Progpal

Lincoln 2022

THE PALAEONTOLOGICAL ASSOCIATION

GEOLOGICAL CURATORS GROUP

GCG

The Palaeontographical Society

Established 1847

UNIVERSITY OF LINCOLN

Digital Delegate Booklet

Contents

Introduction

The Progressive Palaeontology (ProgPal) is an accessible and free conference organised by students, for students. We are honoured to be hosting the conference at the University of Lincoln this year, from 14th-16th June. Previous iterations of the event have made excellent strides towards making the experience as open as possible to all scientists and creating a positive atmosphere to share knowledge and build lasting connections. We aim to maintain this at ProgPal 2022 and are making particular efforts towards neurodivergent accessibility.

To keep up with all the latest news, keep an eye on our social media accounts:

Twitter: @ProgPal2022, using #ProgPal22

Instagram: Progpal_2022

The logo depicts our beautiful cathedral (the tallest building in the world from 1311 to 1548) atop our infamous steep hill. Resting beneath are the fossilised remains of an unspecified plesiosaur and abstracted ammonites and belemnites.

Progpal

Lincoln 2022

Virtual attendees

Thank you for attending ProgPal online. We are sorry new can't offer everything that is available to the in-person delegates, but we hope you will enjoy your virtual experience of progpal2022!

Please see below a link to our discord server:

https://discord.gg/WQQQjhGt

The discord server contains areas for Q and A with delegates for their talks and posters. We also have social channel on the discord for you to interact with other delegates, with a voice channel if you fancy a chat. On the discord you will also find links for the online

talks and posters when they are made available, as well as links to the virtual field trip on the Thursday, and the workshop once it is recorded.

You can find a zoom link to our palaeoart on Wednesday panel here:

Join Zoom Meeting
https://us04web.zoom.us/j/74009142921?pwd=gUVOIZ1lI2ItGoZEj2DIC7FoWYg1_2.1

Meeting ID: 740 0914 2921
Passcode: Progpal22

You can find the link for the neurodiversity panel on discord.

The icebreaker quiz will take place over discord as well. Feel free to make digital teams and play along with other virtual attendees!

Timetable

Day 1: Tuesday 14th June

12:30 – 13:00 @ Engine Shed **Registration**

13:00 – 13:15 @ Engine Shed **Welcome talk**

13:20 – 15:20 @ Isaac Newton Building **Workshops**

@INB2305 '**Phylogenetic comparative methods using R**' Dr Manabu Sakamoto (Computers provided)

@INB0114 '**Science Communication workshop'** Elspeth Sinclair.

13:20 – 18:00 @ Engine Shed Poster drop-in: A chance to see the wonderful posters created by delegates in a flexible way.

15:20 – 16:00 Break

15:20 – 16:00 @ INB0113 LGBTQ+ Meetup

16:00 – 17:00 @ INB0114 Neurodiversity panel: Panellists will engage in discussion alongside attendees about their experiences in academia in relation to being neurodiverse, and how they were able to find success.

19:00 – 21:00 @ Minerva building 3202 Icebreaker: A chance to unwind, enjoy a palaeo-quiz!

Day 2: Wednesday 15th June

09:00 – 09:15 @ INB0114 Opening comments

09:20 – 10:45 @INB0114 Keynote Speech

10:05 – 10:45 @INB0114 Talk slot 1

1. *Complex development in the earliest vertebrate skeletons*
2. *The laws of trophic levels: simulation and palaeoecology*
3. *Calculating Cephalic Blood Flow in Thalattosuchian Crocodylomorphs*

10:55 - 11:10 Break

11:10 – 11:55 @ INB0114 Talk slot 2

1. *Effect of Phylogenetically-Heterogeneous Sampling on Diversity Estimation*
2. *Tooth replacement and endocranial anatomy of a new Antarctic ornithopod dinosaur*
3. *Studies of a new Eocene irregular echinoid assemblage from Madagascar*

4. *New data on the crocodylian Tomistoma dowsoni from the Miocene of North Africa provides insights into gavialoid neuroanatomy*
5. *Nerves of steel: the role of iron in the preservation of the central nervous system*
6. *The first example of cranial material from a UK dryosaurid*

11:55- 12:45 Lunch @INB

11:55- 12:45 @ INB3235 Palaeoart panel

12:45 – 13:45 @ Engine Shed Poster session

13:55 – 14:50 @ INB0114 Talk slot 3

1. *Palaeontologists against systemic racism talk*
2. *The effect of the geological record on the way we perceive trait evolution*
3. *Understanding the macroevolutionary relationship between colouration and colour vision in primates*
4. *The Evolution of Unique Cranial Traits in the Leporid Lagomorphs (rabbits and hares)*

14:50 –15:15 Break

15:15 – 17:00 @ INB0114 Talk slot 4

1. *Multivariate dental topographic metrics demonstrate the dietary breadth and specialisms of conodonts*
2. *Redescribing the cranial osteology and reconstructing the neuroanatomy of the Scottish dicynodont Gordonia*
3. *Evolution of disparity in Neuroptera wing shapes*
4. *Graptolites associated with enigmatic 'mattress'-like structures from northern Vietnam*
5. *Evolutionary innovation and competitive replacement drove the rise of modern coral reefs*
6. *Theft of Nature in Brazil: How can social media support the discussion about the repatriation of fossils?*
7. *A trend of decreasing complexity in the avian appendicular skeleton*
8. *Soft sediment stabilisation via solvent replacement: a novel approach for preserving taphonomic experiments*
9. *The Phylogenetic Relationships of Sebecosuchian Crocodyliforms: Influence of Increased Character and Taxon Sampling Via the Use of Continuous Characters and Standardized Character Construction*

17:00 – 17:15 Break

17:15 – 17:30 @ Engine Shed Closing remarks and awards

17:35 – 18:00 @ Engine Shed Auction winners' announcement

18:30 – 20:30 @ Pho Conference Dinner

Day 3: Wednesday 16th June

08:00 Leave for field trip to Whitby. Coach departing from outside JBL.

10:30 Arrive at Whitby

18:00 Leave and return to Lincoln

20:30 Arrival back in Lincoln

A digital version of the field trip will be available online.

Other information:

The welcome desk will remain up for the duration of the conference, so if you have any questions, please find volunteers there.

