evaluate the role of specific features such as enlarged endites, podomere shapes, and membrane widths. Model results suggest that the proximal-most endite (PME), shape of the podomere (SOP) and membrane width affect the size of prey that can be captured by grasping radiodonts. The PME is much important in *Ampectobelua symbrachiata*, which has an enlarged endite up to two-thirds of the appendage length, while SOP and membrane width were more important in *Anomalocaris canadensis*. The comparison of two species shows that *Ampectobelua symbrachiata* could catch smaller prey than *Anomalocaris canadensis*. Analysis of morphological data of PME, SOP, membrane and endite size alternation from other species in Chengjiang demonstrates different types of raptorial predation in the Chengjiang biota, increasing our understanding of niche differentiation and prey-size partitioning in these earliest apex predators.

## Revisiting the Carboniferous radiation of ray-finned fish
**Molly Tumelty - University of Birmingham**

Ray-finned fish, or actinopterygians, first evolved in the Devonian and subsequently underwent significant diversification in the Carboniferous period. Today, they make up 50% of vertebrate species. The earliest diverging group of actinopterygians are called polypterids, but their fossil record only stems back to the Triassic, despite molecular clock divergence estimates predicting a late Devonian-early Carboniferous origin. Many fossil specimens of ray-finned fish have been placed in 'wastebasket' genera, meaning that their position in early actinopterygian evolution is not fully understood. Redescribing species in these genera using modern techniques like CT scanning is crucial in understanding more about evolutionary relationships of early actinopterygians. This project focussed on a specimen from the Carboniferous referred to the problematic genus *Elonichthys*. The specimen is preserved in 3D and has good preservation across much of the skeleton. Key features like the ectopterygoid process and the morphology of the hyomandibula and lachrymal suggest an affinity to polypterids, filling in a conspicuous gap in the early history of this group. Beyond its evolutionary position, *Elonichthys caudalis* displays features which indicate it was an active predator. This is based on its large and numerous teeth and the presence of short, stubby, widely-spaced gill rakers. Continued focus on redescription of ray-finned fishes reveals more about their evolution and diversification throughout the Carboniferous. More specifically, this work further develops our understanding of evolutionary relationships between actinopterygians, enables more accurate estimations of divergence timings between groups, and provides information on the lifestyles of fish during that period.

## Investigating the Timeline of Organelle Decay in Plants using Experimental Taphonomy
**Morgana Howl - University of Bristol**

There has been a long-standing assumption in palaeontology that cell organelles are too small and fragile to be preserved in the fossil record; however, in recent decades this has been challenged via stunning new discoveries and the recognition of historical finds. Although exceptionally preserved organelles have already been utilised as evidence for evolutionary hypotheses, there is a distinct lack of taphonomic data on them – if significant distortion has occurred during decay and burial, much work on these fossils could be rendered unreliable. An understanding of the conditions that can lead to organelle preservation and their impact on the resultant fossils is therefore an essential tool for much of the future research in this field. We seek to address this through experimental taphonomy, using controlled decay experiments to examine how individual variables alter the order and nature of organelle degradation. Tissues from multiple taxa were incubated in microbially inoculated solution for several weeks, sampled via microscope at stages throughout. Organelle abundance, condition, and size were recorded and analysed as measures for taphonomic bias. Current results demonstrate unexpected resistance to decay in nuclei, often surviving for weeks intact across tissues and taxa. Further research seeks to continue running these experiments over longer periods, allowing better insight into which tissues and taxa may retain the structure and form of their organelles more effectively over during long-term decay, informing us on which their resistance to taphonomic artifacts. Other variables will also be introduced, including the presence of minerals important for diagenesis.

