PROGPAL 2023 LIVERPOOL

1ST - 3RD JUNE 2023

BONUS EVENT

"AN EVENING WITH PALAEONTOLOGISTS" 31ST MAY 2023

General Meeting Information

Acknowledgements

Progressive Palaeontology is supported annually by the Palaeontological Association, and the committee thanks the Association for its assistance! To become a member, check out the website: http://www.palass.org/

The Progressive Palaeontology Committee also thanks the following institutions and individuals for helping to make this event possible:

The University of Liverpool Alumni & Friends Fund

University of Liverpool Staff Support:
Prof. Graham Kemp
Dr. Karl Bates
Prof. Nathan Jeffery

"An Evening with Palaeontologists" Speakers:
Dr. Charlotte Brassey
Dr. Alana Sharp
Dr. Peter Falkingham
Dr. Katrina Jones

Additional image credits:

(p4) *Lepus saxatilis* by Margot Michaud via PhyloPic (CC0)
(p4, 22) *Anas* by Sharon Wegner-Larsen via PhyloPic (CC0)
(p13) *Diplodocus* skeleton modified from NHM Vienna via Sketchfab (CC BY-NC 3.0)
(p8) *Mammuthus* by artrociraptor via PhyloPic (CC0)
(p8) Mammals by T. Michael Keesey and Margot Michaud via PhyloPic (CC0)
(p20) Hanyusuchus by Masaya, Qiao Yu, Lin Wenbin, Peng Youjie, Yoneda Minoru and Liu Jun (CC BY 4.0)
(p21) *Pambdelurion* by Junnn11 via Wikimedia Commons (CC BY-SA 4.0)
(p22) *Ichthyosaurus* by Jagged Fang Designs via PhyloPic (CC0)
(p24) Rhynie Chert Flora by Falconaumanni via Wikimedia Commons (CC BY-SA 3.0)
(p25) Ebola virus by Madiiha Bibi Mandary, Malihe Masomian, & Chit Laa Pooh via Wikimedia Commons (CC BY 4.0)
(p29) *Tachyglossus* by Becky Barnes via PhyloPic (CC0)
(p30) *Mononykus* by PaleoNeolitic via Wikimedia Commons (CC BY 4.0)
(p31) *Thecodontosaurus* by Jaime Headden via PhyloPic (CC BY 4.0)
(p33) *Dunkleosteus* by Jagged Fang Designs via PhyloPic (CC0)
(p38) *Ligia* by Andy Wilson via PhyloPic (CC0)
(p42) *Meganeura* by Zyoute via Wikimedia Commons (CC BY-SA 4.0)
(p42) *Amphistegina* via Iconogrpahica Zoologica, 1928
(p44) *Morturneria* by Connor Ashbridge via Wikimedia Commons (CC BY-SA 4.0)

Images mentioned were modified from their original state into silhouettes matching the ProgPal 2023 colour scheme.

@ProgPal2023
#ProgPal2023

Meet the ProgPal 2023 Committee

Matthew Dempsey
@Sketchy_raptor
PhD Student (4th Year)

“ I work on the biomechanics and functional morphology of animals both extinct and extant to help decipher how dinosaur bodies worked, with a focus on the dynamics and evolution of gait.”

Favourite Fossils:
Stegosaurs

Amber Wood-Bailey
@apwoodbailey
PhD Student (3rd Year)

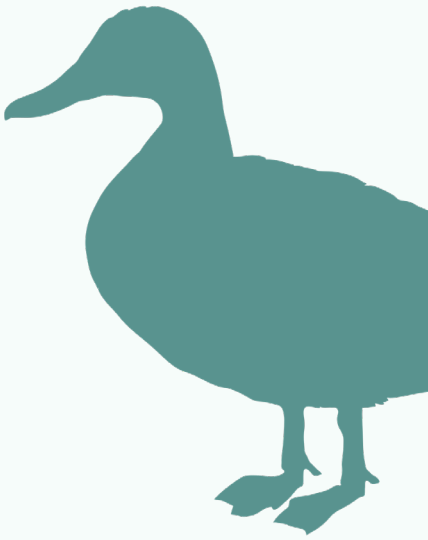
“ My PhD looks at the evolution of unique cranial traits in leporid lagomorphs (rabbits and hares). I’m particularly interested in the functional evolution of the mammalian cranium.”

Favourite Fossils:
Chalicotheres

Samuel Cross
@SamRRCross
PhD Student (2nd Year)

“ My research focuses on locomotor evolution in birds and theropod dinosaurs. I use experimental data from living animals to drive models of extinct ones!”

Favourite Fossils:
Mosasaurs



@ProgPal2023
#ProgPal2023

General Meeting Information

About Progressive Palaeontology

Progressive Palaeontology (ProgPal) is an annual, free-to-register conference organised by students for students, and is supported by the Palaeontological Association. The conference provides a welcoming, supportive space for early-career researchers to present their work and spend time with their peers.

We are thrilled to be hosting ProgPal this year at the University of Liverpool this year, and sincerely hope that everyone has a great event!

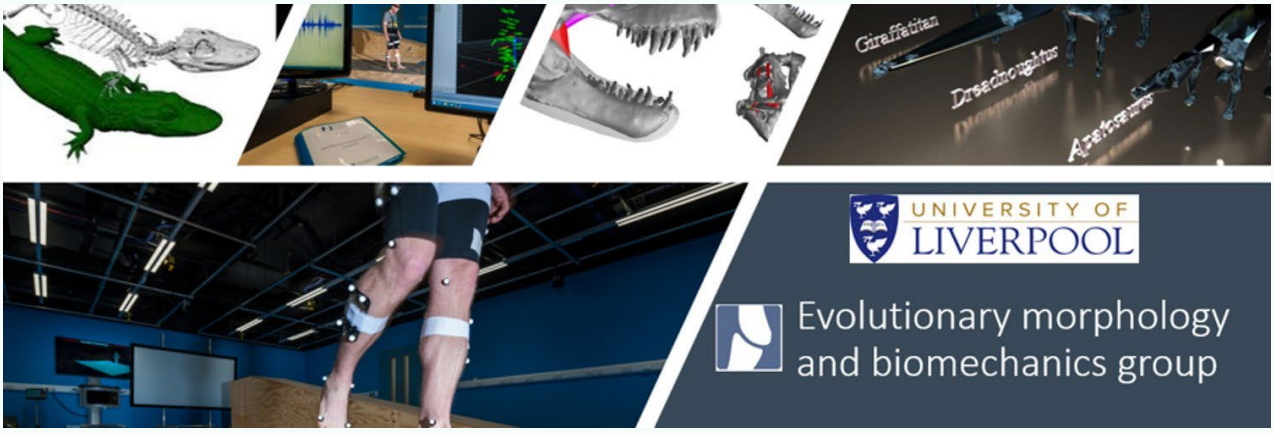
Key addresses

Victoria Gallery & Museum, Ashton St, Liverpool L69 3DR

Liverpool Guild of Students, 160 Mount Pleasant, Liverpool L3 5TR

Duke Street Food & Drink Market, 46 Duke St, Liverpool L1 5AS

University of Liverpool Life Sciences Building, Crown St, Liverpool L69 7ZB



Our research group

This year's ProgPal committee are all based in the Evolutionary Morphology and Biomechanics lab group, in which we seek to understand the evolution of animal form and function across deep time. Our research covers everything from fish, to dinosaurs, to humans, and uses a wide array of physical and virtual methods. Check us out @LivEvoBiomech on twitter!

General Meeting Information

Venue Information

Most of this year's conference proceedings will take place in the Stanley Theatre at the Liverpool Guild of Students. Attendees should aim to arrive at each session in a timely manner to keep the event running smoothly.

We have also booked out the Library Room in the Liverpool Guild of Students for the purposes of the workshop and poster session.

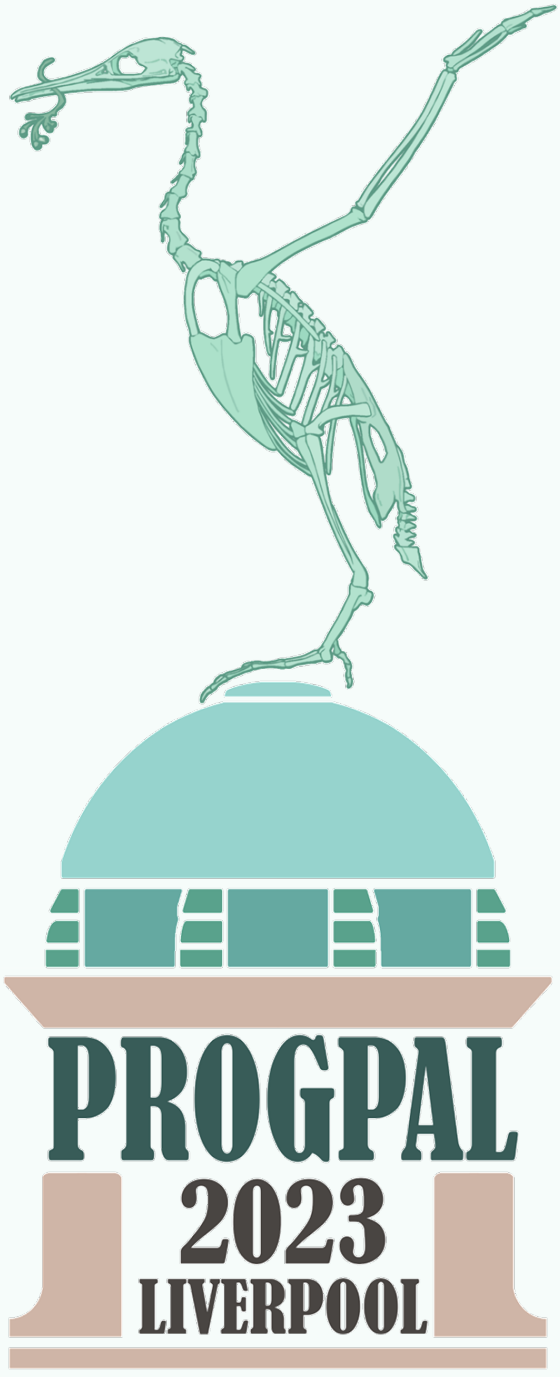
The Guild is easily accessible, and is only a short walk from each of the major Liverpool train stations.

Liverpool Guild of Students, 160 Mount Pleasant, Liverpool L3 5TR

The post-conference social/meal will take place at the Duke Street Food & Drink Market. The Duke Street Market is a food hall with a broad choice of vendors, which caters to a wide variety of dietary needs. Registration to attend the conference dinner at the privately booked Duke Street Food & Drink Market function room is free, but attendees will be expected to order and pay for their own food and drink at the venue on the day.

Duke Street Food & Drink Market, 46 Duke St, Liverpool L1 5AS
https://www.dukestreetmarket.com/

General Meeting Information



This year's logo represents the Liver Bird perched atop the Liver Building, which is an iconic symbol of Liverpool. However, it's looking a bit skinnier than usual… At the University of Liverpool's Evolutionary Morphology and Biomechanics lab, we specialise in musculoskeletal anatomy, so we wanted to create a logo that reflects both our research themes, and the city itself. To that end, the Liver Bird has been represented as an anatomically accurate cormorant skeleton (while the statues themselves are highly stylised, much of the Liver Bird iconography depicts it as a cormorant).

@ProgPal2023
#ProgPal2023

BONUS EVENT – 31st May

Pre-conference event:

AN EVENING WITH PALAEONTOLOGISTS

18:00, 31st May 2023
Victoria Gallery & Museum

Dr Charlotte Brassey
Manchester Metropolitan University

Dr Alana Sharp
University of Liverpool

Dr Peter Falkingham
Liverpool John Moores University

Dr Katrina Jones
University of Manchester

Public seminar, free for ProgPal attendees

(Check your emails for information on free entry)

Main Event Schedule

Day 1: 1st June

Registration
12:30 - 13:00

Welcome
13:00 - 13:15

Workshops
13:30 - 15:30

Poster Drop-in Session
13:30 - 16:00

Break and LGBTQ+ Meetup
15:30 - 16:00

Poster Session 1
16:00 - 18:30

Icebreaker
18:30 - onwards

Main Event Schedule

Day 2: 2nd June

Opening Remarks
09:15 - 09:30

Keynote:
Sophia Anderson
9:30 - 10:15

Break
10:15 - 10:30

Session 1:
Systematics and Evolution
10:30 - 11:35

Break
11:35 - 11:55

Session 2:
Anatomy and Functional Morphology
11:55 - 13:00

Lunch
13:00 - 14:15

Main Event Schedule

Day 2 (Continued)

Session 3:
Environments and Taphonomy
14:15 - 15:00

Break
15:00 - 15:10

Session 4:
Ecology and Extinction
15:10 - 16:20

Poster Session 2 and Auction
16:30 - 18:00

Closing Remarks & Prizes
18:00 - 18:15

Duke Street Food & Drink Market:
Conference Dinner and Social
19:00 - late

Main Event Schedule

Llandudno Field Day:
3rd June

Coach travel to Llandudno

The coach will be arranged to pick up attendees at 8:30 AM by the Life Sciences Building. Travel is estimated to take up to two hours.

Great Orme Fossil Excursion

Upon exiting the coach in Llandudno, we will walk to the Great Orme Summit Complex. Following this, attendees will be toured around key points of interest, and will be given a crash course in the geological history of the area. Attendees will then be able to forage for fossils at the Hill of Names quarry cutting.

Bronze Age Copper Mine

We will then reconvene by the Great Orme Summit Complex for a lunch stop, where there is a café, bar, and gift shop. After lunch, there will be the option to visit the Great Orme Bronze Age Copper Mines**. This will be optional part of the trip, as it requires paid entry,** but attendees who decide to visit will be accompanied by a committee member.