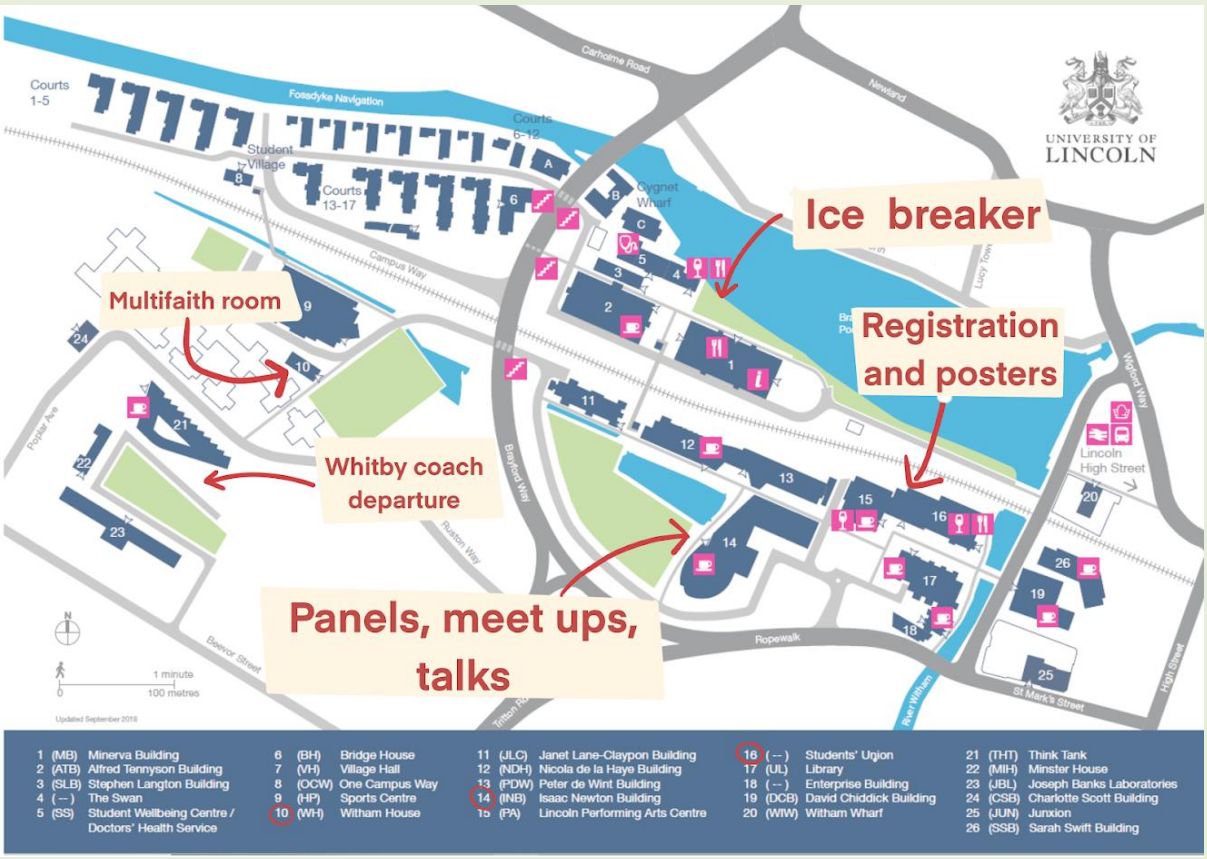
This year's **auction** will be a silent auction in the Engine shed. The auction will be open for bids until the final break of day 2.

Our Multifaith room is located at- **Whitam house**

Dark rooms will be available in **Isaac Newton Building room 1103** and **Nicola de la Haye building room 1009**

All buildings have lifts and toilets available on the ground floor.

Map



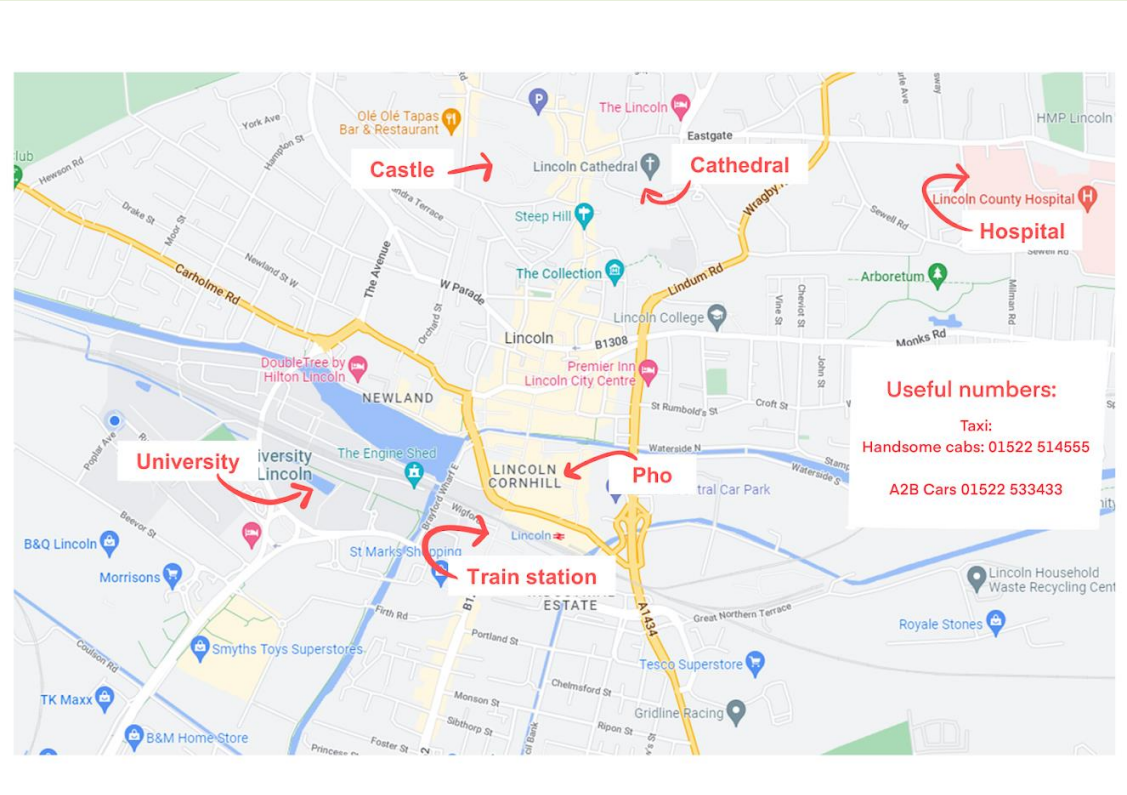
Getting to Lincoln

By train: Lincoln is located centrally, within the East Midlands of the UK. Fortunately, Lincoln has its own rail station, "Lincoln Central Station". It is serviced regularly from several major cities including Manchester, Birmingham, and London. Tickets can be purchased from https://www.thetrainline.com/ and www.nationalrail.co.uk.

By plane: Lincoln's closest airport is the nearby Doncaster Sheffield Airport. The airport is only 26 miles from the city, and it is straightforward to get to Lincoln either by train or taxi.

By coach: Coach travel can be one of the most cost-effective ways to travel long distances across the country. The bus/coach station is located centrally within the city so getting to your accommodation should hassle-free. https://www.nationalexpress.com/ and https://uk.megabus.com/ are among the better providers of coach travel.

By car: Driving in a personal car to Lincoln is possible, but there is limited mutli-day parking in the city, and costs may be quite high.



Getting to the University of Lincoln

The coach and train station are visible to each other (Blue star) and are less than a 5-minute walk apart. From either, the most direct route to the university (Red star) is to follow the train tracks down by the river. Eventually you will come to a large rail bridge (yellow arrow), after which there is a large wooden bridge (green arrow) leading onto campus. This is approximately a 15 min walk. Alternatively, there are nearly always taxis outside the station.

Handsome Cabs (01522 545352) are a popular choice among students, whilst A2B Cars Lincoln (01522 533433) have the highest review score on Google reviews.

Accommodation

Lincoln offers a variety of accommodation options at a range of price points, the establishments listed here are offered as suggestions due to good reputation and location close to the university. When booking accommodation, it is often cheaper to book multi-person rooms than booking the same number of individual rooms.