**A Taphonomic classification and environmental interpretation using ganoid scales**
**Niclas Bücker - Friedrich-Alexander Universität Erlangen-Nürnberg**

Ganoid scales are common fossils found in the Paleozoic and Mesozoic fossil record. They are characterized by a hyper-mineralized enamel-like tissue, called ganoine, which covers the outermost layer of the scale. Recent studies have measured enhanced resistance to pressure and stress in modern ganoid scales. However, currently, the literature lacks discussions about the taphonomy and preservation of these scales in the fossil record. In this upcoming study, we propose a qualitative classification for ganoid scales. Specimens from the extant *Atractosteus spatula*, the Messel Pit Fossil Site in Germany and the Rhaetian bonebed of southwestern Germany are analysed. Using abrasion experiments and the classification system outlined by Bücker et al. (2024) we examine the abrasion behaviour of ganoid scales under different conditions over time. This will be used to introduce a classification system for abrasion stages of ganoid scales. Machine learning will support our study to examine large sample sizes and to reduce human bias. Afterwards, we compare the expected transport distances and energy-levels with the literature. If this study is successful, fossil aquatic environments that containing ganoid scales, can be interpreted in greater detail.

**A Phylogenetic Analysis of Candidate Bilaterians within the Ediacaran Biota**
**Oghenovo Ukiri - Independent**

The Ediacaran biota consists of large, complex, multicellular organisms of various morphologies and biological affinities from 579–539 Ma. Molecular clock and trace fossil data suggest that stem and crown group bilaterians were present in the Ediacaran Period, but the body fossil record shows few recognisable bilaterians. It is likely that fossil taxa of the Ediacaran biota include bilaterians, but determining which taxa belong within that clade has proven difficult, limiting our understanding of early bilaterian evolution. Members of the Ediacaran biota have previously been grouped within ‘morphogroups’ based on their morphological similarities, interpreted to imply close phylogenetic relationships. I tested the validity of the hypothesised kimberellomorph group and reassessed previous bilaterian hypotheses for individual fossil taxa such as Kimberella and Temnoxa, to constrain both their interrelationships and whether individual fossil taxa might be reconciled with the larger metazoan tree as bilaterians. I generated a homology scheme for the group by identifying potentially homologous morphological characters among kimberellomorphs. I then ran a Bayesian phylogenetic analysis based on a novel, comprehensive metazoan character matrix to establish the placement of taxa within the metazoan tree. My results demonstrate likely evolutionary relationships between members of the Ediacaran biota, as well as body fossil evidence for bilaterians within the Precambrian fossil record. This helps reconcile temporal estimates for the origin of bilaterians given by molecular clock data with the fossil record and evidences the evolutionary groundwork laid prior to the basal Cambrian radiation of bilaterians.

**Molar opposites – The Secret Tooth Morphology of Mixosaurids Reveals a Higher Diversity of Triassic Ichthyosaurs than Previously Thought**

**Petter Nordenhaug - Natural History Museum of Oslo**

The Permian-Triassic extinction event not only erased 81% of marine species; it also facilitated immense radiation in biodiversity in the Early Triassic. The Spitzbergen Mesozoic Research Group has during the last 11 years revealed much new information of this radiation from new material collected in the Svalbard archipelago. The area was in the Early and Middle Triassic a seabed within the large, northern embayment of the Panthalassa Ocean approximately 42°N. The mixosaurids, an early group of ichthyosaurs, are common in the Middle Triassic Botneheia Formation localities of Flowerdalen and Edgeøya at Svalbard. The mixosaurid family, previously consisting of seven species in two genera worldwide, now sees the addition of new diversity and species revisions from Svalbard. This has been possible through X-ray and micro computed tomography, examining tooth morphology across mixosaurid specimens, revealing previously unrecognized taxonomic distinctions. Analyses led to the identification of two new species distinguished by unique dental characteristics, supported by other morphological differences. Additionally, two previously assigned species exhibited greater morphological divergence to other geographical regions than previously thought, warranting taxonomic reassessment. These findings refine our understanding of mixosaurid phylogeny and suggest more complex trophic partitioning within Middle Triassic marine ecosystems. The use of advanced imaging techniques highlights the potential for further discoveries within ichthyosaur evolution in a time where morphological diversity was at its greatest.