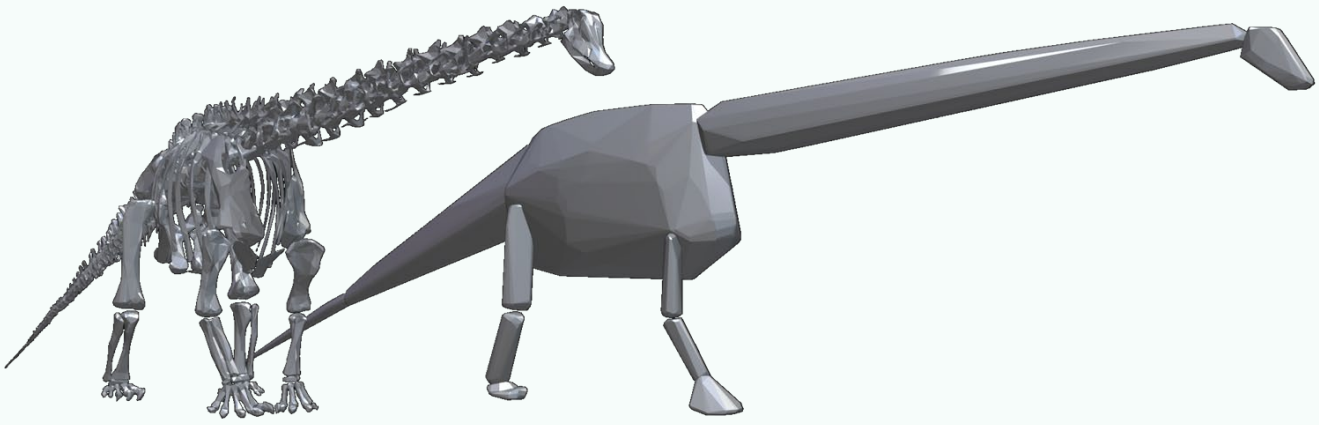
Visiting Llandudno

Once the guided part of the trip has concluded, attendees will be given the option to explore the town of Llandudno before reconvening at the coach pickup site at 17:30. The coach will depart at 18:00. We expect to arrive back in Liverpool by around 20:00, but this will depend on traffic conditions.

Main Event Schedule

Workshops

13:30 - 15:30, 1st June



How to weigh your animal: An introduction to volumetric methods in vertebrate palaeontology

Library Room, Liverpool Guild of Students

Delegates will be introduced to 3D volumetric principles and their application to the study of the functional morphology of extinct animals. The session will start with a talk from Dr. Karl Bates, covering the history and application of 3D volumetric methods in palaeontological research. A practical classroom session will follow, in which delegates will be provided with partially prepared 3D skeletal models, and will be taught how to estimate body segment mass properties from those models using Blender.

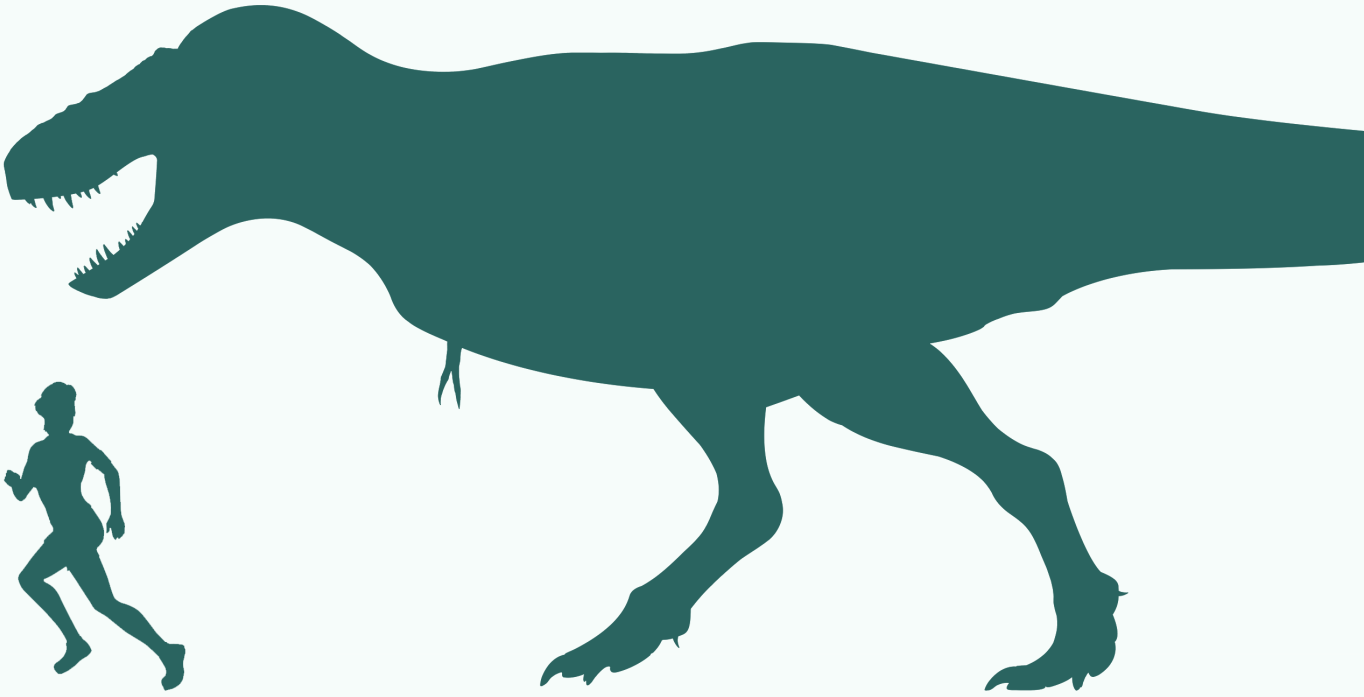
The 3D skeletal models have been sourced from museum digital repositories, and are available for educational, non-commercial use. Please use them responsibly!

This workshop has limited spaces, and those who have registered should bring their own laptops with the most recent version of Blender installed in order to participate in the practical class. The worksheet and resources will be provided via cloud link closer to the event.

Main Event Schedule

Workshops

13:30 - 15:30, 1st June



Art and Palaeontology: The history and applications of illustration to our research

Stanley Theatre, Liverpool Guild of Students

Led by Matt Dempsey, this workshop will encourage delegates to examine the role of the visual arts in palaeontology via an extended talk with interactive elements and an open Q&A session.

Topics covered will include the influence of extinct animal artwork from the media, the application and importance of illustration to palaeontological research and public outreach, and advice on improving scientific illustration skills, working with artists, etc.

This workshop is open to all delegates, with no space limitations.

Code of Conduct for Palaeontological Association Meetings

Behavioural expectations:

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.

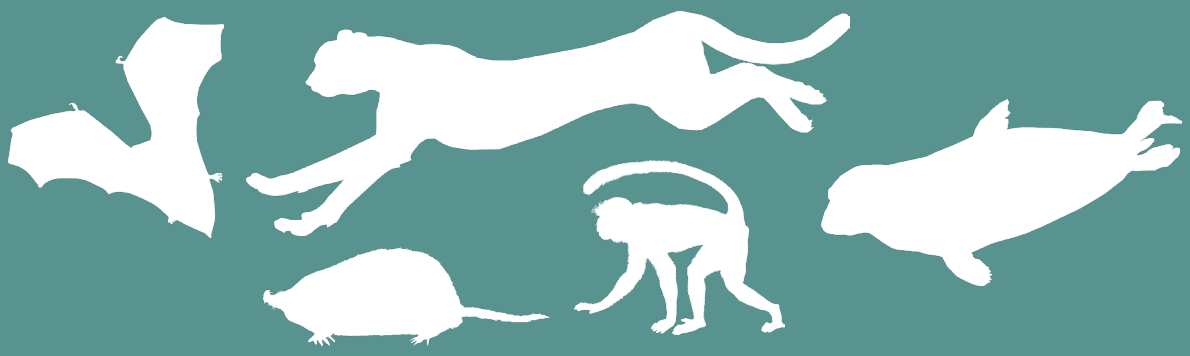
Reporting unacceptable behaviour:

If you are the subject of unacceptable behaviour or have witnessed any such behaviour, please notify the organizing committee and a member of the Palaeontological Association Council in a designated leadership position (Executive Officer Dr Jo Hellawell: executive@palass.org; President Prof. Rachel Wood: president@palass.org; Vice-Presidents Prof. Paul Barrett: vicepresident1@palass.org, or Dr Uwe Balthasar: vicepresident2@palass.org).

Anyone experiencing or witnessing behaviour that constitutes an immediate or serious threat to public safety, or a criminal act is expected to contact the emergency services by phoning 999. Those witnessing a potential criminal act should also take actions necessary to maintain their own personal safety.

Keynote

A novel approach to quantifying mammal locomotor repertoires using cluster analysis



Sophia C Anderson[1],
Philip G Cox[2], Eloy Gálvez-López[1]

[1] University of York, [2] University College London

A novel approach to quantifying mammal locomotor repertoires using cluster analysis

Sophia C Anderson[1], Philip G Cox[2], Eloy Gálvez-López[1]
[1] University of York, [2] University College London

The study of anatomy in palaeontology relies on our understanding of anatomy in extant animals. In particular, our ability to make inferences about an extinct animal's lifestyle and ecology relies on functional morphological research – the study of the relationship between anatomical form and biomechanical function – in extant taxa. Functional morphology, as well as other fields of comparative anatomy and even non-anatomical research, frequently utilises behavioural and dietary traits as categorical variables, for example, placing each species within a dataset into one of a predetermined list of locomotor categories (arboreal, fossorial, aquatic, etc.). Despite behavioural categories being a staple of functional morphology studies on living and fossil taxa for decades, this has long been associated with caveats. Firstly, there is considerable subjectivity within this process, both in the decision of how many and which categories to include, and in the decisions regarding actual assignment of a given species. Arguably of most significance, however, is the loss of information on behavioural repertoire when assigning a single category to each species. The water shrew, for example, digs its own burrows and is also an extremely adept swimmer – should this species be placed in a semifossorial or semiaquatic category? Either way, information on the animal's behavioural repertoire is lost.

In order to address this, we provide a novel method for defining and assigning locomotor categories which is based on quantitative data, minimises subjectivity, and preserves more information on behavioural repertoire. We present an example usage of this method on 235 mammalian species, representing every mammal family. Each species is scored on its ability in five locomotor behaviours (swimming, climbing, digging, running, and aerial movement) based on a strict set of scoring criteria. This scoring matrix contains a large quantity of multidimensional behavioural repertoire information, and its dimensionality can then be reduced using Ward's hierarchical clustering which mathematically groups species according to their scores into biologically informative clusters (the number of which can be optimised using cluster validation methods). The resulting clusters can then be used to define the locomotor categories for assignment in further research. We find that 6 clusters is optimal, broadly representing specialised swimmers, flyers (bats), climbers, diggers, subterranean mammals, and runners/terrestrial mammals.

Through this method, behavioural repertoire information contained within the locomotor categorisation is increased, and subjectivity is reduced to the scoring stage. The scoring criteria are designed with as little room for interpretation as possible to minimise subjectivity and increase interobserver repeatability. A subset of the species were scored independently by the three co-authors, all successfully re-creating the 6 clusters above. Thus, this method addresses the main caveats of behaviour being reduced to categorical variables for the purposes of functional morphology research and other fields, without drastically increasing the time or resources necessary to assign each species to a category. Though locomotor behaviour in mammals is used here to demonstrate the method, it can be applied to any taxonomic group and any similar behavioural or biological variable, such as diet or habitat preference.

Abstracts

Session 1:

Systematics and Evolution

PROGPAL

2023

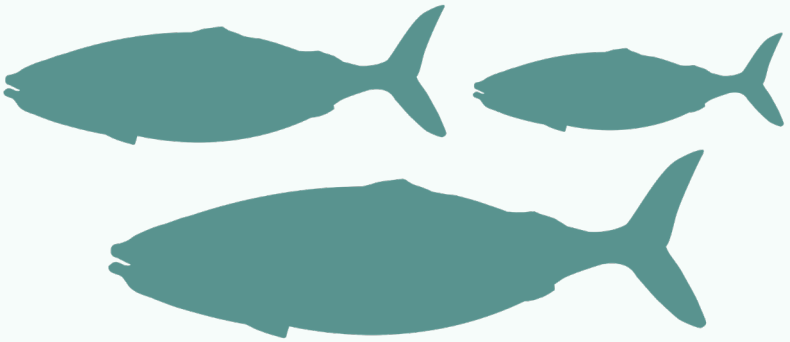
LIVERPOOL

Full Talk:

Synchrotron and CT Scanning Provides insight into the Anatomy and Evolution of Exceptional Mesozoic Fishes

Jake Atterby[1], Matt Friedman[2], Zerina Johanson[3], Sam Giles[1]
[1] University of Birmingham, [2] University of Michigan, [3]Natural History Museum UK

Teleost fishes comprise more than half of all living vertebrate species. They are exceptionally diverse and occupy a wide range of aquatic ecosystems. However, despite their overwhelming success, taxa outside of the living radiation – stem teleosts – remain poorly understood. They include a plethora of iconic fossil groups, such as pholidophorids, aspidorhynchids and pachycormids. However, efforts to understand their phylogenetic placement have been hampered by inappropriate outgroups, poorly constructed characters, and outdated descriptions based almost entirely on external anatomy. Ultimately, fossil teleost fishes lack a solid phylogenetic foundation, which has undermined attempts to investigate macroevolutionary patterns on the stem. Here, we present a series of remarkably preserved fossil specimens, including potentially new taxa. This includes a new, three-dimensionally preserved specimen of *Dorsetichthys bechei*, a herring-like fish from Early Jurassic Lyme Regis and the crania of a new genus of Caturidae (Amiiformes), previously misidentified as an aspidorhynchid. Crucially, through high-resolution CT and synchrotron scanning, we have been able to resolve and code their internal anatomy, including the braincase and endocast. This has informed a markedly strengthened phylogeny of the teleost stem, which sets in motion a wide range of future macroevolutionary studies and will allow us to far better understand the origins of this exceptionally important vertebrate group.