Holiday Inn (City Centre): Address- Brayford Enterprise Park, Ruston Way, Lincoln LN6 7DB. The Holiday Inn is located a short walk away from the campus (and the local McDonald's), offering a luxurious air-conditioned room (~£75 p/n) that includes free Wi-Fi and breakfast. For more information, see their website: https://www.ihg.com/holidayinnexpress/hotels/gb/en/lincoln/eamlc/hotelde....

Travel Lodge: Address- 16 Tentercroft St, Lincoln LN5 7DB. Located close to both the university and the train/ bus stations, Travel Lodge offers a predictable and comfortable experience at a reasonable rate (~£60 p/n). For more information, see their website: https://www.travelodge.co.uk/hotels/648/Lincoln-City-Centre-hotel.

Queen in the West: Address- 12-14 Moor St, Lincoln LN1 1PR. Located further away from the University, the Queen in the West offers an affordable B&B option (~£60 p/n) perfect for those that enjoy a local pub feeling, though with limited spaces available. For more information, see their website: https://qitw.co.uk/.

Brayford Guest House: Address- 79 Carholme Rd, Lincoln LN1 1RT. A further walk away from the conference venue but offering a similar great B&B service at a slightly cheaper price point (~£50 p/n) including Wi-Fi, free parking, and a quieter accommodation experience. For more information, see their website: https://www.brayfordguesthouse.co.uk/.

There are plenty of AirBnB rooms available in Lincoln, with a few being managed by the Student's Union at a very reasonable price, e.g. https://www.airbnb.co.uk/rooms/14312246.

Code of conduct

Code of Conduct for Palaeontological Association Meetings

The Palaeontological Association was founded in 1957 and has become one of the world's leading learned societies in this field. The Association is a registered charity that promotes the study of palaeontology and its allied sciences through publication of original research and field guides, sponsorship of meetings and field excursions, provision of web resources and information and a programme of annual awards.

The Palaeontological Association holds regular meetings and events throughout the year. The two flagship meetings are the Annual Meeting, held at a different location usually in December each year, and the annual Progressive Palaeontology meeting, run by students for students with the support of the Palaeontological Association. The Association Code of Conduct relates to the behaviour of all participants and attendees at annual events.

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, you can report it (anonymously if you choose to) via the online reporting form.

Anyone experiencing or witnessing behaviour that constitutes an immediate or serious threat to public safety, or a criminal act is expected to contact the appropriate law enforcement agency. Those witnessing a potential criminal act should also take actions necessary to maintain their own personal safety.

COVID-19

For the Annual Meeting and Progressive Palaeontology 2022, all delegates are required to comply with local and national COVID-19 guidelines, and the other measures in place to minimise as far as possible the risk associated with COVID-19. These will be detailed on the Meetings & Events webpages and updated as necessary.

Field trip

Schedule

A complete agenda for the fieldtrip which includes timings will be provided closer to the conference date.

Departure: We will meet outside the Engine Shed and aim to leave at 8:00 am. The coach should take approximately 2 hours and 30 minutes to arrive at Whitby. We will not be making any stops on the journey, but a toilet will be available on the coach.

Arrival into Saltwick Bay: The coach will drop us off at Whitby Holiday Park at Saltwick Bay. From here we will follow a mud foot path down to the shore. The whole group will wait at the bottom of the stairs until all members of the party have reached the bottom.

Beach walk: Once everybody is on the beach, we will walk north from Saltwick Bay towards Whitby. This section of coastline is one of the world's most famous and well-studied sections. We will pass through Toarcian deposits of the Whitby Mudstone Formation and see Middle Jurassic dinosaur footprints. Low tide is estimated around 12:13 pm, giving us plenty of time on the beach. This walk is approximately 1.5 miles long, and there will be a small amount of climbing over rocks involved.

Lunch: We will break for lunch whilst on the beach. We advise you pack lunch the night before or get it before we leave in the morning as we won't be visiting any shops before we get off the coach. You will have the opportunity to buy more food including hot food (restaurants/takeaways ect) when we are in Whitby town centre.

Ascent from the shore: Once we reach Whitby, we will leave the shore via a vehicle ramp just below Whitby Abbey. You will then have time to explore Whitby at your leisure.

Leaving Whitby: The coach will pick us up from Whitby Harbour Car Park for the return journey back to Lincoln. We anticipate a departure time of around 18:00 pm, but this will be confirmed closer to the date.

Alternative travel arrangements

We will be travelling to and from Whitby as a group by coach operated by Lincoln-based PC Coaches. Places on the coach are limited to 43, but if you wish to arrange alternative travel (e.g., by car) for yourself you are more than welcome to do so. This also includes if you wish to stay in Whitby longer or travel home directly instead of traveling with the group back to Lincoln.

Delegates who travel to/from Whitby separately for both legs of the journey will be offered a discount on the cost of the fieldtrip. You must let us know upon registration if you will be travelling separately for both legs of the journey.

During the conference, we will provide committee contact details to all fieldtrip participants. If you travel separately and are delayed on the way to Whitby, please contact us immediately. We expect you to arrive in Whitby between 10:00 am and 10:30 am, but in the case of any significant delays we cannot guarantee the group will be able to wait and we may set off without you.

Please also note that parking may not be available in Saltwick Bay. You would need to plan your parking ahead of time and meet us at Whitby Holiday Park.

Accessibility and inclusion

Progressive Palaeontology 2022 strives to be as accessible and inclusive as possible, and this extends to the fieldtrip. We have listed all anticipated accessibility concerns below to allow you to make an informed decision whether to participate.

Unfortunately, no part of this fieldtrip is wheelchair accessible. As a result, a pre-recorded virtual version of the fieldtrip will be available online to all delegates the morning of the trip. Fieldtrip content will also remain accessible for a short time after the end of the content. If any wheelchair users still wish to attend, please contact committee as soon as possible so we can arrange alternative accommodations. However, you will not be able to participate on the geological walk and the coach is not wheelchair accessible.

We will ensure that all parts of the fieldtrip are as manageable as possible for all abilities. This fieldtrip has been tested against existing accessibility requirements including mobility issues on committee, but we understand that the ability of everyone will differ significantly. Therefore, it is your responsibility to decide if your participation is safe both before and at any point during the trip.

The walk will involve several obstacles which may be difficult to navigate in the event of reduced mobility. These obstacles include:

A descent down a mud foot path which includes steps throughout and is very steep at times. A handrail is not available for part of the descent, and the path may be slippery.

Navigating over boulders and loose, uneven surfaces.

A small climb down a rock face at Saltwick Nab.

Slippery and wet wave-cut platform covered in seaweed. These surfaces may be uneven, with unevenness concealed by seaweed.

Walking up a vehicle ramp off the beach.

In the event of bad weather, all these conditions may be worse than anticipated.

If at any point during the trip you believe any part is beyond your ability or you need to tap out, please let a committee member know immediately and we arrange appropriate the safest possible accommodations. However, once we are on the beach there will be no exits off the shore until we reach Whitby. Please note the safest option may be to continue the walk.

Regular stops will be scheduled during the walk to accommodate those who may need to rest more frequently. There are no toilet facilities available between Saltwick Bay and Whitby, so we recommend using the one on the coach before we descent. However, we intend to bring a portable camping toilet and pop-up tent cubicle to make a private area at several of the stops.