**New dinosaur dominated trackway of Dinosaur Provincial Park, Alberta, Canada.**

**Sarah Ashby - University of Reading**

Dinosaur Provincial Park (DPP), Alberta is a site of global importance to palaeontologists due to its rich abundance of diverse body fossils and long history of specimen collecting. However, the field of dinosaur palaeontology is not limited to the study of fossilized bones. During the 2024 field season a new trackway was uncovered, named The Skyline Tracksite for its high elevation. Before its discovery only a small number of tridactyl concretionary prints had been recorded from DPP, making this site significant as it is the first multitaxic dinosaur trackway in the Park that is comprised of natural moulds. Six new trackways have since been discovered with this new search image. In the DPP study system we are now able to study body fossils and footprints (ichnites) together, providing researchers with a more complete picture of the local ecosystem, community structure and behaviours contemporary to sediment deformation. Due to the friable nature of ichnites in the Park, it is essential they are collected in a timely manner and digitally preserved making them accessible to researchers for present and future studies. This coming field season will concentrate on further excavation and measurements of the Skyline trackway (paper in review), recording the new sites and prospecting for further sites.

**Patterns of intrinsic vulnerability and range shift in Pliocene to Recent bivalve assemblages.**
**Sarah Gale - University of Birmingham**

The excellent Pliocene fossil record of bivalves in the North Atlantic presents an opportunity to identify patterns of extirpation and extinction risk across a significant climatic change. The Pliocene is comparable in many ways to the modern oceans; with atmospheric $CO^2$ levels similar to the present and very near-contemporary ocean geography. The Plio-Pleistocene transition (~2.3 million years ago) and the associated glaciations, drop in global temperatures, lowered sea levels, coincides with a pulse of extinction that can be observed in a number of different taxonomic groups, including the marine bivalves. The range of many surviving bivalve species contracted or shifted southwards during this time, presumably following their preferred thermal tolerance. This further exaggerated extinction in some regions by extirpation, particularly at higher latitudes as the range of many species contracted towards the equator even though many never became completely extinct. These patterns urged us to investigate the predictability of bivalve sensitivity to climatic change, and how they correlate with intrinsic properties. Here, we examine patterns of range shift and estimate the intrinsic vulnerability of shallow marine bivalves to climatic change along the northeast Atlantic coasts, comparing the geographic range of species and correlations, if any, between properties such as taxonomic identity, ecological function or redundancy; and extirpation or extinction risk.

**Competition in Ediacaran Communities**
**Shujie Chang - University of Cambridge**

The fossil record of early animals from the Avalon (Ediacaran, ~570–560 Ma) represents the earliest known metazoan marine communities. Their in-situ, near-census, non-time-averaged preservation enables the use of spatial ecological methods commonly applied to modern plant communities, facilitating detailed exploration of Ediacaran community dynamics. Here, we applied spatial point pattern analysis to 18 populations across 7 communities to investigate the drivers of pairwise interactions, specifically competition. Most communities appear governed by non-competitive neutral processes, yet some show spatial segregation, potentially indicating the emergence of competitive interactions. We further examined the drivers of such competition by comparing tiering (extent of vertical niche partitioning) with phylogenetic relatedness. As in modern sessile communities, height is a key functional trait linked to competition and is frequently compared to phylogenetic relatedness, with contentious conclusions on their relative strength. We quantified the degree of tiering through vertical overlap in both height and feeding zones between populations and leveraged a newly established phylogenetic tree of all rangeomorphs to calculate the phylogenetic affinities. Finally, we test these two factors separately to explore whether the strength of competition changes with each, then combined them into a single model to determine which factor exerts a stronger influence on competition at the metacommunity level. By investigating the relative importance of height and phylogenetic relatedness within the earliest metazoan communities, this work provides new insight into the assembly and ecological processes operating at the dawn of complex animal life.

**The functional consequences of morphological variation in the avian rhamphotheca**
**Sophie Pollard - University of Hull**

Bird beaks are comprised of a bony core surrounded by a keratinous rhamphotheca. While both the bony and keratinous elements of the beak change dramatically among bird species, the functional consequences of relative changes to bone and keratin remain unexplored. This is particularly due to a lack of available 3D data including both the bony core and a complete rhamphotheca. Using CT scans, a 3D model of a bird beak was used as a baseline for geometric transformations of the upper bill rhamphotheca (rhinotheca). These included overall thickness, ventral thickness, tip extension and variation in the posterior boundary, creating a theoretical morphospace which mimicked the morphological variation seen in modern birds. Finite element analysis (FEA) was then used to examine the distribution of overall values in stress, strain and deformation in the generated models to quantify the functional consequences of changes across the hypothetical morphospace. By adjusting the material properties of both bone and keratin, the relative importance of geometry versus building materials was examined. I found that changes to overall shape of the beak are more important than material properties in determining stress and strain patterns, although material properties still hold a and important role in determining stress and strain magnitude. Not only does this allow for a better understanding of function, morphology and material properties in bird beaks, but also has implications for the reconstruction of the rhamphotheca in extinct beaked organisms such as dinosaurs.