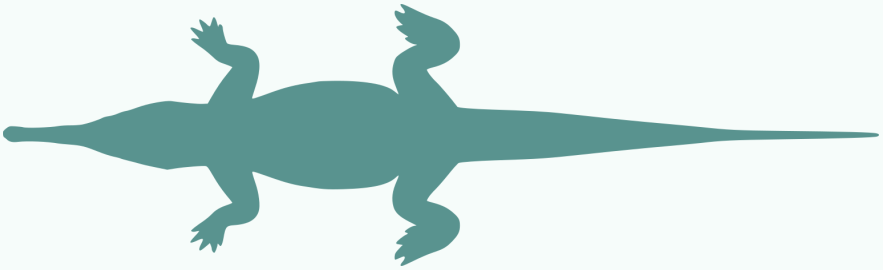


Full Talk:

What can neuroanatomy tell us about the evolutionary history of gavialoids?

Paul Burke[1], Philip Mannion[1]
[1] University College London

The interrelationships of Crocodylia have been subject to debate for decades, particularly pertaining to the extant longirostrine species, *Gavialis gangeticus* and *Tomistoma schlegelii*. Molecular analyses show a sister taxon relationship between these two gavialid species, whereas morphological analyses typically recover Gavialis as the outgroup to all other extant crocodylians. Recent morphological analyses have resolved this discrepancy, recovering the molecular topology; however, a temporal incongruence remains, with numerous putative gavialid from stratigraphic units that greatly predate *Gavialis-Tomistoma* molecular divergence time estimates. We evaluated the neuroanatomy of numerous fossil gavialoids, with the eventual aim to develop new characters to incorporate into a morphological phylogenetic dataset. Using CT scans, we found that the neuroanatomy of *Tomistoma dowsoni*, a fossil gavialoid from the Miocene of North Africa has an intermediate morphology between the two extant species, more closely resembling Gavialis. Preliminary neuroanatomical results from other gavialoids indicate that the recently extinct Chinese species *Hanyusuchus sinensis* is morphologically more similar to Gavialis gangeticus, whereas the Miocene Austrian taxon *Gavialosuchus eggenburgensis* more closely resembles *Tomistoma schlegelli*. The neuroanatomy of *Eothoracosaurus missippiensis*, a potentially "problematic" taxon within Gavialoidea given its Late Cretaceous age, appears to show a close resemblance to both extant species, indicating that perhaps gavialid neuroanatomical features evolved early in the clade, remaining relatively conserved. Via comparison to other longirostrine species, we can gain further clarity over when certain features evolved, whether specific features are unique to gavialoids, and subsequently, their importance in inferring gavialoid phylogeny and ecomorphology.

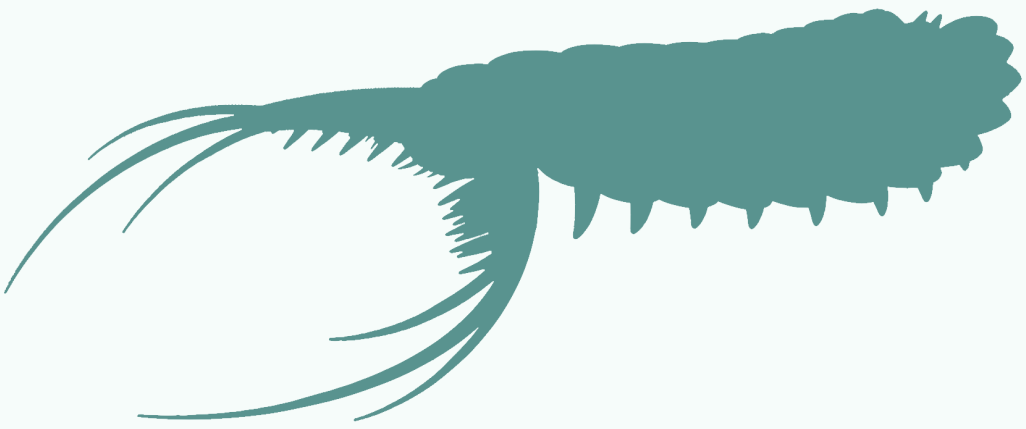


Full Talk:

New evidence suggests radial Symmetry in the mouth of *Pambdelurion* is an oversimplification of its anatomy

Campbell Marsden Hendrick[1], Thomas Farrell[1], Jakob Vinther[1]
[1] University of Bristol

Pambdelurion whittingtoni, a 'gilled lobopod' (stem-Arthropoda) from Greenland's Sirius Passet, has been used in the past to help clarify the complexities of ecdysozoan phylogeny. In particular, the arrangement of sclerites within its 'radial' oral cone expresses potential homologies with priapulids that may have originated in the last common ancestor of Ecdysozoa. We aim to use a new, exceptionally well-preserved individual along with previously described specimens to clarify the animal's oral anatomy and correct flaws in previous reconstructions. Detailed photography along with Reflectance Transformation Imaging (RTI) is used to bring out fine details from the low relief specimens and construct accurate diagrams to summarise the overall structure. Observations of the newest specimen present strong evidence that the arrangement of plates is less radial than previously interpreted, showing disparity in size, shape and placement of elements with particular variation anterior-posteriorly. This suggests a more derived oral cone than has been previously recognised, and yet ancestral characteristics are still identifiable from the arrangement of plates. As such, *Pambdelurion* may represent an evolutionary trend in gilled lobopods away from a radial mouth towards a more polarised, bilateral arrangement that so far has not been clearly understood.

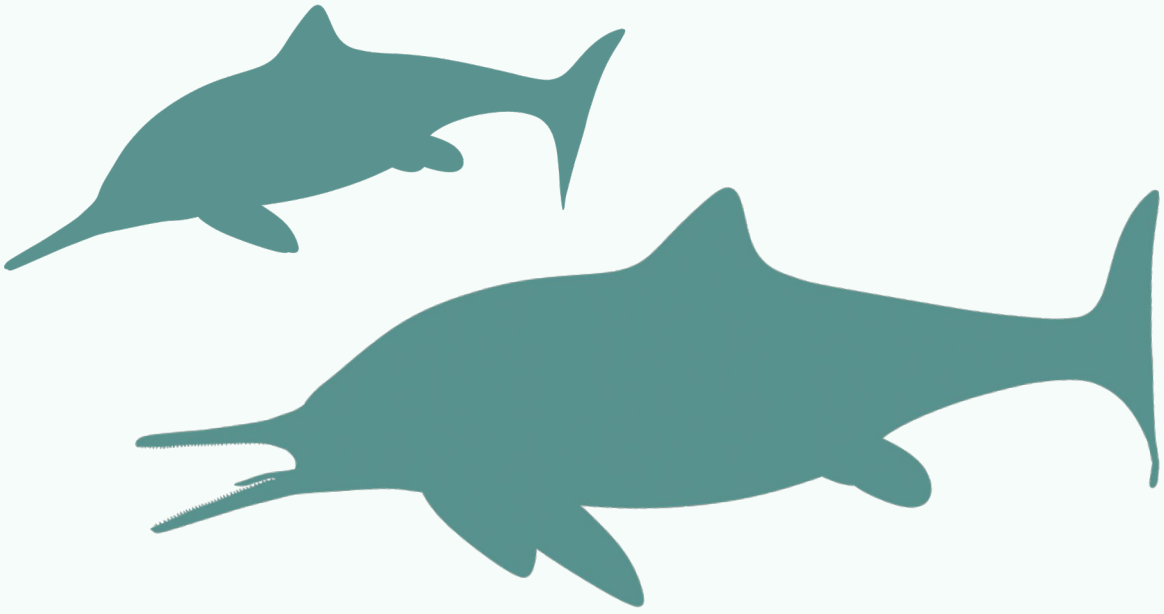


Lightning Talk:

A New Ichthyosaur Jawbone from the Jurassic of the Isle of Skye, Scotland

Alexandra McCombie[1], Steve Brusatte[1], Dugald Ross[2], Gert Greitens[3]
[1] University of Edinburgh, [2]Staffin Museum, [13]Dental Dirket, Germany

The Early-Middle Jurassic rocks of the Isle of Skye hold fossils of global importance due to their preservation during a time interval that is not only poorly sampled but is also crucial in the evolution of numerous groups of dinosaurs, mammals, and marine reptiles alike. Here we describe an ichthyosaur jawbone from the Dun Caan Member of the Bearreraig Formation in Skye. The fossil includes part of the dentary as well as 16 teeth, all of which were analysed via methods of x-ray computed tomography scanning (CT) and was then identified using both phylogenetic analysis and comparison against previous literature. This analysis suggested the jawbone most likely belonged to a neoichthyosaurian ichthyosaur. With the fossil being Toarcian in age, it provides insight into ecosystems at a time of both recovery from the end-Triassic mass extinction, but also a time of upheaval during the Toarcian Ocean Anoxic Event.

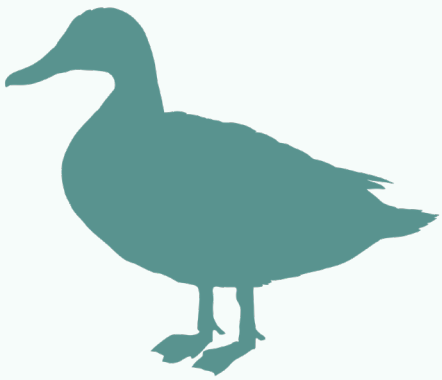


Lightning Talk:

Melanosomes in extant animals – Implications for the functional evolution of melanin in vertebrates

Aaron Quigley[1], Beatriz Carazo del Hoyo[1], Daniel Cirtina[1], Catherine McCarney[2], Jane Brennan[2], Maria McNamara[1]
[1] University College Cork, [2]University College Dublin

Melanosomes are melanin-rich organelles that, in extant vertebrates, are located in the integument, eyes and internal tissues. Although melanins underpin critical physiological functions, certain fundamental aspects of melanin biology in extant vertebrates remain poorly understood. Previous studies have reported tissue-specific melanosome geometries in a limited number of extant vertebrates and body tissues. Whether this existing dataset is representative of vertebrates more broadly is unclear. To test this and to better resolve taxonomic and tissue-specific trends, our new expanded dataset incorporates 18 additional taxa in which 11 tissue types were analysed (including three tissue types not previously studied). We generated pure melanin extracts from these tissues and analysed them using scanning electron microscopy. Preliminary results confirm that melanosomes in all vertebrate groups analysed show tissue-specific geometries, thus validating existing models. Intriguingly, birds and mammals show greater variation in the geometry of melanosomes from internal organs than reptiles and amphibians. This is consistent with the expanded range of melanosome geometries previously reported in avian and mammalian integumentary tissues and supports the hypothesis that melanosome geometry is fundamentally linked to metabolism. Characterisation of melanosome geometry across a broad phylogeny is essential to understanding the functional evolution of melanin through deep time.

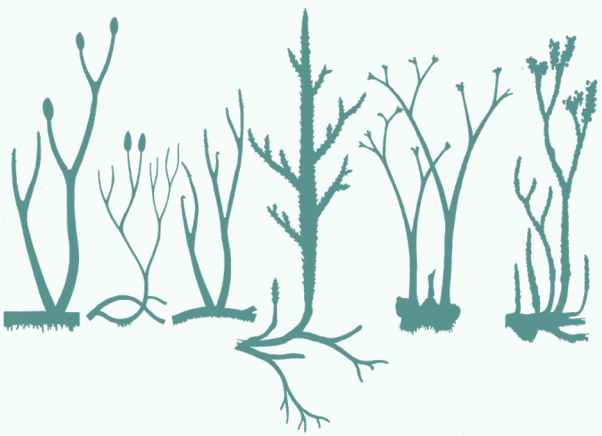


Lightning Talk:

Superresolution imaging of 'phloem-like' tissue of *Asteroxylon mackiei*, an early-diverging vascular plant from the Rhynie chert

Laura Cooper[1], Sandy Hetherington[1]
[1] University of Edinburgh

The Early Devonian Rhynie chert is a Lagerstätte preserving fossils of early land plants such as *Asteroxylon mackiei*, an early-diverging lycopsids. The Rhynie chert is renowned for exceptional cellular, three-dimensional preservation, including delicate plant tissues. By combining exceptional preservation and a taxonomic position at a crucial point in plant evolution, *A. mackiei* can provide insight into the origin and evolution of plant tissues. Phloem is the specialised sugar-conducting tissue of all extant vascular plants – including extant lycopsids. As the origin of phloem is associated with increased size and complexity of vascular plants, phloem can be considered a key innovation in plant evolution. Phloem is defined by the presence of sieve pores, which enable highly efficient movement of sugar between cells. Though *A. mackiei* possesses so-called 'phloem-like' tissue, the presence of small, subcellular sieve pores in this tissue has not been confirmed - in part due to the resolution limit of light microscopy. Airyscan Confocal Laser Scanning Microscopy (CLSM) is a superresolution form of microscopy, which allows structures to be observed at a resolution of 10-100 nm, far greater than that of light microscopy. This technique can therefore overcome previous limitations on detecting sieve pores in A. mackiei. I will demonstrate how Airyscan CLSM can be used to image the walls of the 'phloem-like' tissue of *A. mackiei* and determine whether sieve pores were present in this early lycopsid, with implications for the origin and evolution of phloem across all vascular plants.