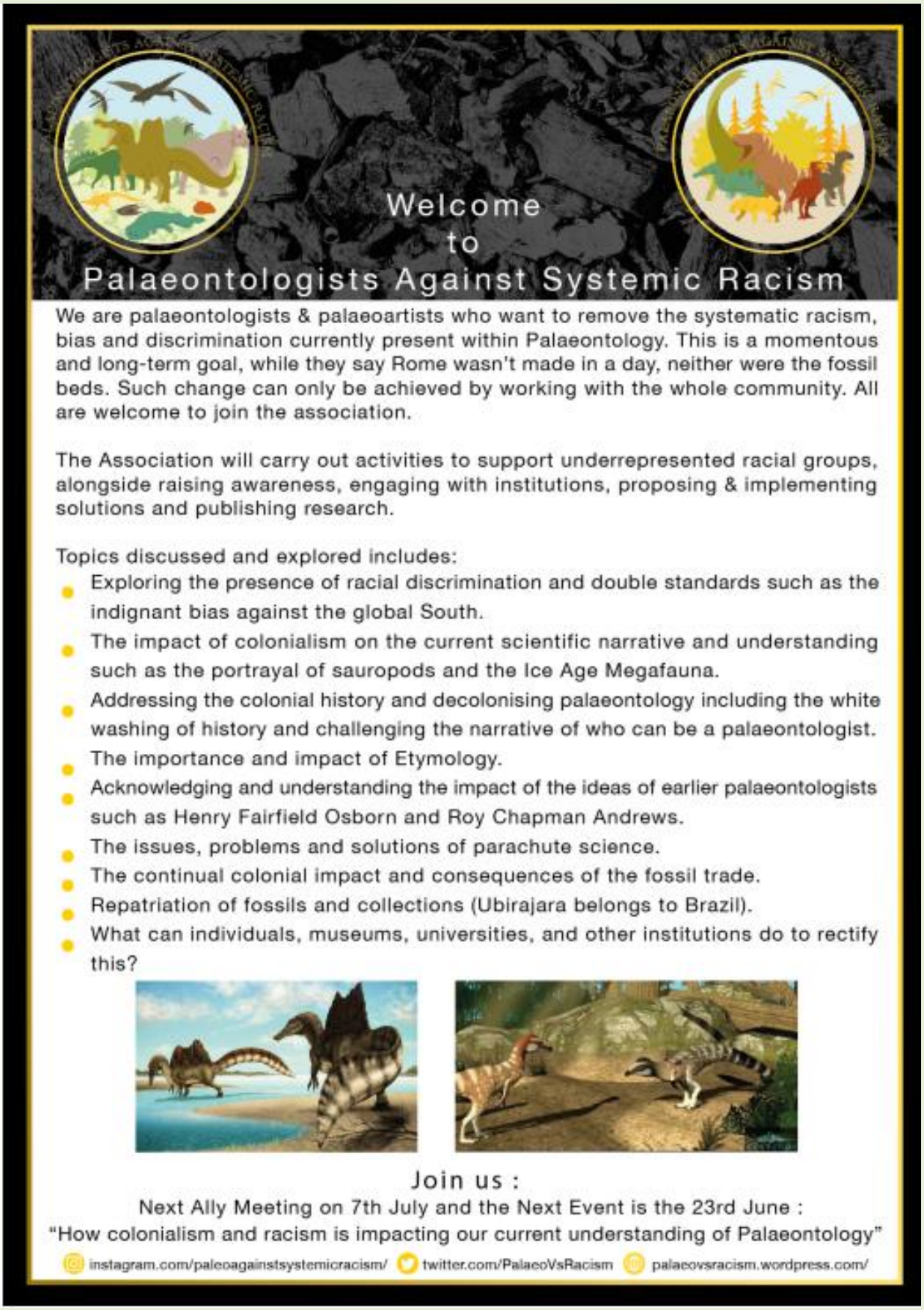
Committee will carry extra water in case you need it, as well as other essential supplies, but please bring your own if you can. In Whitby there are plenty of public toilet facilities. These cost 40p to enter, but accept both cash and card. Many restaurants and cafes also have facilities.

Upon registration, please tell us of all accessibility requirements you may have during the trip so that we can make arrangements to accommodate your needs in advance.

COVID statement

Despite the relaxation of all COVID-19 restrictions in England, we will be enforcing strict mask rules on the coach at all times. Masks may be removed briefly to eat or drink but must be worn unless you are medically exempt. This is to ensure the safety and inclusion of all participants who are vulnerable or might otherwise avoid the field trip due to mental or physical concerns. Masks will not be required outside of the coach.

Palaeontologists against systemic racism



Workshops

This year we are hosting two workshops:

Workshop with Dr Manabu Sakamoto!
Phylogenetic comparative methods using R!

- This workshop will introduce you to the basics of phylogenetic comparative methods (PCMs): what they are and why we need them.
- We will go through worked examples using R, focusing mostly on phylogenetic regression (Wait, it's all regression? Always has been...).
- The workshop will cover all the basics: starting with an intro/recap on R; how to read a phylogeny into R and how to handle them; how to match trait data with phylogenies; how to fit phylogenetic regressions; and how to interpret the results.

Workshop with Elspeth Sinclair !
Science communication workshop!

- This Science Communication (sci comm) workshop aims to answer your questions and help you to grow your knowledge about the aspects of public engagement that are important to you. The format of the workshop is flexible and will allow you to design an experience around the topics you want to learn about. Proposed topics include but are not limited to:
  - the basics of exploring research through storytelling
  - how to define your target audience
  - engaging an audience using objects
  - co-developing and evaluating engagement projects
  - turning an idea into a fully developed, costed programme
- Whether you are completely new to sci comm or have experience and want to learn more, there is something from everyone.

Panels

Palaeoart panel

Zoom link:

Join Zoom Meeting
https://us04web.zoom.us/j/74009142921?pwd=gUVOIZ1lI2ItGoZEj2DIC7FoWYg1_2.1

Meeting ID: 740 0914 2921
Passcode: Progpal22

Welcoming 3 fantastic palaeoartists, and finding out all about their work, art styles, and techniques!

Our first palaeoart panel member is Melissa Morales Garcia

@NuriaMelisaMor1

Melisa is Mexican biologist who recently earned her PhD in Palaeobiology from the Uni of Bristol. She's a freelance graphic designer, working for Designs that Cell and her own business-Science Graphic Design

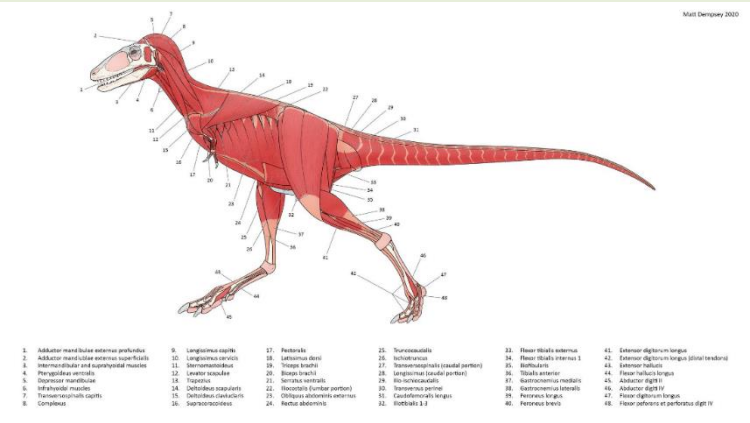
If you would like to see more of Melisa's work please check our her Instagram and website linked below:
https://sciencegraphicdesign.com
https://instagram.com/nmelisa.morales?igshid=YmMyMTA2M2Y=

Our second palaeoart panel member is Matt Dempsey.