**Spring-foot or foot-pad: did Anchitheriine horses exhibit an alternative foot condition?**
**Tanya Gunnarsdottir - University of Bristol**

The Anchitheriini were a successful “side branch” within equid phylogeny that flourished in the Miocene. As their fossils don’t possess the osteological correlates for the fully unguligrade “spring-foot” seen in the Equinae (including modern Equus), i.e. elongated proximal phalanx, they were assumed to retain a foot-pad and sub-unguligrade stance. The foot-pad is a basal mammalian feature seen among modern perissodactyls (odd-toed ungulates) in tapirs and rhinoceroses, and inferred in more basal equids. However, the discovery of a hoofprint assigned to an anchitheriin that shows a “frog”, as seen in Equus, calls into question the presence of a foot-pad. To determine whether anchitheriins employed an alternative foot condition to the pad-foot or spring-foot, even-toed ungulates (artiodactyls) were examined as possible functional analogues to perissodactyls. Artiodactyl and equid evolution show similar trends (e.g. digit reduction, spring-foot evolution, increasing body size). A pad-foot is seen in modern hippopotamuses and inferred in basal artiodactyls, however, modern suids (pigs) are fully unguligrade with neither a foot-pad nor the elongated proximal phalanx indicative of a spring-foot. Osteological correlates for this condition in artiodactyls include reduced volar processes on the carpals and proximal metacarpals, representing the transformation of the interosseus muscle into a suspensory ligament. In anchitheriins these processes are similarly reduced, indicating full unguligrady without a spring-foot. Further work on this question is in progress, including biomechanical analysis (second moment of area and finite element analysis) comparing extinct perissodactyls with extant zebra and tapir specimens.

**The global context of a new theropod track-way from Dewars Farm, Oxfordshire.**
**Thomas Beard - University of Birmingham**

A major new dinosaur track-site was uncovered at Dewars Farm, Oxfordshire, England in 2024. This Middle Jurassic site has over 200 dinosaur tracks in five long track-ways; four sauropod and one theropod. This project aims to describe the new theropod track-way at Dewars Farm and place it into a global context. Data collected during fieldwork included track measurements, anatomical observations, track-way feature identification, sediment observations, and taking photographs for photogrammetric models. The palaeoenvironment at Dewars Farm is thought to have been lagoonal, evidenced by the sedimentology and presence of marine benthic organisms. Observations and 3D-models highlighted key findings based on the tracks: a crossing of sauropod and theropod track-ways showed that the theropod had moved through the area first. Track measurements were used to estimate the track maker's speed, which was a walking pace of ~4-5km/h. The track maker's identity has been hypothesised to be Megalosaurus using the anatomical observations and track measurements which enabled estimates of hip height. The literature supports this identity through geographic range and time period. Adding Dewars Farm into a global context consisted of collecting global track-site data, (lithology, palaeoenviroment, time period and geographical location), categorising it, and calculating relative percentages. The results highlighted preferred preservation conditions in palaeoenvironments and lithologies. Terrestrial palaeoenvironments and clastic sediments preserve theropod tracks most frequently. There are also large biases in geographic location and time period with most track-sites being located in the northern hemisphere and from the Early Jurassic.

**De-carcinisation in true crabs (Decapoda: Brachyura) and the evolution of novel body forms**
**Yuan Xue - University of Cambridge**