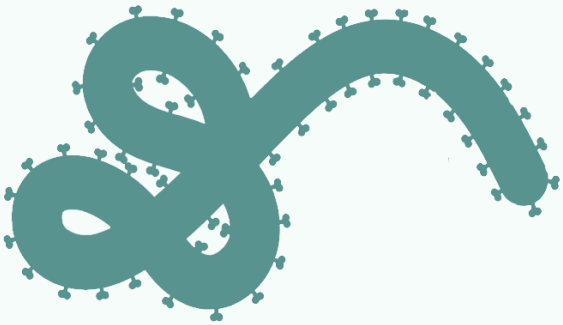


Lightning Talk:

Reconstructing Pleistocene filoviruses from endogenous viral elements

Alice de Sampaio Kalkuhl[1], Robert James Gifford[2]
[1] Smurfit Institute of Genetics, Trinity College Dublin, [1] MRC-University of Glasgow Centre for Virus Research

The genomes of eukaryotic species frequently contain vertically inherited, virus-derived DNA sequences called endogenous viral elements (EVEs). These EVEs likely arose in ancestral host species when virus-derived DNA was integrated into the nuclear genome of infected germline cells. While most of these EVEs have likely been lost due to genetic drift, some have become fixed and can provide insight into the ancient genomic diversity and evolutionary timeline of contemporary viruses. Most EVEs are thought to be neutrally evolving and their sequences degraded by mutation. However, where multiple orthologous copies are identified, ancestral sequences can be reconstructed that better represent the ancient "paleoviruses" from which EVEs are derived. Filoviruses (family Filoviridae) are RNA viruses that occasionally cause outbreaks of haemorrhagic fevers in humans and other mammals. Here, we used DIGS (database-integrated genome screening) to identify filovirus-derived EVEs in published mammalian genome sequences, and to discriminate between orthologous and paralogous EVE copies. We used these data to estimate the minimum ages of distinct filovirus lineages infecting bats, rodents and marsupials, and to derive ancestral sequence estimates for ancient filovirus genes. We show that while estimates based on contemporary sequences place the origin of extant filoviruses in the mid to late Holocene, EVEs demonstrate that they originated millions of years earlier. Our results allow calibration of the filovirus evolutionary timeline. In addition, we obtain an overview of ancient filovirus genome diversity, revealing that conserved motifs in filovirus genomes were present in ancient ancestors.



Abstracts

Session 2:

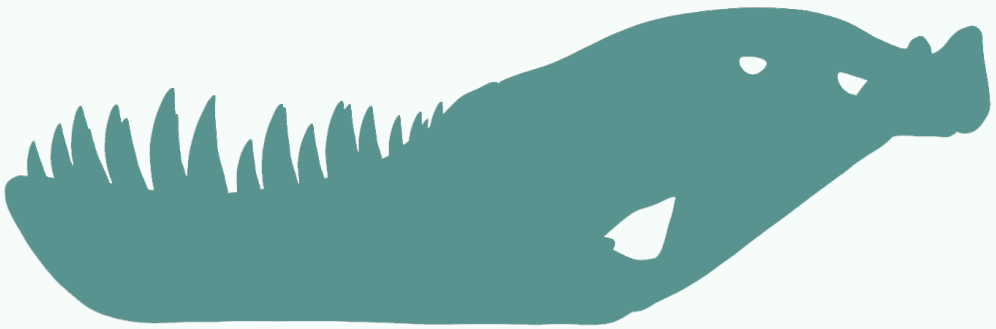
Anatomy and Functional Morphology

Full Talk:

Evolutionary patterns in the composition of the tetrapod lower jaw

Emily Watt[1,2], Ryan Felice[2], Anjali Goswami[1]
[1] Natural History Museum UK, [2] University College London

Tetrapods (limbed vertebrates) are a diverse clade that originated around 390Ma and are seen today in over 30,000 species of amphibians, reptiles and birds, and mammals. Tetrapods have exploited a broad range of ecological niches through this time, and the lower jaw, as the primary feeding mechanism, has undergone substantial morphological and functional evolution. For instance, the earliest tetrapods had up to twelve elements comprising their jaw, whereas mammals have only retained one element. We wanted to understand how the composition of lower jaw elements changed through Tetrapoda. We coded the presence or absence of lower jaw elements for over 1000 tetrapod species. We also coded the presence and absence of teeth on variably tooth-bearing elements, and other characters that could be tracked across the tetrapod tree such as the presence or absence of a beak or a mandibular fenestra. We combined the species level data into clade scores and reconstructed the evolution of the individual elements through ancestral state reconstruction. We found that there have been losses in elements in nearly every tetrapod clade, but also multiple gains across the tree. Tooth-bearing elements have unilaterally decreased, resulting in simpler dental compositions towards the extant tetrapods. Our results demonstrate that the lower jaw has undergone significant compositional evolution over the last 390 million years, towards an overall simplified mandibular composition seen across living tetrapods.

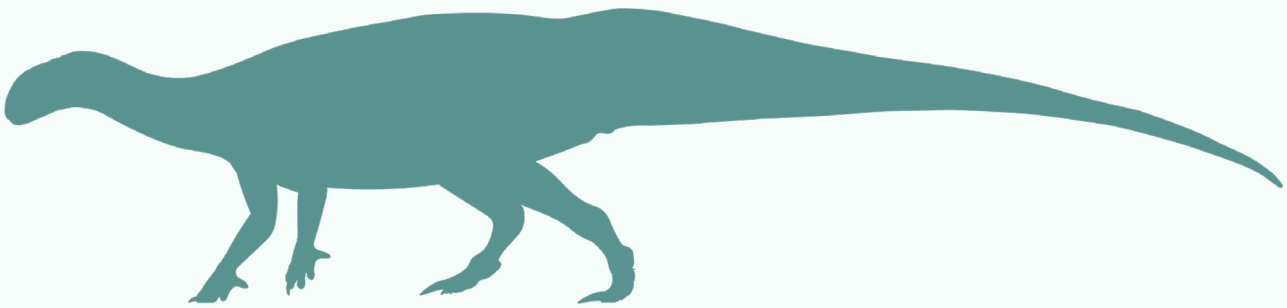


Full Talk:

The Conservation and Installation of a *Tenontosaurus* Skeleton at the Manchester Museum

Emily Gershman[1]
[1] Durham University

In 2004, a *Tenontosaurus* skeleton, known as April, was taken off display from the Manchester Museum after research indicated that it had been mounted inaccurately. 19 years of conservation and academic research has culminated in April finally being re-exhibited this past February. The primary aim for the conservation and redisplay of April was to present the skeleton honestly and accurately without the use of excess filler or replicas common in most dinosaur displays, and to ensure it remained accessible for future research. To achieve this goal, aged adhesive and filler were mechanically removed and any glossy varnish was cleaned from fossils using a laser. The fossils were repaired using an appropriate adhesive and small amounts of an epoxy putty where necessary. The long bones were strategically left broken as their cross sections have potential for future research. To mount the specimen, a custom frame was commissioned which could be manipulated to support each bone in an anatomically accurate position. Fishing line, in conjunction with various barrier materials, was then used to attach the fossilised bones to the frame. The result of this approach is less visually obtrusive when compared with traditional mounts, it allows for easy removal of bones for research, it enables more flexibility in the positioning of the bones to create a more anatomically accurate display, and it presents a unique opportunity to see the variable preservation levels in fossilized dinosaurs.



Full Talk:

The development of *Tachyglossus aculeatus*, the short-beaked echidna, and evolution of the mammalian jaw and middle ear

James Rawson[1] Neal Anthwal[2], Abigail Tucker[2], Emily Rayfield[1]
[1] University of Bristol, [2] King's College London

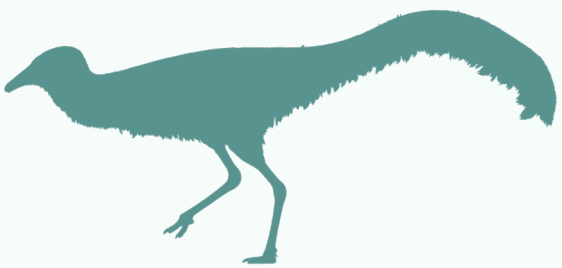
Developing extant mammals are key to understanding the evolution of the mammalian jaw joint and middle ear. Previous work has described developmental sequences in placentals and marsupials but the development of monotremes, which possess extremely altricial offspring and an independently evolved mammalian middle ear, has been comparatively understudied. Juvenile monotremes possess an additional jaw joint between the incus and petrosal creating an articulation similar, but not identical to, the double jaw joint in early mammaliaforms. The 3D morphology of this joint and its interactions with other anatomical structures remains unexplored. A comprehensive description of monotreme jaw and ear development is therefore vital to expand our knowledge of mammalian evolution. In this study we utilise computed tomography data and histological slices of the echidna *Tachyglossus aculeatus* to map development of the jaw and middle ear from hatchling to adult. We find that the malleus of the echidna temporarily abuts the skull providing extra support before the mammalian temporomandibular jaw joint has fully formed, a feature not described in any other mammal. We also observed postnatal attachment of jaw muscles to Meckel's cartilage, mimicking the condition seen in embryonic eutherians. During this time, the dentary is linked to Meckel's cartilage via a tight collagen connection, allowing the two structures to act as a single functional unit. These findings show that Tachyglossus possesses a mixture of plesiomorphic and derived features, firmly placing monotremes in a unique position in the story of mammalian jaw and middle ear evolution.

Lightning Talk:

Biomechanical assessment of digging forelimb function in the Late Cretaceous Alvarezsauroid *Mononykus*

Sidney Leedham[1], Zichuan Qin[1], Benjamin Griffin[1] , Antonio Ballell[1], Emily J. Rayfield[1]
[1] University of Bristol

Alvarezsauroids are an enigmatic group of maniraptoran theropod dinosaurs, notable for the dramatically reduced yet highly robust forelimb of derived taxa. These structures are commonly hypothesised to function in digging and foraging for insects, although few studies have tested alvarezsaur forelimb function with quantitative biomechanics. I present a computational range of motion (ROM) analysis – the first for an alvarezsauroid – of the shoulder and elbow joints of *Mononykus*, a Late Cretaceous alvarezsaur with highly derived forelimb morphology, with the aim of characterising function and assessing the mechanical viability of digging. Assessment of digging ability is also informed by a novel reconstruction of the forelimb musculature of *Mononykus*, and comparison of relevant muscle moment arm ratios to those of extant forelimb diggers. In light of these analyses, I discuss forelimb specialisation to certain motions or behaviours, and how different styles of digging are quantitatively supported. Preliminary observations suggest limited motion about the shoulder and elbow joints, but significant modification of bone morphology and musculature to enhance the mechanical efficacy of remaining possible movement, accomplished through increased moment arms for humeral retractors and elbow extensors. Quantitative musculoskeletal analyses and comparisons with putative extant functional analogues are crucial to support proposed palaeoecological functions of unique structures like the alvarezsauroid forelimb. The results of this study will inform interpretations of the niche of these bizarre dinosaurs, shed light on how reduction of the theropod forelimb may reflect ecological specialisation, and enable future comparison with the independently reduced forelimbs of other theropods.

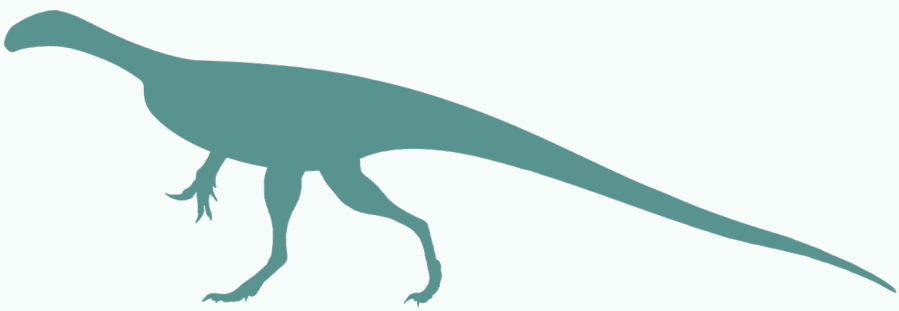


Lightning Talk:

Simulating forelimb function throughout the early evolution of Sauropodomorpha

Juned Zariwala[1], Antonio Ballell[1], Benjamin Griffin[1], Emily J. Rayfield[1]
[1] University of Bristol

Sauropodomorphs were a diverse group of dinosaurs that included small early bipeds as well as large quadrupeds like the huge sauropods, and many intermediate forms. Previous studies based on functional morphology have suggested that non-sauropodan sauropodomorphs included obligate bipeds, facultative quadrupeds and even graviportal quadrupeds, suggesting high variability in forelimb mechanics. However, the transition in forelimb function throughout the early evolution of Sauropodomorpha remains to be documented with quantitative biomechanical analysis. The aim of this study is to simulate the forelimb function in the context of the postural transition sauropodomorphs, using *Thecodontosaurus* - an early diverging Late Triassic species considered to be an agile biped as a key example. We present a reconstruction of the pectoral girdle and forelimb of *Thecodontosaurus* (YPM 2195), obtained from CT and surface scanning data, and compare it to the larger *Plateosaurus*, and the early ornithischian *Lesothosaurus*. The range of motion (ROM) of the shoulder and elbow joints were simulated using the APSE (Accelerated Pose Searching with Electrostatics) algorithm ROM mapping technology. Examination of the aforementioned species' articulation, and manipulation of scapulocoracoid, humerus, and antebrachium using previously published methods will help us gain a more nuanced understanding of their locomotor abilities. These analysis will also help us map out quantitative differences in the forelimb function of early small bipedal sauropodomorphs, and how its function shifted and evolved in later sauropodomorphs and sauropods to better facilitate weight support and locomotion.