@Sketchy_raptor

Matt is PhD student at the Uni of Liverpool and NHM, UK with an interest in anatomical form & function, particularly

in dinosaurs. Matt aims to help further the understanding of their research through visual mediums.



Matt has dabbled in a few different palaeoart styles. Recently his main illustration output has been reference diagrams of dinosaur anatomy, which you can check out here:

Our third palaeoart panel member is Oliver Demuth.

@OliverDemuth

Oliver is a PhD student at the University of Cambridge and a professional scientific illustrator. From his background as an artist he brings computational modelling techniques from the entertainment industry into paleoart

These techniques are used to study the locomotion & biomechanics of living & extinct animals. He also creates illustrations & 3d models of prehistoric animals or their remains for scientific publications & museum exhibits. Check out his website below: odemuth.wordpress.com

Neurodiversity panel

This panel seeks to draw on the experiences of the neurodiverse community in academia to enable peers to better navigate academia and for Neurotypical students to better understand the difficulties faced by the neurodiverse community. This panel will also assess the current accessibility of academia to neurodiverse people and what future changes can be made to make academia more accessible.

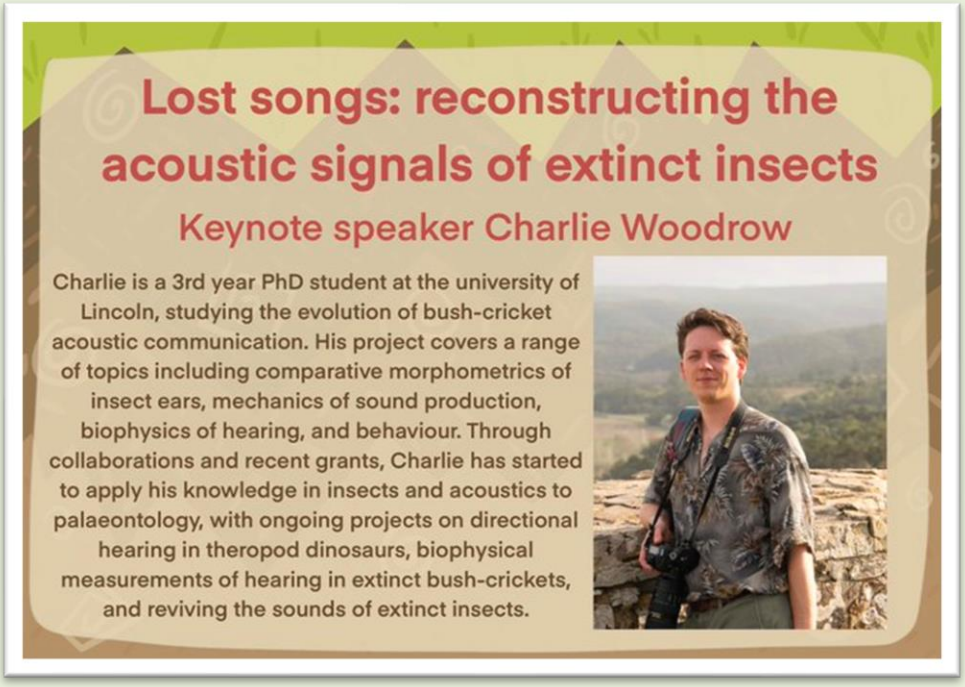
Keynote talk by Charlie Woodrow

Lost songs: reconstructing the acoustic signals of extinct insects

Charlie Woodrow[1], Thorin Jonsson[2], Ed Baker[3], Fernando Montealegre-Z[1]

[1]*University of Lincoln*
[2]*Institute of Biology, Karl-Franzens-University Graz, Graz, Austria*
[3]*Natural History Museum, London, United Kingdom*

One of the major aims of palaeontological research is to gain insights into the ecology and behaviour of the deep past. However, such aspects of an organism's life history do not fossilize, and thus can only be studied by combining our knowledge of extant species with unique fossil data to infer potential ecological interactions. This is particularly challenging for investigations of acoustic ecology, as sound production organs are rarely fossilized, and often not well understood enough to infer acoustic signals from geometry alone. In ensiferan insects (Orthoptera), sounds are produced by a stridulatory organ in the forewings, and the properties of these sounds are dictated almost entirely by the geometry of the wings. Thus, the Ensifera offer a unique opportunity to study the acoustic ecology of the past. Here, using laser-doppler vibrometry, scaling relationships, and a developing mathematical model, we reveal how the geometry of forewings can be used to reconstruct the acoustic signals of both elusive and extinct ensiferans. The model is described using a 150-year-old museum specimen, and then applied to a 165-million-year-old fossil relative. These studies demonstrate how insects can offer accurate insights into the ecology of the past and provides an avenue for reconstructing further sounds from fossil taxa in the future.



Full talks

Complex development in the earliest vertebrate skeletons

Will Crabbe[1], Mark A. Purnell[1], Duncan J. E. Murdock[2], Thomas H. P. Harvey[1]

[1]*University of Leicester, UK*
[2]*Oxford University Museum of Natural History, UK*

Paraconodonts are among the earliest skeletonizing vertebrates within the fossil record and are represented entirely through their disarticulated, tooth-like elements. However, there are some morphologically complex types of paraconodont element – specifically the U- and W-shaped form-genus Westergaardodina – that display apparently paradoxical internal structures that seem incompatible with our current understanding of early conodont morphogenesis. Without understanding the growth of these elements, their anatomical homology, function, and phylogenetic position remain uncertain.

We examined Westergaardodina elements preserved as small carbonaceous fossils from the Deadwood Formation, Saskatchewan using transmitted light to reveal exceptional preservation of their internal structures. We imaged further specimens from the Alum Shale Formation, Sweden, using oil immersion and synchrotron tomographic microscopy, which allowed for segmentation of the internal element structure in three dimensions for the first time.

Results have revealed that all Westergaardodina elements share key structural homologies with coniform paraconodont elements, which supports a broad group-wide homology between the two. We have also revealed two distinct modes of development in Westergaardodina: 1) A modified form of basal accretion similar to coniform elements, with complex basal allometry of lamellae; 2) Development of elements through the incorporation of additional u-shaped units.

The second development mode is similar to what is seen in the morphogenesis of derived euconodont elements, and the scales and teeth of other basal vertebrates. Therefore, Westergaardodina represents the earliest known example of multidenticulate growth within vertebrate skeletons, showing that complex growth in vertebrates was established in the Cambrian - much earlier than has previously been appreciated.