True crabs, or Brachyura, are a speciose and anatomically disparate group of crustaceans, found across a broad range of marine and non-marine environments, exhibiting diverse adaptations to pelagic, nektonic, epibenthic, and infaunal lifestyles. A core novelty aiding their ecological success is the evolution of a flattened body, termed 'carcinisation', characterized by a widened carapace, fused sternal segments, and a reduced, bent, non-muscular tail (pleon) tightly pressed against the sternum. It has been suggested that a carcinised body form facilitates locomotion, protection, and predator avoidance, compared to their uncarcinised decapod relatives, e.g., lobsters. However, some groups have secondarily evolved body forms superficially similar to their uncarcinised ancestors. This phenomenon is termed 'decarcinisation', typified by elongated bodies, a narrowed sternum, and an unfolded pleon. While increasing molecular data availability, new fossil discoveries, and modern imaging techniques renewing the phylogenetic relationships among carcinised and decarcinised groups, the evolutionary sequence, polarity, and direction of anatomical changes leading to decarcinisation remain understudied. To investigate this, we have studied key carcinised and decarcinised crabs from across the brachyuran tree of life with landmark-based geometric morphometrics. Our result showed that decarcinisation is characterised by lateral compression and axial elongation of the carapace and sternum, with more posteriorly located pleon elements. Despite the anatomical commonalities, decarcinised taxa reside discretely in morphospace, implying further niche-specialised morphological adaptation. Our analysis offers new insights into anatomical commonalities among decarcinised species, and suggests a framework for quantitatively analysing the anatomical evolution of true crabs.

**Flat-pebble conglomerates through time and space: a proxy for the evolution of burrowing?**
**Zachary Cover - University of Uppsala**

Flat-pebble conglomerates (FPCs) are intraformational limestone conglomerates that form when thin crusts of lithified limestone on the seafloor are ripped up and redeposited as a jumble of flat tabular clasts. FPC occurrence spikes in early Palaeozoic (Cambrian-Ordovician) strata, in synchrony with the initial radiation of bilaterian animals. This correlation has led to hypotheses that FPC abundance is to some degree biologically influenced. FPCs form via exhumation, breakup and redeposition by storm waves, but whether FPCs are able to form in the first place may be linked to the initial influence of benthic burrowing on the depth of seafloor carbonate cementation. To investigate these links, a database of 169 FPC occurrences was collated to analyze their temporal and spatial distribution throughout the Phanerozoic. FPCs were found to be most abundant prior to the Ordovician radiation (GOBE), when shallow burrowing prevented widespread microbial mat binding of substrates, but before the evolution of deeper burrowing behaviours that generated extensive sediment-mixing later in the Phanerozoic. This early phase of shallow bioturbation is here hypothesized to have created a "Goldilocks zone" for FPC formation. FPCs were also found to cluster around extinction events. Here we propose that during benthic extinction events, this "Goldilocks" window may reopen, allowing shallow carbonate cementation to return in seafloor sediments, promoting FPC formation as an anachronistic facies. The apparent absence of FPCs following the KPg extinction, which primarily affected pelagic environments, highlights that extinction associated FPC formation is likely dependent on disruption to benthic ecosystems.

**Investigating the functional ecosystem structure and dynamics of the Late Jurassic Morrison Formation**
**Cassius Morrison - University College London**

The Upper Jurassic Morrison Formation of the United States spans 7-9 million years and contains an iconic dinosaurian fauna, including taxa such as Stegosaurus and Allosaurus. Despite an intense study history, a comprehensive analysis of ecosystem structure and relationships between taxa and broader environmental context is lacking. Rather than employing a taxonomy-based approach to assess disparity in ecosystem structure, this study used functional fauna: categorising species based on dietary guild, size class, and tiering groups to analyse disparity throughout the formation. Preliminary results suggest that the Morrison Formation was a stable ecosystem through geological time, with different species entering similar functional roles despite taxonomic turnover. Our results strongly support local environments and habitat diversity as the driving factor of functional faunal disparity. Localities with similar palaeoenvironments that did not preserve small vertebrates showed no significant difference in their functional fauna. These results support environmental heterogeneity within the Morrison Formation, where a mosaic of distinct local paleoenvironments was a major driver of functional variation between communities and likely drove species diversity. Variations in localised Morrison Formation paleoenvironments are comparable to the mosaic grassland savannahs of sub-Saharan Africa. Localised habitats appear to be a key driver of functional diversity in the Morrison Formation rather than functional diversity varying over time. The abundance of giant grazing sauropods probably played a key role in generating habitat heterogeneity in the Morrison Formation. Utilising a functional fauna approach makes it possible to assess the difference between faunal turnover and ecosystem functional changes.