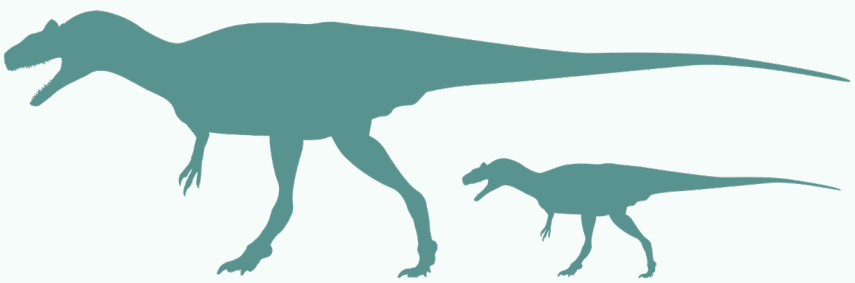


Lightning Talk:

Unveiling Late Jurassic Theropod Niche Partitioning and *Allosaurus* ontogeny using 3D Dental Microwear Textural Analysis

Dino Chak Hei Chu[1], Jordan Bestwick[1], Richard Butler[1]
[1] University of Birmingham

The Late Jurassic Morrison Formation contains some of the most renowned dinosaurs and an ecosystem with a disproportionately higher predator to prey ratio compared to past or present ecosystems. We selected the Cleveland-Lloyd Dinosaur Quarry (CLDQ) near Price, Utah, U.S.A for a time-calibrated Morrison ecosystem to test theropod niche partitioning and the vast quantity of immature *Allosaurus* specimens at CLDQ allows this project to investigate ontogenetic dietary shift in *Allosaurus*. We used 3D dental microwear textual analysis (3D DMTA) that offers a robust approach for testing Morrison Formation theropod dietary partitioning as it quantifies different dietary guilds based on diet rather than phylogeny. Microwear formation is determined by the material properties of consumed foods abrading against the enamel of the tooth. This method has been tested in both extant and extinct organisms including theropods to assess their dietary guilds. This project uses 3D DMTA to quantify differences between Morrison theropods - *Allosaurus fragilis*, *Ceratosaurus nasicornis*, and *Marshosaurus bicentesimus* diets and infer how carnivores of this unusual ecosystem co-existed. Our data demonstrated a statistically significant difference between *Marshosaurus* and *Allosaurus* dietary partitioning using 3D DMTA. For ontogenetic dietary changes in *Allosaurus*, our data shows a relatively strong correlation in increasing food hardness consumed by older *Allosaurus* than those of juvenile *Allosaurus*. We demonstrated that 3D DMTA managed to separate dietary guilds of contemporaneous theropods from a past ecosystem and could provide new insights into ontogenetic dietary changes in *Allosaurus*.

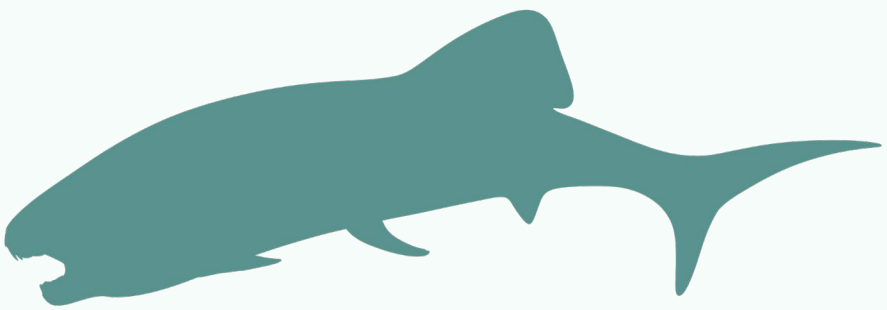


Lightning Talk:

Ontogenetic variation in function in the Arthrodire *Compagopiscus croucheri*

Sophie Pollard[1], Emily J. Rayfield[1], Antonio Ballell[1], Liz Martin-Silverstone[1],
[1] University of Bristol

Jaws are key to the success of the vertebrate lineage, with gnathostomes (or jawed vertebrates) making up over 99% of the ~58,000 vertebrate species alive today, making an understanding of jaws vital to the study of vertebrate evolution. Placoderms were the first vertebrate group to possess jaws and use them for active predation, although the functionality of this process is poorly understood. The placoderm arthrodire *Compagopiscus croucheri* is known from many three-dimensional specimens of varying size (denoting ontogenetic stage), with teeth which wear down into blade-like structures with age. This provides a unique opportunity to further understand ontogeny in placoderms. The project aims to characterise the relationship between ontogenetic stage and functionality within *C. croucheri*, which will be achieved through the use of SRXTM and micro-CT data, which will be used to generate 3D models for FEA analysis. Stress and strain metrics will be compared across jaws of varying sizes, allowing for inferences to be made regarding jaw strength across ontogenetic stage. It is anticipated that there will be a significant positive relationship between stress and strain metrics and size in *C. croucheri* jaws, denoting a negative allometric trend in jaw strength, as has already been observed in the species *Dunkleosteus terelli*, another arthrodire species. This will provide an improved understanding of ontogenetic characters in not only arthrodires, but placoderms as a whole, and will allow for knowledge of morphology, function, and phylogeny of placoderms to be better understood.



Abstracts

Session 3:

Environments and Taphonomy

Full Talk:

A 125-million-year-old mystery: what killed the *Hypsilophodon*? A sedimentological investigation into the genesis of the *Hypsilophodon* Bed (Wessex Formation, Isle of Wight)

Marie Marsden[1], Richard Butler[1], Susannah Maidment[2], James Wheeley[1], Gary Nichols[3]

[1] University of Birmingham, [2] Natural History Museum UK, [3]RPS Energy

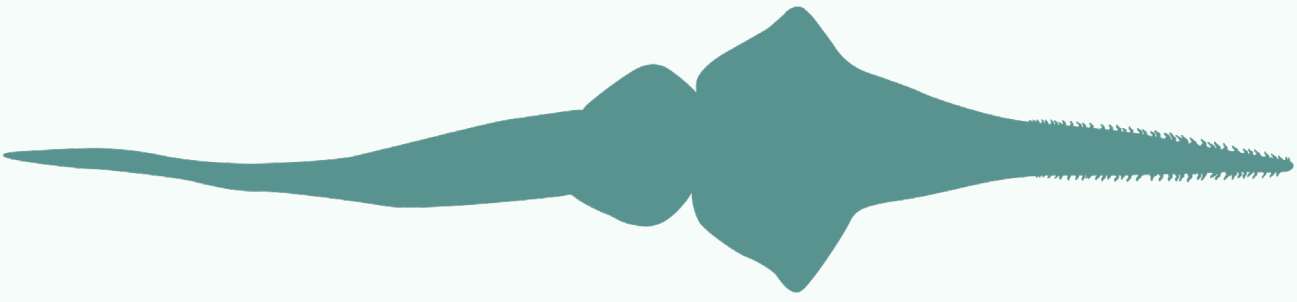
The Hypsilophodon Bed is a 3m-thick layer of mudstone and sandstone located in the uppermost Wessex Formation (Early Cretaceous, Barremian) of the Isle of Wight, England. Large numbers of skeletons from the small ornithischian dinosaur *Hypsilophodon* foxii have been recovered from the bed since the mid-19th century. Previous theories for the formation of the fossil assemblage have focused on mass death events involving either miring or flood-related mortality. However, no detailed sedimentological study has been conducted on the horizon and consequently its depositional environment is unclear. Additionally, there is a lack of information regarding the location of historic fossil finds, which combined with substantial coastal erosion and a scarcity of recent finds hinders our ability to evaluate different formation hypotheses. Here, we aim to investigate the genesis of the *Hypsilophodon* Bed through undertaking a comprehensive sedimentological study to constrain its depositional environment, with methods including sedimentary logging, drone imagery, petrographic and microfossil analysis. Furthermore, examination of fossil matrix of *Hypsilophodon* specimens in museum collections has been carried out to determine their location within the bed. Results reveal a river floodplain which became permanently waterlogged, forming muddy tidal flats as relative sea level rose prior to the formation of a lagoon which deposited the overlying Vectis Formation. *Hypsilophodon* fossils are both spatially and stratigraphically widely distributed and display varied levels of articulation, completeness, and preservation, suggesting the fossil assemblage did not form as the result of a single mass death event.

Full Talk:

A review of the Lebanese Lagerstätten with a focus on future research directions and scientific colonialism

Hady George[1,2] Pierre Abi Saad[3], Thomas Clements[4]
[1] University of Edinburgh, [2] University of Bristol, [3]Memory of Time,
[4]Friedrich-Alexander Universität Erlangen-Nürnberg

The fossils of the Cretaceous Lebanese Lagerstätten are well renowned for their exquisite soft tissue preservation and for providing vital information concerning the evolution of cephalopods, lobsters, hagfish, sharks, bony fish, marine reptiles, pterosaurs, and even birds. These fossils are also historically relevant as documentation of them extends back to not only the Crusades, but even the Roman Empire. Despite knowledge of the sites for thousands of years, a thorough understanding of the depositional environments, taphonomy, and palaeoecology is lacking. Here, we compile a review of the environments represented by the Lebanese Lagerstätten. Our synthesis highlights key taxa, the ecological roles various species might have played, as well as demonstrating the substantial differences in the environments represented by different localities. We suggest numerous methods ranging from electron microscopy to network analyses to further study the soft tissues, trophic interactions, and habitant preferences of the many fossil species. Additionally, we locate where holotypes from the Lagerstätten are accessioned, and find most holotypes of every major fossil group to be reposited outside of Lebanon. These results, in combination with a history of research largely led by academics based in Europe and the USA, allow the study and collection of fossils from the Lebanese Lagerstätten to be examined as an archetypal case of scientific colonialism. Interrogating the colonial history of palaeontology has gained traction in recent years, and the case presented here provides insight into the geopolitical and economic barriers needed to be overcome to achieve a more equitable global research community.



Lightning Talk:

Controlling factors on brachiopod distribution in upper Mississippian mud mounds in the Peak District, Derbyshire

Alessandro Paolo Carniti[1], Giovanna Della Porta[1], Vanessa J. Banks[2], Michael H. Stephenson[2,3], Lucia Angiolini[1]

[1] Università degli Studi di Milano. [2]British Geological Society, [3] Stephenson Geoscience Consulting Ltd

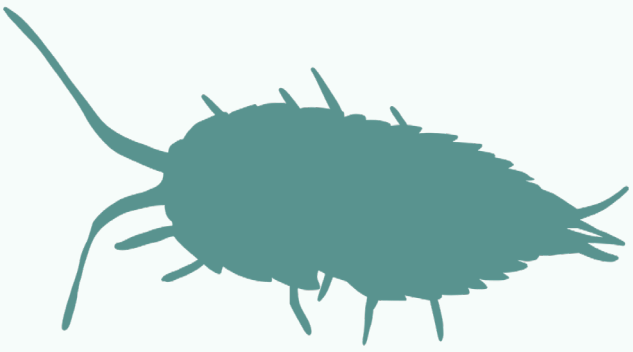
Mud mounds from the upper Visean (upper Mississippian) of the Derbyshire Carbonate Platform, outcropping in the Peak District of UK, host a brachiopod fauna traditionally thought to be mostly confined to dm-sized “pockets” scoured in the mud mound surface by storm currents. New outcrop investigation, lithofacies analysis and palaeontological studies on various mud mounds of the Peak District have shown conversely that brachiopods are a major skeletal constituent, alongside fenestellid bryozoans and calcite-replaced siliceous sponge spicules. The brachiopod fauna is rather diversified, with at least 45 species, representing 36 genera and seven orders. Lithofacies in the mud mounds show a diversity of carbonate muds: allomicrite of detrital origin including bioclastic debris and structureless leiolite and clotted peloidal mud (automicrite) derived from in-situ biologically-induced and influenced carbonate mud precipitation, related to the presence and activity of microbial mats and decaying sponge tissues. Substrate variety supported the rich diversity of the brachiopod fauna: soft substrates (detrital allomicrite) were colonised by seminfaunal productides, while firm (in situ precipitated automicrite) to restricted hard substrates (large brachiopod shells and fenestellid bryozoan fronds) were colonised by pedicle attached to ambitopic rhynchonellides, spiriferides, and terebratulides. The reconstructed food chain for the mud mound complex palaeocommunity is dominated by suspension feeders (brachiopods, bryozoans, siliceous sponges) sustained by particulate organic matter and microbial mats underneath the mud mound surface. The dominance of productides in terms of biovolume suggests that they efficiently exploited environmental resources. This may be indicative of a mesotrophic environment with scattered food resources.

Lightning Talk:

The experimental effects of wave processes on arthropod taphonomy: implications for Lagerstätten and small carbonaceous fossils

Laura Devine[1], Nicholas Minter[1]
[1] University of Portsmouth

Taphonomy is the study of the biological, chemical, and physical processes that lead to the remains of an organism becoming a fossil. These processes include decay, transport, and preservation; and it is important to understand them because they affect the preservation quality of certain organisms, as well as the fidelity of fossil assemblages as reflections of organismal communities. Actualistic experiments using analogue organisms provide some of the best ways to study these processes, but they have tended to focus on decay and preservation rather than transport. Arthropods are one of the most diverse and evolutionarily significant phyla of animals on Earth, and so it is important to determine if there are any biases in their fossil record. We conducted taphonomic experiments using a wave-generating flume tank to investigate the effects of the duration of exposure to waves on the decay and disarticulation of the marine arthropod, Ligia oceanica. We used *Ligia oceanica* as an analogue for segmented, multipodous marine arthropods, which are common as fossils through the Palaeozoic. Our results include identification of the stages of bodily damage and a statistical analysis of the effects of wave action compared to static decay for Ligia oceanica. Future work will expand to analogues for other arthropod groups found as fossils, together with comparison to fossil assemblages to identify the processes involved in the formation of an exceptionally preserved fossil "Konservat Lagerstätten" or the disarticulated and fragmented remains of small carbonaceous fossil (SCF) deposits.