The laws of trophic levels: simulation and palaeoecology

Euan Furness[1], Philip Mannion[2], Mark Sutton[1]

[1]*Imperial College London*
[2]*University College London*

A wide variety of research has been conducted on the nature of trophic levels in modern ecosystems, and some of this has been used to inform studies of trophic levels in past ecosystems as well. One framework through which trophic levels can be viewed is the Exploitation Ecosystems Hypothesis (EEH), which states that the population sizes of trophic levels alternate between food-limited and predator-limited states along the food chain. Many modern-day ecosystems provide empirical support for this hypothesis, but this support is often dampened by the inherent complexity of real-world food webs. We avoid these complications using a first-principles simulation tool, REvoSim, to test the predictions of and underlying controls on the EEH. We find that REvoSim provides good support for many of the predictions of the EEH: the abundance of top predators always correlates with productivity, but correlations between abundance and productivity in other trophic levels depend upon the level of predation experienced by that trophic level. However, in contrast to the strict predictions of the EEH, scaling of population size with productivity within a trophic level is rarely suppressed completely. Combined with existing palaeoecological and geochemical methods, this eco-evolutionary modelling has the potential to demonstrate the importance of known, modern-day processes in extinct ecosystems. Discrepancies between model predictions and observed patterns in fossil ecosystems could point to the importance of unmodelled phenomena, such as seasonality, or to the importance of poorly-preserved taxa, such as soft-bodied animals.

Calculating Cephalic Blood Flow in Thalattosuchian Crocodylomorphs

Arthur Erb[1], Mark Young[1], Stephen Brusatte[1]

[1]*University of Edinburgh*

Extant crocodylians are generally considered to be ecomorphologically conservative compared to their extinct relatives. Of the many crocodylomorph clades that radiated into new ecological niches during the Mesozoic, the thalattosuchians are perhaps the most aberrant. Known for their increasingly aquatic lifestyle, one thalattosuchian subclade, Metriorhynchidae, evolved into 'dolphin-like' forms with flippers and tail fins. Curiously, all thalattosuchians had skulls with hypertrophied venous systems, suggesting they had increased encephalic blood flow compared to extant crocodylians, and the cranial shifts requiring greater blood flow occurred prior to the evolution of

pelagic metriorhynchids. I explored these hypotheses using a CT dataset consisting of 23 extant crocodylians, 13 thalattosuchians, and four non-thalattosuchian fossil crocodylomorphs. From the CT datasets, I digitally segmented the brain endocasts (subdividing them into the olfactory bulbs, pituitary fossa, fore-, mid, and hindbrain), and calculated flow rates based on the radii of the carotid and orbital artery canals. I found that thalattosuchians did have higher cephalic blood flow rates than extant crocodylians, and that both groups had different subdivided endocranial proportions. In extant crocodylians the forebrain grows negatively allometrically, whereas it is closer to isometry in thalattosuchians – consistent with qualitative statements that thalattosuchians had expanded cerebral hemispheres. However, higher blood flow through the carotid foramen may not be directly linked to changes in the brain as blood flow exhibits a greater allometric exponent than endocranial volume. I hypothesize that the soft tissues of the snout, such as salt glands or a thermoregulatory structure, are driving this trend.

The effect of the geological record on the way we perceive trait evolution

Joël Koelewijn[1]

[1]*Utrecht University*

This research asks what the effects of the structure of the sedimentary record in carbonate platforms are upon the perception of trait evolution. Stratigraphic height is commonly used to represent time while researching trait evolution, but to what extent does it distort the identification of the mode of evolution? To test its effect, trait evolution is here simulated over time as stochastic processes. A forward simulation of a carbonate platform creates a stratigraphic record with gaps, which is then used to determine how the trait evolution would be recorded in this record. Statistical tests are then performed to assess the impact of the geological record on the tested modes. The results shows ways in which the geological record skews our perception of trait evolution. Often the original mode of evolution is no longer identified correctly using the tests, instead returning another mode as the most likely. Also, gradual changes over time appear as clear and sudden changes in the stratigraphic record, corresponding to hiatuses or periods of lower production on the platform. If encountered in the empirical rock record, these changes could be interpreted as sudden bursts in the rate of evolution or even a speciation event, while they are only the result of the geological record and do not represent reality correctly.

Understanding the macroevolutionary relationship between colouration and colour vision in primates

Robert MacDonald

Primates display considerable variation in pelage and skin colour in comparison to other mammals, with many species exhibiting bare red skin or red-orange pelage. This is thought to be linked to the enhanced ability of some primates to differentiate colours in the red-green part of the visual spectrum, widening the colour palette available for use in sociosexual signalling. However, such a link remains to be demonstrated. Here, we quantify how the frequency of red skin and pelage differs among the major primate radiations, which broadly exhibit different colour visual ability, as well as using phylogenetic comparative methods to investigate the nature of the link between colour vision and pelage colouration in one major primate clade, the strepsirrhines (lemurs, lorises, and galagos). We find that the clade with the most widespread ability to distinguish red from green most often exhibits red skin, but least often exhibits red pelage, while within strepsirrhines, the colour vision-colouration link varies between body regions. Our results highlight the complexity of the macroevolutionary relationship between colouration and colour vision. While the evolution of red skin may be facilitated by colour vision, evolutionary drivers other than visual system may be the primary influence on variation in red pelage among primates.

The Evolution of Unique Cranial Traits in the Leporid Lagomorphs (rabbits and hares)

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The leporid lagomorphs (rabbits and hares) are adapted to running and leaping (some more than others) and consequently have unique anatomical features that distinguish them from ochotonid lagomorphs (pikas) and from their rodent relatives. One such feature is an intracranial joint that circumscribes the back of the skull, thought to facilitate skull mobility. This joint separates the anterior portion of the cranium (including the dentition, rostrum and orbital apparatus) from the posterior portion of the cranium (which encompasses the occipital and the auditory complex). Aside from the observation that the intracranial joint is absent in pikas (generalist locomotors) and appears more elaborate in the genera with cursorial and saltatorial locomotory habits, the evolutionary history, biomechanical function and comparative anatomy of this feature in leporids lacks a comprehensive evaluation. The present work analysed the intracranial joint (as well as facial tilting and lateral fenestration of the maxilla) in the context of leporid evolutionary history using a Bayesian inference of phylogeny (18 genera, 23 species) and ancestral state reconstruction to gather information about the likelihood of its presence in ancestral groups. Our phylogenetic analysis found it highly likely that the last common ancestor between all living leporids had an intracranial joint (92.9% likelihood) and that the last common ancestor of all living lagomorphs did not (70.1% likelihood). These findings provide a broader context to further studies of

evolutionary history and will help inform the formulation and testing of functional hypotheses.

Multivariate dental topographic metrics demonstrate the dietary breadth and specialisms of conodonts

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Conodonts have one of the best fossil records of any organism and their evolutionary significance is well recognised. Despite their abundance in Palaeozoic and early Mesozoic marine ecosystems, their role in those communities is poorly constrained. Here, we present the first quantitative large scale analysis of conodont dietary range and specialisms. Using multivariate dental topographic metrics we analysed the 3D morphology of food processing P1 elements in 48 species sampled from across the diversity of morphologically complex conodonts. This homology-free methodology allows direct statistical comparison with analogous feeding tools of extant mammals and grasshoppers, providing robust inference of conodont diets. This reveals that conodonts have a dietary breadth comparable to both mammals and grasshoppers, ranging from taxa specialised in consumption of soft prey, through to species with tooth morphologies adapted for optimal processing of tougher cuticularized foodstuffs. Comparison of our results with qualitative morphological traits indicates that none accurately predicts diet, highlighting the need for quantitative analyses. Further application of this method to the abundant fossils record of conodonts, occupying a range of primary consumer niches through time, will facilitate investigation of ecosystem evolution and functioning across perturbation events.

Graptolites associated with enigmatic 'mattress'-like structures from northern Vietnam

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We describe Tremadocian, Lower Ordovician graptolites from the Than Sa Formation of northeast Vietnam that are intimately associated with enigmatic, three-dimensional 'mattress'-like structures, unlike anything previously described with graptolites. The structures have transverse corrugations that align with the spacing of the thecae on the ventral side, and which also extend outwards from the dorsal surface of the graptolite, effectively encasing the entire length of the graptolite. Various lines of evidence are

used to dismiss an abiotic origin, especially the close alignment of the corrugation with the thecae, the lack of a preferred structural orientation, and the textural contrast between the 'mattress' and the surrounding sediment. We review various possible biotic interpretations for these structures, including microbial interactions with the graptolite on the seabed.

Evolutionary innovation and competitive replacement drove the rise of modern coral reefs

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After a cryptic Ordovician origin, modern corals (Scleractinia) appeared in the fossil record in the Triassic during a remarkable period of reef recovery following the end-Permian mass extinction. Microbially-bound biostromes proliferated in the aftermath of the catastrophe before the rise of sponge-dominated Wetterstein reefs in the Middle Triassic. These were then supplanted by coral-dominated Dachstein reefs in the Late Triassic, yet the tempo and drivers of this succession remain unexplored using deep time climate reconstructions or modern macroevolutionary methods for inferring diversification processes. We infer sampling-corrected scleractinian and sponge diversification dynamics in a Bayesian framework (PyRate, mcmcDivE). We then use ecological niche modelling to link the biogeographic radiation of scleractinians to macroscale changes in palaeogeography and climate. We show that sponges were competitively replaced by scleractinians as dominant reef builders with the advantages provided by evolutionary innovations of coloniality and photosymbiosis offset by broader environmental controls, including a potentially undocumented middle Norian mass extinction event, to produce an episodic pattern of expansion through the Late Triassic. This origin is antithetical to the current crisis facing corals, with widespread coral bleaching from photosymbiote loss under ecologically stressful conditions precipitating their mass replacement by sponges and algae in reef ecosystems.

A trend of decreasing complexity in the avian appendicular skeleton

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The maximum complexity of organisms – however defined – has increased since the origin of life. However, the nature of overall patterns in mean or median complexity through time, and whether putative trends are active or passive, remains controversial. Ancestor-descendent tests offer one way to test for directional changes within a phylogenetic framework. By inferring ancestral states, we quantify the magnitude of changes between pairs of parent and daughter nodes (hypothetical ancestors, and descendants), and assess the significance of inferred patterns. Here we apply this method to appendicular skeletal complexity in a sample of over 1,000 species of living and extinct birds. Despite an increase in mean, maximum, and variance in complexity during the lifespan of the clade – indicators of a passive trend of increase – we infer an active trend of decreasing complexity in the appendicular skeleton using the ancestor-descendent test. The apparent pattern of increase seems to be caused by less frequent larger increases, countered by a tendency for significantly more frequent smaller decreases, which are temporally and phylogenetically widespread. This work therefore highlights 1. the critical need for more sophisticated and realistic models of assessing macroevolutionary trends; 2. the importance of incorporating fossil data when attempting to understand macroevolutionary processes.

The Phylogenetic Relationships of Sebecosuchian Crocodyliforms: Influence of Increased Character and Taxon Sampling Via the Use of Continuous Characters and Standardized Character Construction

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Noted for their bizarre, morphologically disparate bauplans, Notosuchia is an extinct, speciose group of crocodyliforms with high apparent diversity in the middle–Late Cretaceous of Gondwana. Since the erection of the clade, there have been disputes regarding the inter-relationships and composition of Notosuchia, especially in terms of the placement of sebecid sebecosuchians, the only putative notosuchian taxa to survive the Cretaceous/Paleogene mass extinction event, 66 Ma. Here, these inconsistencies are confronted through improved taxon and character sampling, with emphasis placed on the increased inclusion of continuous data and sebecosuchian taxa. A new character-taxon dataset is produced via standardized approaches to character construction and first-hand study of the majority of taxa. It comprises the largest matrix yet to be compiled for Notosuchia, consisting of 602 characters (157 of which are continuous characters) scored for 115 crocodyliform taxa, of which 88 are notosuchians. This represents an increase in the total character count of ~35% compared to the largest existing notosuchian-relevant dataset. Under multiple character weighting schemes, including equal and extended implied weighting,

Sebecosuchia is recovered within Notosuchia and contains a monophyletic Baurusuchidae and Sebecidae. Eremosuchus elkoholicus, an enigmatic species from the early Eocene of Algeria, is recovered as an early diverging member of Sebecosuchia. Given that the fragmentary sebecosuchian remains from Europe and north Africa are often neglected from phylogenetic studies, their inclusion here is important in elucidating the dispersal and radiation of the clade, especially considering ongoing continental fragmentation during the Late Cretaceous and Paleogene.

Lightning talks

Effect of Phylogenetically-Heterogeneous Sampling on Diversity Estimation

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Incomplete sampling in the fossil record is one of the central obstacles faced by paleobiologists when trying to reconstruct past diversity on Earth. It can exaggerate, eliminate, or create spurious signals in reconstructed palaeodiversity. In a simplified scenario of evolution, preservation, and discovery, the rate of detection of fossils belonging to an inferred multi-lineage phylogeny may be assumed to be constant. In real-world scenarios, however, different branches of a single phylogeny can have varying rates of fossil recovery. This study investigates if and how phylogenetically-influenced sampling heterogeneity impacts origination and extinction rate estimates. To do this, we simulated phylogenies, and then sampled according to both a constant sampling rate condition and a phylogenetically-heterogeneous sampling rate condition. For the phylogenetically-heterogeneous sampling rate condition, a starting value was selected and the rate was allowed to drift according to Brownian motion along each branch of the phylogeny as time progressed. This produced two data sets of fossil occurrences, one for each sampling condition, which record both the taxon and the time of preservation for each fossil. Three suites of methods were compared to understand which is best-equipped to handle this type of data. Non-model-based approaches (divDyn package), Bayesian inference (PyRate), and capture-mark-recapture (MARK) techniques were used to estimate the origination and extinction rates and then compared to the true rates under which the phylogenies were simulated. Preliminary results suggest that phylogenetically-heterogeneous sampling leads to a slight inflation of the true origination and extinction rates regardless of the method used.

Tooth replacement and endocranial anatomy of a new Antarctic ornithopod dinosaur

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Ornithopods are a group of herbivorous dinosaurs that were incredibly successful and diverse during the Cretaceous period (~144 – 66 Ma). Fossil remains from this group have been found on all seven continents, demonstrating that ornithopods had a worldwide extent at their apex. Here we use computed tomographic (CT) scan data to investigate the dentary and partial braincase of a new species of ornithopod from the Late Cretaceous of Antarctica. The dentition and neurovascular canals within the dentary

were digitally segmented from the CT data. The relationships between functional teeth, replacement teeth, and non-functional old teeth at each tooth row was examined to investigate the different stages of tooth replacement in this new ornithopod. A complete sequence of tooth replacement could be interpreted from the segmented dentition. By digitally segmenting the internal cavities within the braincase, we were able to partially reconstruct the inner ear of the ornithopod, as well as part of the brain cavity, which would have housed the flocculus in life. The morphology of this flocculus is highly unusual, in that it is forked and extends through the anterior canal of the inner ear. An enlarged flocculus has been linked to increased agility in modern birds, indicating that this ornithopod may have had similar specialisations. These results inform us on the evolution of sensory abilities and dental systems within both ornithopods and other major dinosaur groups.