Abstracts

Session 4:

Ecology and Extinction

PROGPAL

2023

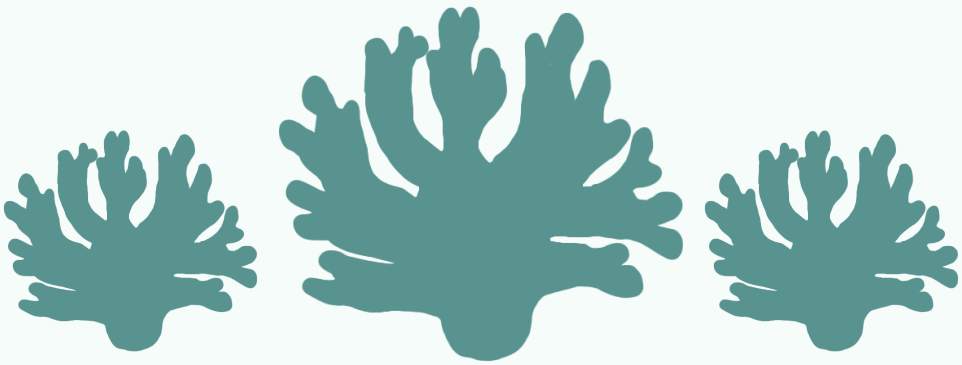
LIVERPOOL

Full Talk:

Deep time ecological niche modelling is sensitive to palaeogeographic reconstruction

Joseph Flannery Sutherland[1], Alex Farnsworth[1], Michael Benton[1]
[1] University of Bristol

Over the last decade, palaeobiologists have increasingly used ecological niche models (ENMs) to investigate clade distributions through geological time. ENM is a powerful tool for macroevolutionary hypothesis testing, for example the response of habitable area to environmental upheavals during mass extinction events, and within conservation palaeobiology to determine distributions of now endangered taxa in the recent past. ENM uses the relationship between a taxon's observed distribution and the environmental conditions across that distribution to quantify the breadth of its ecological niche, in palaeobiological cases by leveraging the wealth of data from deep time climate simulations. The impacts of climate simulation procedure, namely the choice of model and palaeogeographic boundary conditions, on deep time ENM are unexplored, however. We investigate the distributions of corals and sponges from the Late Permian to Early Jurassic, an interval characterised by dynamic succession of reefs built by these taxa, using ENMs constructed from several different suites of climate simulations. We find that trends in habitable area are strongly dependent on palaeogeographic reconstruction and highly discordant between different reconstructions. Consequently, the uncertainty introduced by palaeogeographic reconstruction choice may be a major limitation on our view of biogeographic patterns inferred using ENM.

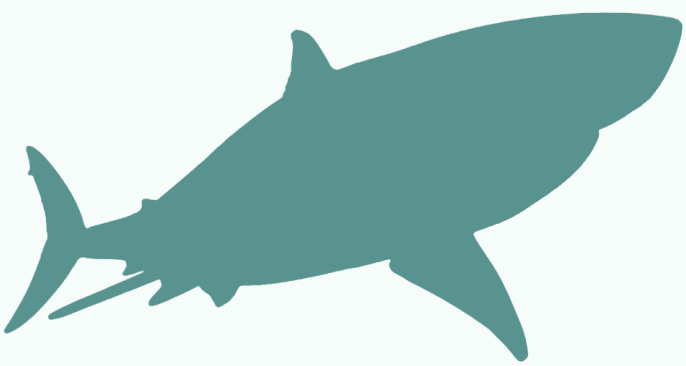


Full Talk:

Marine ecosystem structure changes following a Pliocene megafaunal extinction

Amy Elizabeth Shipley[1], Tracy Aze[1], Catalina Pimiento[2,3], Andrew P. Beckerman[4], Jennifer A. Dunne[5], Jack O. Shaw[5], Alexander M. Dunhill[1]
[1] University of Leeds, [2]University of Zurich, [3]Swansea University, [4]University of Sheffield, [5]Santa Fe Institute

The end of the Pliocene (~2.5 Mya) saw a period of biotic turnover in marine ecosystems with significant losses in marine megafauna (36% of genera globally) including the giant apex predator, *Otodus megalodon*. Hypothesised to have been driven by glaciation of the Northern Hemisphere and a subsequent drop in global sea level, a positive correlation has been found between extinction probability and those genera that had high energy requirements and were associated with coastal, shelf habitats. Megafauna, and particularly apex predators, are known to play important trophic roles in extant communities yet the ecological consequences of losing these large taxa from marine ecosystems is currently not well understood. Using a trait-based inference model, we reconstructed food webs to assess the impact of this Pliocene extinction event on North Atlantic trophic community structure and dynamics. Feeding links are distributed based on functional traits assigned to each genus (e.g., body size, position in the water column and feeding habit). Through analysing the differences in food web topology pre- and post- the megafaunal extinction event, we identify consistency in structure and connectedness between taxa within the webs. However, a decrease in vertical complexity post extinction and shifts in diversity within trophic levels indicate this turnover event saw some changes to marine ecosystem makeup. Further, we find the trophic position held by *O. megalodon* in the Pliocene is not present in the Pleistocene, suggesting this ecological role may have been lost.

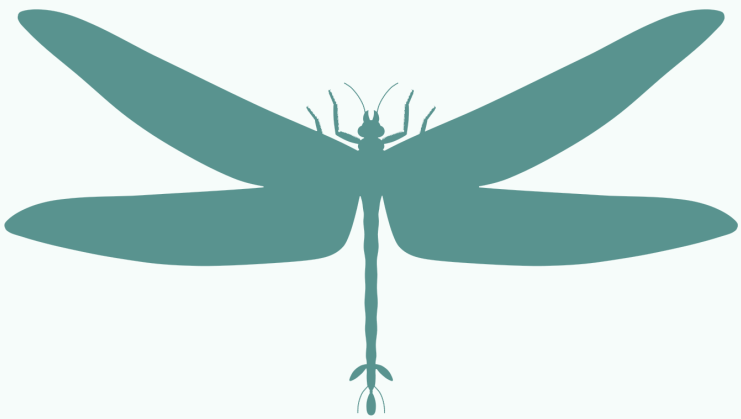


Lightning Talk:

Changes of insect colouration patterns throughout the late Palaeozoic and early Mesozoic and its implications for their ecology

Edward Field[1], Jakob Vinther[1], Erik Tihelka[1]
[1] University of Bristol

The colouration of an organism is primarily driven by its predators and is typically used to aid in predator avoidance. Insect colour patterns were different today than they were in the late Palaeozoic and Early Mesozoic. The most important modern insect predators are birds which were yet to evolve. In this study, we analyse fossil insect colour patterns and how this placed them in the context of their wider ecosystem. We will analyse these colour patterns using software called ImageJ and a plugin called the QCPA framework. The distribution of colour on the insect wings will be examined, and percentage coverage will be recorded. Using the QCPA framework, cone catch values of a modern Odonate visual system that have been modified to best simulate that of a prominent insect predator, *Meganeura*, will be used to analyse the colour patterns of representative insects from select time bins. This will determine whether the patterns are appropriate for fooling *Meganeura* visual systems or whether they would have been more effective against another predator. As atmospheric oxygen did not play a direct role in the decrease in insect body size from the carboniferous onwards, the observed decrease in their body size in the fossil record must have been driven by something else. Therefore, the decrease in the body size of these insects could be attributed to pressure created by the rise of winged Tetrapods in the early Triassic.



Lightning Talk:

The Impact of Warming on Large Benthic Foraminifera as Carbonate Producers and Ecosystem Engineers

Nikita Jane Rothwell[1], Danna Titelboim[1]
[1] University of Bristol

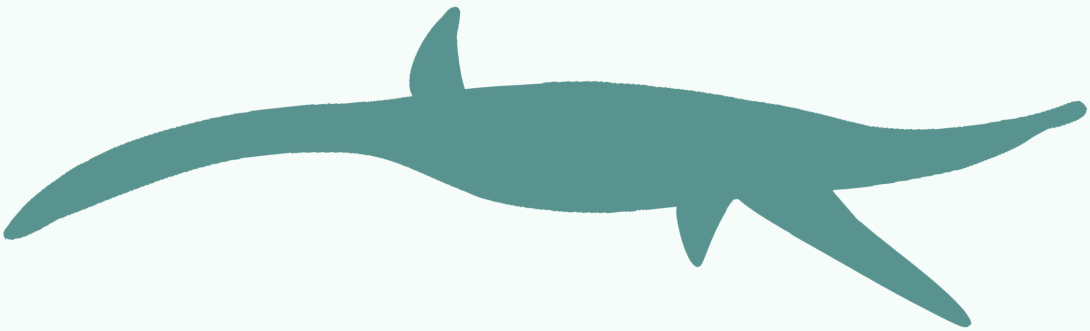
Calcifying creatures are fundamental to marine life, and are vulnerable to shifting environmental conditions, which can have a dramatic influence over oceanic ecosystems. Within these environments, Large Benthic Foraminifera are a focus of concern regarding the impact of climatic change on marine biotas, as abundant calcifiers, their future survival is paramount. Here, I explore impacts that continued ocean warming will have on the morphology, carbonate production and structural integrity of the genus *Amphistegina*, which is known to contribute considerably to the production of sediment in many ocean habitats. I use a thermally polluted, natural setting within the Eastern Mediterranean Sea, to demonstrate the potential consequences of increasing ocean temperatures. Quantitative comparisons have been made between specimens collected across a 15-month interval to compare the morphology of *Amphistegina lobifera* specimens between control and thermally polluted sites. This analysis shows that even a slight temperature increase can have significant detrimental effects, with warming leading to an overall decrease in foraminifera shell size and carbonate production. This is a troubling indicator for the many tropical ecosystems which depend on shell matter for stability, as well as habitat construction. The impact of these changes on the species resilience to stress has also been considered, using finite element modelling to simulate wave forces under current and potential future ocean conditions. These models suggest that despite a reduction in the volume of calcite produced, thermally stressed foraminifera may be better adapted to endure both current conditions as well as enhanced stress levels in the future.

Full Talk:

The K-Pg Mass Extinction did not affect Marine Trophic Structure

Lydia Woods[1], Alexander M. Dunhill[1], Maria Beger[1], Chris Hassall[1]
[1] University of Leeds

The K-Pg mass extinction occurred around 66 Ma and removed roughly 75 % of global species. The timing, rate, and magnitude of taxonomic loss across the K-Pg extinction have been well-documented over the years. However, the effect of the K-Pg on the interactions within ecosystems and effects on community structure remain largely unexplored. In addition, the K-Pg extinction has previously been put forward as a possible origin for modern ecosystem structure, yet this idea remains untested. Our study used trophic network reconstruction to investigate the community-level effects of the K-Pg mass extinction on the fossilised marine community at Seymour Island, Antarctica. We used a fossil data set and a trait-based inference model to reconstruct four food webs, across the K-Pg boundary, with time intervals spanning from the Campanian (80 Ma) to the Eocene (56 Ma). We found despite undergoing a huge loss of diversity, the Seymour Island trophic community experienced no change in structural properties across the K-Pg boundary, from neither the Chicxulub bolide impact nor the onset of the main phase of the Deccan Traps Large Igneous Province Region. Overall, considering the Cenozoic trophic networks share roughly identical structural characteristics with the Late Cretaceous communities, we can rule out the K-Pg as being the event from which modern marine ecosystem structure originated, and we begin to fill in the gaps in contemporary knowledge regarding the structure of marine communities across deep time.



Full Talk:

Geological constraint on the plankton adaptive plasticity to future global warming

Rui Ying[1], Daniela Schmidt[1], Fanny Monteiro[1]
[1] University of Bristol

Global oceans are warming at unprecedented rate and imposing selective pressure to marine plankton. However, the exact range of adaptable warming rate is unknown, and it hinders us to evaluate the possibility of plankton adaptation. Here we explore the adaptive capacity based on existing planktic foraminifera fossil records and sea surface temperature (SST) in the Last Glacial Maximum (LGM, 21 thousands of years before present, or 21 ka) and the late Holocene (0-5 ka). We find foraminifera have significantly increased their thermal maximum, minimum and optimum by averagely 3.1, 2.9, and 3.7 °C. This suggests the averaged glacial-interglacial SST change at 0.2°C ka–1 is suitable for plankton adaptation. To quantify the upper limit of adaptive phenotypic plasticity, we analyzed the foraminifera time series data in the North Atlantic. The extirpation occurred at the mean SST change of -0.57 °C ka–1 and in species with < 3% relative abundance. This implies the upper limits of adaptable environmental change at 0.57 °C ka–1 with a greater risk of rare taxa which contribute enormously to the modern marine species richness. Our results provide the first quantification of baseline and upper limit of adaptable warming rate. Current warming rate already exceeds the upper limits of adaptive phenotypic plasticity, and the extirpation rate should at least double the background level. A projected future lower primary productivity will further jeopardize the rare marine species pool.

Poster Abstracts

Unravelling diversification patterns in Anseriformes

Darcy Adhami[1,2], Eloise Hunt[1,2], Christopher D. Dean[3], Philip D. Mannion[3], Anjali Goswami[1]
[1] Natural History Museum UK, [2]Imperial College London, [3]University College London,

Anseriformes is an order of birds with over 160 species of extant waterfowl (ducks, geese, and the screamers) as well as many fossil groups with a global distribution. It has previously been hypothesised through phylogenomic analyses that Anseriformes diversified in the Plio-Pleistocene. Raw fossil data appears to contradict this hypothesis, but this could be an artefact of sampling biases in the fossil record. Here we use Shareholder Quorum Subsampling to show that major diversification occurred some 15 million years earlier than genetic estimates: during the Oligocene, with connections to eustatic sea level. This suggests a possible environmental factor which may affect modern Anseriformes in changing climates, highlighting the need to include both fossil data and extant taxa in estimates of diversity.

The Coevolution of Facial Keratin and Tooth Distribution in Dinosaurs

Isaura Aguilar Pedrayes[1], Jacob D. Gardner[2], Chris L. Organ[2]
[1] Montana State University, [2]University of Reading

Teeth evolved early in vertebrate evolution, and their morphology reflects important specializations in diet and ecology among species. The toothless jaws (edentulism) in extant birds likely evolved dependently with beak keratin, which functionally replaced teeth. However, extinct dinosaurs lost teeth multiple times independently and exhibited great variation in toothrow distribution and beak-like keratin structures. To test hypotheses about the coevolution of facial keratin and edentulism, a wide comparative framework is needed to account for this variation. We use facial jawbone surface texture as a proxy for facial keratin covering and generalized phylogenetic models to test for the effect of evolving facial keratin on toothrow distribution in dinosaurs. We find that the evolution of keratin cover explains partial toothrow reduction but not edentulism. Toothrow reduction only precedes the evolution of keratin cover in theropods. Non-theropod dinosaurs evolved continuous toothrows despite the presence of keratin cover. We also show that keratin cover does not significantly increase the evolutionary rate of tooth loss, which further obscures the antagonistic relationship between both structures. Our study suggests that facial keratin evolution had a limited effect on tooth growth suppression. Further and complete tooth loss may have been facilitated by other independent changes in jaw development and the inactivation of tooth-related genes. Moreover, the evolution of strong chemical digestion, a gizzard, and a dietary shift to omnivory or herbivory alleviated the selective pressure for tooth growth.

Posters

Comparative morphology of the avian mandible: Implications for the fossil record of early crown birds

Abigail Crane[1,2], Juan Benito[2], Albert Chen[2], Daniel T. Ksepka[3], Daniel J. Field[2]
[1] University of Southampton, [2]University of Cambridge , [3]Bruce Museum

The detailed morphology and configuration of the lower jaw bones is among the least understood aspects of avian anatomy due to a high level of fusion among these bones in adult birds. *Asteriornis maastrichtensis* is one of the earliest well-supported crown birds, known from a three-dimensionally preserved skull, which provides substantial insight into the early cranial anatomy of the crown bird group. The phylogenetic position of *Asteriornis* is contested, having been thus far proposed as either a member of total-clade Galloanserae (the water and landfowl) or stem-group Palaeognathae (the ratites and tinamous). Despite the pivotal importance of *Asteriornis* for understanding avian cranial evolution, the anatomy of its mandible has yet to be assessed in detail. Here we present a detailed characterisation of the morphology of the mandible of Asteriornis, as well as representatives of several major crown bird lineages and key near-crown Mesozoic stem-birds, using high-resolution µCT-scans. Our results support the diagnosis of *Asteriornis* as a crown bird and illustrate that the lower jaw of *Asteriornis* shows several features characteristic of crown Galloanserae. Although the mandible of Asteriornis appears to exhibit a few features typical of extant anseriforms ('duck-like birds'), the morphology overall is considerably more similar to that of extant galliforms ('chicken-like birds'). Features shared with galliforms most notably include an asymmetrically forked dentary with a significantly shortened dorsal ramus. This work provides further evidence of a total-clade galloanseran affinity for *Asteriornis* and yields unprecedented insight into the jaw morphology of the earliest crown birds.

Characterisation of melanin-based colour expression and melanosome characteristics across the avian phylogeny

Hollie Bean[1], Daniel Field[2], Maria McNamara[1]
[1] University College Cork, [2]University of Cambridge,

Melanin pigments, synthesised and stored in organelles termed melanosomes, contribute to the expression of black, brown, grey and rufous colours in feathers and play an important role in visual communication. Fossil feathers preserving melanosomes can therefore potentially inform on fossil behaviour, but current models for predicting the colour of fossil feathers yield low accuracies of <60%. In this study we aim to improve these models with an approach that includes data from melanosome geometry and chemistry. We sampled feathers that express melanin-based colouration from 112 birds that represent all 44 extant avian orders. We used reflectance spectrophotometry to characterise feather colour quantitatively and multivariate statistics to compare the spectral data for feathers with different colours. Our data shows that spectrally derived colour parameters such as brightness and saturation do not fully differentiate visual reflectance spectra of feathers with different melanin-based colours. Future analyses will use scanning electron microscopy (SEM) to characterise the geometry of feather melanosomes. Integration of this data with chemical data (alkaline hydrogen peroxide oxidation (AHPO) and synchrotron x-ray fluorescence (synchrotron-XRF)), plus a fuller understanding of feather taphonomy, will provide a new opportunity to revise existing predictive models of fossil feather colour.

Taxonomy and phylogeny of Scottish 'cephalaspids' and the evolution of paired fins

Amin El Fassi El Fehri[1]
[1] University of Bristol

Osteostracans are a group of jawless fishes from the Devonian period, and are the first group of vertebrates to show paired fins with endoskeletal support. Many fossil osteostracans from the Old Red Sandstone of Scotland were assigned to the genus *Cephalaspis* at the time of their description. Recent re-analyses of such specimens have revealed significant morphological disparity, which is not reflected in their taxonomy. Many *Cephalaspis* species have subsequently been re-assigned to other existing or newly named genera. We aim to further explore the variation within Scottish 'cephalaspids' to inform phylogenetic analyses. We will collect morphological data from high resolution photography and microscopy. This data will be analysed using principal component analysis. We expect to find distinct clusters of specimens, indicating morphological disparity. Where appropriate, these will be re-assigned to potentially new species or genera. We will then add these taxa to the most recent phylogenetic dataset of Osteostraci, and perform parsimony and Bayesian analyses. The latter has never been attempted before on this group. Using our new phylogenetic trees, we will then conduct ancestral state reconstruction of paired fin characters. Our goal is to explore the evolutionary history of paired fins by testing a modern hypothesis based on the classical 'lateral fin fold theory'. It proposes paired lateral fins evolved from a single ventrolateral fin fold, which is genetically homologous to median fins. Preliminary results show significant morphological variation, suggesting multiple distinct taxa, indicating Scottish jawless vertebrates were more diverse than has previously been appreciated.

A new palaeoscolecid from the Sirius Passet Lagerstätte (Cambrian Series 2, Stage 3)

Thomas Farrell[1], Morten Lunde Nielsen[1], Luke A. Parry[2], Tae-Yoon S. Park[3,4], Jakob Vinther[1]
[1] University of Bristol, [2] University College London, [3]Korea Polar Research Institute, [4]University of Science and Technology, Republic of Korea

Palaeoscolecids are extinct, armoured worms whose affinity within Ecdysozoa remains under debate. They have a spiny introvert, an eversible, toothed pharynx, and a slender, annulated trunk bearing characteristic phosphatic sclerites. Here, we present a new palaeoscolecid from the Sirius Passet Lagerstätte of North Greenland (Cambrian Series 2, Stage 3, c. 518 Mya). It differs significantly from previously described palaeoscolecids in this locality in its high length-to-width ratio, double paired posterior hooks, and more lightly armed introvert, resembling more closely the palaeoscolecids from the contemporaneous Chengjiang Biota. The ventral nerve cord is preserved in several specimens and may be present more widely among palaeoscolecids from Sirius Passet.

Synapsid communities in the Southwestern United States after the Carboniferous Rainforest Collapse (CRC)

Rei Fujita[1], Suresh Singh[1], Michael Benton[1]
[1] University of Bristol

In the late Carboniferous, the widespread coal forests of equatorial Central and West Pangaea almost completely disappeared as the climate experienced tremendous changes from wet and tropical to seasonally dry conditions, termed the Carboniferous Rainforest Collapse (CRC). While general trends in tetrapod diversity through this crisis interval are known, specifically the diversification of amniotes and dry-adapted temnospondyls and reptiliomorphs, it is not clear how ecology and individual communities were affected. We aim to answer questions of potential trophic relationships and niche specialization among synapsids as tetrapod ecosystems shifted further onto the land. We investigate the state of synapsids after the CRC, focusing on the Halgaito and El Cobre Canyon formations of Utah and New Mexico. These formations are dated to similar timespans in the late Paleozoic, with the Carboniferous-Permian transition having occurred during their deposition. Using published literature, we record the synapsid taxa from these locations and source lateral images of their skulls. A geometric morphometric approach using two-dimensional landmark analysis of intact tooth shape reveals the dental disparity of synapsids, as well as their potential dietary diversity and feeding behaviours through functional ratios and traits. With these inferences, we propose food webs to enable the comparison of conditions before and after the CRC, especially noting the role of synapsids soon after the crisis.

Investigation into Geochemical Properties and Possible Melanin Presence in Diplodocus Skin, With Possible Physiological Implications

Tess Gallagher[1], Jakob Vinther[1], Jason Schein[2], Glenn Storrs[3], Sarah Fearn[4]
[1] University of Bristol, [2] Elevation Science, [3]Cincinnati Museum Center, [4]Imoperial College London

Fossilized dinosaur skin is incredibly rare, but can give a rare glimpse into the physical appearance, physiology, and behavior of these extinct animals. Integument fossils can vary in the mode of preservation, usually being preserved either as an impression or organically preserved 3-dimensionally. Integumentary fossils of Diplodocus sp. from the Mother's Day quarry are preserved as the latter, exhibiting 3-dimensionality and appearing black in colour. The fossils are most likely preserved as a carbonaceous mold, but may also preserve traces of melanin. These specimens are unique as they appear to show a new type of scale morphology, as some of the polygonal scales are porous and exhibit elongate struts which protrude deeper into the matrix rather than being a carbonaceous film on the surface of the rock. In order to investigate the taphonomy of these scales, time-of-flight secondary ion mass spectrometry (TOF SIMS) is utilized to look for chemical signals of melanin, and a scanning electron microscope (SEM) to search for the presence of melanosomes and potentially melanosome shape to identify colour. Micro computed tomography scanning (micro CT) will also be utilized in order to create a 3D model of the porous structures within the scales. Considering the possibility that these pores did not form through taphonomic means and were present in life on Diplodocus, they most likely would have acted as a 'heat sink'. The pores would have shed excess heat from the body by increasing surface area and allowing for natural convection.

Back to the Sea II: Evolution of Ecospace Occupancy in Cenozoic Marine Tetrapods

Piero Giuffra[1] Mike Benton[1], Thomas Stubbs[1]
[1] University of Bristol

Over the last 250 million years, a variety of ancestrally terrestrial tetrapods has transitioned into the marine realm. By overcoming the difficulties that come with shifting to a subaqueous medium, they have radiated into a disparate spectrum of morphological ecospaces associated with distinct feeding strategies, innovative swimming modes and unique physiological adaptations. In this work, we map and quantify the evolution of the functional morphospace distribution of secondarily aquatic tetrapods (SATs) during the Cenozoic using Principal Coordinate Analyses (PCOa). Based on a discrete character matrix, we study the impact of the K/Pg extinction event on the span of form and function in tetrapod-dominated oceanic ecosystems, measure how ecological diversity changes over time and evaluate ecospace changes in the light of both intrinsic and extrinsic factors. The principal coordinate analysis reflects the radiation and extinctions of taxa and the major climatic events at the terminal Eocene, as well as peak disparity during the Miocene. Beyond the occurrences of incomplete evolutionary convergence and generally widespread carnivory, we also identify major divergences in the trophic spectrum, morphological constraints and rates and modes of evolution in Cenozoic taxa with respect to previous work done on Mesozoic SATs. Our results also allow us to compare past diversity to the modern ocean ecosystems and help us to better understand the relation between morphology and ecosystem services.

Evidence of a dynamic coal swamp locked in ancient lycopods from Brymbo, Wrexham

Tom Hughes[1,2]
[1] Bangor University, [1] Brymbo Heritage Trust

The relatively newly discovered Brymbo fossil forest is internationally important for its well preserved, in-situ, growth position Carboniferous plant fossils. This PhD research has aimed to unlock more palaeoecological information from the rocks and fossils of Brymbo by studying their geochemistry. Stable isotope analysis has allowed us to understand more about the ecology of these plants and how they were so well preserved. Carbon isotope ratios measured from the Brymbo plant fossils allowed the calculation of their water use efficiencies and has raised questions about how the lycophytes differed from the other contemporaneous carboniferous plant groups.

How did the origin of herbivory in tetrapods expand terrestrial food webs?

Natanel Jimenez[1], Mike Benton[1], Suresh Singh[1], Arjun Mann[2],
[1] University of Bristol, [2] National Museum of Natural History, Smithsonian Institution

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

Constraints on Hopping in the Hindlimb of Giant Kangaroos

Megan Jones[1], Robert Nudds[1], Katrina Jones[1]
[1] University of Manchester

In the Pleistocene, giant kangaroos reached masses of over 200 kg, much greater than the largest individuals seen today, which reach 90 kg at most. How did such large species move? Were they capable of the hopping gait seen in extant kangaroos, or would their size have rendered it impossible? Here, we investigate three potential factors which may have limited the ability of these animals to hop. First, we look at the strength of the hindlimb bones, to determine whether they would have been likely to risk fracture under forces associated with hopping. Next, we investigate the allometric scaling of the ankle extensor muscles, and whether they would have been capable of producing the forces required to resist ground reaction forces while hopping. Finally, we calculate the minimum size of the ankle extensor tendons required to withstand hopping, and compare this to the available insertion area on the calcanea of two giant extinct kangaroo species. We find that, while bone strength and muscle force are unlikely to have limited the ability of these animals to hop, tendon size is far more likely to have been a limiting factor. This finding uses the measured dimensions of tendon insertion areas to validate the assumptions of prior attempts to calculate the upper size limit of hopping, which have focused on identifying the point at which the ankle extensor tendons would risk rupture. This study demonstrates the importance of multiple lines of investigation when attempting to predict the locomotor constraints of an extinct species.

Posters

Can minimal sets of broadly sampled loci produce stable megaphylogenies in birds?

Morgan Jones[1], Davide Pisani[1]
[1] University of Bristol

Larger phylogenies have the potential to help us understand complex evolutionary relationships across a broader spectrum of taxa. In recent years with the vast accumulation of molecular data stored in databases such as NCBI GenBank, these megaphylogenies have become popular; but the phylogenies we produce are only as good as the data and methods we use to create them. For larger sets of taxa, the data matrices can become concerningly sparse due to the unequal sampling range of the loci used. In this study, we aim to determine if using only the highly sampled regions, often associated with DNA barcodes, we are able to produce stable and resolved megaphylogenies for extant birds. Gene trees are created using IQ-Tree2 for COI, CytB, and ND2 regions of the mitochondrial genome and we assess their utility for resolving taxonomic groups when compared to the avian genomic tree from Prum et al. 2015. We then investigate the differences between the supermatrix and supertree approaches to phylogenetic reconstruction when combining the loci, and assess the utility of each method based on taxonomic congruence with the genomic tree. We hypothesise that through using these broadly sampled regions, with less missing data between taxa, that the phylogeny will converge to a topology with reasonable branch support values despite the maximised taxa set. Furthermore, we will look at how genomic trees could be used as backbones of families, which can then be populated with all available taxa to produce useful megaphylogenies.

Morphological plasticity responses and resilience of shelf-dwelling benthic foraminifera across the K-Pg boundary

Adam Shatwell[1], Daniela Schmidt[1], James Witts[1], Rui Ying[1]
[1] University of Bristol

Intragenerational plastic responses to environmental stimuli may be vital for species with short generation times – such as benthic foraminifera - to rapidly adapt within and survive through abrupt earth system changes. One such example is the aftermath of the Chixculub bolide strike at the K-Pg boundary, with geologically abrupt (<1kyr) impact-induced environmental perturbations followed by prolonged (≈10Ma) recovery of ecosystem structure, biogeochemical cycling and diversity. With <15% extinction rates, benthic foraminifera are well-suited for K-Pg plasticity analyses; however, previous examples have focused exclusively on at-shallowest bathyal deposits with limited temporal resolution. In this study, we used automated microscopy and µ-CT scanning to quantify benthic foraminiferal morphological variation - size, chamber number, surface area: volume ratio and proloculus volume - within boundary-spanning continental shelf deposits, most prominently that of Lenticulina-Robulus at Brazos River (Texas). Results were compared with local to global environmental proxy data to assess the relative contribution of potential drivers to certain responses. Brazos Lenticulina-Robulus displayed a ≈80% end-Cretaceous abundance decline by 40kyr post-impact, coinciding with a diameter range constriction from 150 – 2000µm down to 200 - 500µm. Alongside the loss of rare 'giants', the vacancy of the smallest size fractions - the most populous pre-impact - resulted in a statistically significant cross-boundary rise in median size. These suggest a reduced population carrying capacity alongside major pressures favouring intermediate size acquisition during individual development, adding to our understanding of earth system impacts during this mass extinction as well as calcifier response capacity and resilience across various seafloor settings.

Population dynamics of North Atlantic coccolithophores over the past 200 ka

Matthew Sutton[1], Tracy Aze[2], Erin Saupe[1]
[1] University of Oxford, [2] University of Leeds

Pleistocene glacial-interglacial cycles are associated with major changes in global climate, biological communities, and ocean biogeochemistry. Marine phytoplankton are the major primary producers in oceanic ecosystems and exert control on pelagic communities through bottom-up trophic processes, as well as strongly influencing the strength of the organic carbon pump. In this study we aim to quantify changes in the abundance and demographics of coccolithophores, the major eukaryotic phytoplankton in the open ocean, by analysis of coccolith assemblage data. Using the automated neural network software SYRACO, and vetted with traditional microscopy, we quantified the accumulation rates and taxonomic composition of assemblages from two North Atlantic sediment cores over the last 200 ka. Our samples derive from subpolar ODP 982B and subtropical IODP U1313A and have an average temporal resolution of 5 ka. The assemblage is dominated by Florisphaera profunda and the reticulofenestrid coccoliths (Family Noelaerhabdaceae). Fluctuations in the relative abundance of these two taxa are interpreted as shifts between local oligotrophic and eutrophic states. We resolve significant changes in the accumulation rate of calcareous nannofossils between glacial and interglacial times in the higher latitude core, but not at lower latitudes, suggesting non-uniform controls on North Atlantic coccolithophore productivity over glacial-interglacial cycles.

Morphometric study of the forelimb and femur of *Ictitherium ebu* (Mammalia: Hyaenidae) from the late Miocene of Lothagam, Turkana Basin, Kenya

Julien van der Hoek[1], Lars Werdelin[2]
[1] University of Manchester , [2] Swedish Museum of Natural History

Hyaenidae have been well-studied due to their role as bone collectors and their common occurrence in Miocene–Pleistocene sites in Europe. Therefore, in Europe their evolutionary pattern is quite clear. However, in Late Miocene Africa this pattern is less well known. The nearly complete skeleton of *Ictitherium ebu* from the fossil site of Lothagam (Kenya) can help us improve our knowledge of the ecology of one of these hyaenids. It has been suggested that the long, slender limb bones of *I. ebu* were an adaptation for cursoriality, although this hypothesis has never been tested. The forearm and femur of I. ebu were compared to four extant Hyaenidae and five extant Canidae. To compare the different species, indices were calculated through linear measurements of morphological characters. Landmarks were marked on the anterior distal epiphysis of the humerus, which forms part of the elbow joint. By calculating distances between landmarks, a truss shape was created to represent the joint. I. ebu has on overall morphology similar to the maned wolf (*Chrysocyon brachyurus*, Canidae) and a truss that resembles the aardwolf (*Proteles cristatus*, Hyaenidae). Multivariate statistics mainly separated the data by species, yet family, locomotor and habitat categories were analysed as well. The limb bones of I. ebu were found to mainly group with less cursorial species. They are likely adapted for similar purposes as the maned wolf: energetic efficiency, pouncing hunting behavior and peering over tall grass.

Do Optimal Forms Exist in Bird Wings: Using Theoretical Morphospace to Examine Optimality in Wing Evolution

Benton Walters[1]
[1] University of Bristol

Morphological study of bird wings has often been implemented to analyse how wing shape varies for particular flight styles and adaptational niches within observed taxa. Theoretical morphospace analysis provides a useful companion to traditional analyses, by decoupling shape space from empirical taxa and generating a landscape of hypothetical shapes which encompass all possible variation in form, occupied or otherwise. This is particularly helpful as theoretical planforms allow for a examination of wing shapes beyond those of observed in nature and even impossible wings denoting the limits of what shapes can exist. By mapping aerodynamic traits of aspect ratio and second moment of area onto the theoretical morphospace, my study takes advantage of these qualities to examine the relationship of observed bird wings to optimal peaks in theoretical space. Using a classic dataset of extant birds, I demonstrate that optimal areas within the morphospace are unoccupied by the wing shapes realised by evolution, and that bird wing shapes generally occupy low to middling positions. This supports an understanding that aerodynamic properties are not primary drivers of variation in bird wing shape, and suggests that the majority of volant birds exist on an 'adaptive plateau' that represents a minimum threshold which birds must overcome in order to become volant. This analysis lays the groundwork for a larger, deep-time comparative study of wing shape across all volant vertebrate groups, examining convergence in morphospace occupation and whether the mechanical trade-offs affect vertebrate lineages differently.

Deciphering Desmoceratoidea turnover rates during Cenomanian-Turonian Ocean Anoxic Event 2 using a Bayesian phylogenetic approach

Kaylee Walty[1]
[1] Bowling Green State University

The Cenomanian-Turonian (C-T) boundary of the Late Cretaceous, around 93.9 million years ago, was a time of environmental perturbation, particularly in marine ecosystems. Ocean Anoxic Event 2 (OAE2) spanned this interval, lasting between 440,000-820,000 years and is characterized by high amount of carbon sequestration and the deposition of black shales. OAE2 is thought to have been caused by the eruptions of two large igneous provinces (LIPs), the Caribbean LIP and the Madagascar LIP. These LIPs spewed carbon dioxide and water vapor into the air, causing global warming and intense nutrient cycling. It is hypothesized that over 25% of marine invertebrates went extinct during this interval. Studying marine invertebrate response during OAE2 coincides with today's warming climate and modern biotic response to environmental perturbations. One ammonoid superfamily, Desmoceratoidea, survived through this interval, but the effects of OAE2 on this group have not yet been assessed. I am using a Bayesian phylogenetic approach in order to determine OAE2's impact on Desmoceratoidea. This project is one of the first Bayesian phylogenetic hypotheses in Ammonoidea and producing the first phylogenetic hypothesis for Desmoceratoidea. I expect to see that not all defined taxa in this superfamily are unique, requiring reclassification. I also expect genera to group together, and from there to be able to decipher origination and extinction patterns of genera through the C-T interval. This new phylogeny will help to better define clades within Desmoceratoidea, as there is no great description of the superfamily or its occupants to date.

Pedal morphology and macropod movement: the importance of the fifth metatarsal in kangaroo locomotion

George Watts[1], Christine Janis[1], Emily Rayfield[1], Amber Wagstaffe[2],
[1] University of Bristol, [1] University of Hull

The locomotion styles of kangaroos (Macropodoids) are generously more disparate than reducing them to hoppers; locomotory styles vary greatly (including climbers, walkers and bounders), with this disparity comes variance in pedal morphology. The role of the 5th metatarsal (which differs in relative robusticity to the 4th) in weight-bearing and locomotion is unknown. This digit is reduced or lost in some taxa large extant hoppers and short-faced kangaroos (sthenurines). Questions here remain regarding how important robusticity of the 5th digit is for different locomotors and the reasons for its reduction/loss. Here we use geometric morphometrics of linear data from 86 macropod individuals and micro-CT scans of metatarsal bones from 7 kangaroos to investigate the correlation between foot bone morphology and proposed locomotory styles. Morphometrics show the relative robusticity of the 5th metatarsal differs varying with locomotion style and body mass. Large extinct species such as Protemnodon(90kg) and Macropus titan(150kg+) cluster away from endurance hoppers with relatively larger 5th metatarsals, supporting the hypothesis of their divergent locomotory capabilities (quadrupedal progression and hopping at extreme size respectively). Via second moment of area analysis, differences in resistances to bone bending will inform the relative role of the 5th /4th digit in locomotion and weight bearing. Expected is relative low resistance to bending in the 5th metatarsal of hoppers and for other species the 4th and 5th metatarsals will be more congruent.

Hindlimb evolution in theropods: A paravian breakpoint for hindlimb shape

Shane Wheatley[1], Manabu Sakamoto[1], Marcello Ruta[1]
[1] University of Lincoln

Theropods are a long lived, diverse clade with a large body of literature, rich phylogenetic history both in the past and present. Theropods were incredibly active and adaptable, filling a wide variety of niches and novel adaptations like 4 wing flight and an enlarged, and hyperextended second pedal ungual. Despite all of this, the evolution of the hindlimbs through the phylogeny of theropods is poorly understood, both in terms of the acquisition of the enlarged 2nd pedal ungual and the origin of flight. To address this, a comprehensive dataset was produced consisting of 34 measurements from the femur, tibia, 2nd metatarsal and the second toe of Theropods. These measurements then had size accounted for using log Mosimann transformations and subjected to principal component analyses. To compliment this, outlines of lateral images of 73 pedal unguals from both non-avian and avian theropods were subjected to elliptical fourier analysis to quantitatively test the specialised shape of the enlarged 2nd pedal ungual of Troodontidae and Dromaeosauridae. In Maniraptora, the group Paraves displays a highly significant shape change of the entire upper limb and 2nd pes at the paravian split. Lastly, results support enlargement of the second pedal ungual and distinct claw shape only in Dromaeosauridae. These results provide strong evidence to support the single origin of flight within Paraves and the single acquisition of a hyperextended second pedal ungual, which was then enlarged within Dromaeosauridae, independently of Troodontidae and Avialae.

Palaeontological Association Mentor Scheme

The Palaeontological Association mentoring scheme aims to assist palaeontologists at the start of their academic careers. The scheme is open to Association members at any stage of PhD study and those conducting post-doctoral research who do not have a permanent position. Mentoring is a valuable tool, helping individuals make informed choices via the exchange of knowledge and experience. The scheme uses a direct mentoring approach, with mentors in permanent positions offering direct contact via e-mail, Zoom or other forms of communication. Guidelines on expectations, lines of communication and length of mentorship are provided. It is expected that mentors should provide open and honest advice whilst maintaining confidentiality at all times. If you are a PhD student or a soon-to-be postdoctoral palaeontologist and are interested in having a mentor, please fill out our mentor request form available on the Careers section of the Association's website and we will endeavour to partner you with a suitable mentor as soon as possible. If you have any questions, please e-mail me (vicepresident1@palass.org) for more information.

Paul Barrett
PalAss Vice-President

STUDENTS!

Are you a student who works in or is interested in palaeontology?

The **Palaeontological Association** is an international organisation that exists to promote the study of palaeontology and its allied sciences.

Did you know we subsidise memberships for students? For **only £20 a year** we offer:

Access to the latest palaeo science and news!

Online access to Association journals *Palaeontology* and *Papers in Palaeontology*, a discount on other publications (e.g. field guides) and we keep you up to date with the latest news in our Association newsletter.

We can help fund your research and travel to conferences!

Grants of up to £1500 are available to students to fund research projects. We also offer grants of up to £200 to postgraduate student members for travel to any international meetings (even those not run by the Association).

Want career guidance and mentorship?

The Association has established a mentoring scheme to assist you throughout your academic career. The scheme is open to all PhD student members.

Want to get involved with science engagement?

The Association participates in many outreach activities (including fossil festivals and our own YouTube channel) and offers grants for public engagement. We support the increased participation of diverse voices in palaeontology!

Don't forget our student conference ProgPal!

The Association helps support Progressive Palaeontology, an annual conference **run by PhD students for PhD students**. Meet your peer group, discuss your science and gain experience presenting!

We make attending the Annual Meeting cheaper!

The Association's flagship Annual Meeting is a major international conference with several hundred delegates. Registration is subsidised for students, and contributions to travel costs may be made for students giving a presentation. All students are eligible for our poster or presentation prizes!

icons: FREEPIK flaticon.com

Become a member of the Palaeontological Association!

For more details and to sign up go to: **www.palass.org**


PROGPAL
2023
LIVERPOOL