The first example of cranial material from a UK dryosaurid.

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In 1997, iguanodontian dinosaur material (including teeth, skull elements, forelimb elements and metatarsals) was collected in association with the holotype specimen of the theropod Eotyrannus lengii, from the Wessex Formation of the Isle of Wight (Lower Cretaceous, Barremian). The iguanodontian has been interpreted as possible gut contents of Eotyrannus. Here, I attempt to resolve whether these elements are from the same individual and which iguanodontian species they belong to.

Following proportional comparisons of the lengths of the metatarsals and forelimb bones, as well as the presence of isolated teeth embedded in the matrix surrounding postcranial elements surrounding postcranial elements, it is clear that the elements belong to a single associated individual. Comparisons with other Wealden taxa have shown that this specimen is most similar to dryosaurids (cf. Valdosaurus) but it possesses some derived features of the teeth that were previously unknown for this clade. If confirmed, this would represent the first cranial material from a UK dryosaurid. Additionally, it offers new information on the distribution of dental characters within Dryosauridae. One other Wealden specimen from the Isle of Wight, an isolated dentary, has similar dental characters and might also be a dryosaurid as a result.

Further investigation is planned to determine the ontogenic age of the specimen. Segmentation of µCT scan data is also in progress in an attempt to derive additional character data from specimens still partially encrusted in matrix.

New data on the crocodylian *Tomistoma dowsoni* from the Miocene of North Africa provides insights into gavialoid neuroanatomy

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The interrelationships of the crocodylian species Gavialis gangeticus and Tomistoma schlegelii has been historically disputed. Whereas molecular analyses indicate a sister taxon relationship between the two species, morphological datasets typically place Gavialis as the outgroup to all other extant crocodylians. Recent morphological-based phylogenetic analyses have begun to resolve this discrepancy, with Gavialis more closely related to Tomistoma than to any other living species. However, several stratigraphically old fossil taxa are recovered as closer to Gavialis than Tomistoma, resulting in anomalously early divergence rates. This includes several species currently referred to Tomistoma. Here, we provide new insights into the neuroanatomy of Tomistoma dowsoni from the Miocene of Egypt, based on a near-complete and well-preserved referred skull, which allows enhanced visualization of the braincase. Tomistoma dowsoni appears to be characterized by an intermediate neuroanatomical morphology between Gavialis gangeticus and Tomistoma schlegelii. This is reflected both in olfactory capability, calculated by comparing the greatest diameter of the olfactory bulb with the cerebral hemisphere, and the shape of the inner ear, which exhibits an intermediate morphology between Gavialis gangeticus and Tomistoma schlegelii. This is a starting point in understanding more about the evolution of ecomorphological features in gavialoids that might help resolve the group's phylogenetics interrelationships. By incorporating such previously inaccessible information from the neuroanatomy of extinct and extant crocodylians into phylogenetic analyses, we might be able to resolve remaining problems surrounding the Tomistoma-Gavialis debate.

Studies of a new Eocene irregular echinoid assemblage from Madagascar

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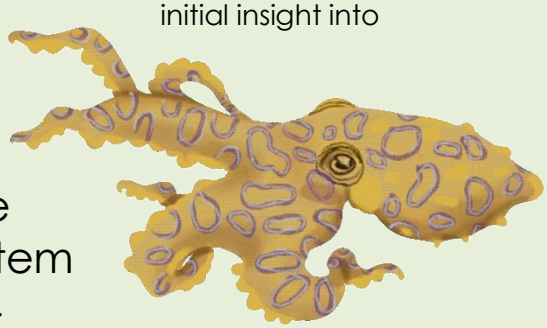
Population and ecological studies of invertebrate palaeocommunities have important implications for past climates and environments. In Madagascar, where the focus has generally remained on exceptional vertebrate palaeontological finds, invertebrate assemblages remain comparably uncollected and understudied. This project examines 116 irregular echinoids from two Middle Eocene sections in the Toliara region of Madagascar to help fill the gap in

knowledge in invertebrate palaeontology, and increase understanding of Eocene climate and environment in this region. The assemblage consists of cassiduloids, clypeasteroids and a few possible spatangoids.

Population and sedimentological analyses have been carried out and the results compared to those found in other Eocene echinoid assemblages. Analysis of morphology using eight measurement points has so far pointed to approximately 20 echinoid morphotypes in Toliara. In addition, a tailored Preservational Index ranging from 1 (crushed) to 10 (perfect preservation) indicated the majority of echinoids featured poor preservation of the aboral surface. These preliminary findings appear consistent with the idea that Eocene irregular echinoids were relatively high in abundance and diversity worldwide. It is known that Madagascar was in a subtropical latitude during the Paleogene compared to today. The specimens were found in a carbonate substrate with varying inferred energy levels. An initial comparison with literature data from the Eocene of Jamaica shows similarities to the Madagascan assemblage and supports a warm climate for Toliara. Whilst much remains to be studied to fully understand shallow marine ecosystems of the region, this work provides an initial insight into a poorly known echinoid fauna.



Nerves of steel: the role of iron in the preservation of the central nervous system

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Over 390 putative neural tissues have been identified in fossils as old as the Cambrian Period, providing unique insights into the palaeobiology of extinct taxa. However, decay experiments suggest that the central nervous system (CNS) is amongst the first organs to decompose postmortem, and there is no known pathway to fossilisation accounting for its exceptional preservation. Iron chemistry, at the core of cellular processes in life, may play a part in the preservation of organic matter after death; and iron is especially profuse in the brain, where it accumulates with ageing in diverse animal families. When iron-protein binding is disrupted postmortem, the free radicals generated as iron reduces and oxidises induce a cascade of protein-lipid crosslinking that might act to preserve the brain during diagenesis. We present the results of investigation by X-ray diffraction of archaeological human brains spanning the last 8ky of the geological record in Northern Europe, demonstrating iron oxides and sulphides are associated with preserved neural tissues. The mineralogical data is supported by palaeoproteomic investigation via liquid

chromatography-tandem mass spectrometry, which demonstrates iron chelation of the ancient brain proteins. Future work will employ advanced metallomic imaging and micro-X-ray absorption near edge structure to refine the precise role of the neuronal iron-redox cycle in stabilising labile cellular elements and constituent biomolecules in the decomposing CNS. Resolving the processes by which the CNS preserves in the early diagenetic window will ensure we can interpret fossilised neural structures with confidence.

Evolution of disparity in Neuroptera wing shapes

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Neuroptera (lacewings) is an ancient insect order, known from about 6500 extant and 930 extinct species, the oldest fossil records of which are early Permian. Lacewings exhibit high morphological diversity in their wing shapes among extant species. Entomologists have presumed that this is a relictual shadow of pre-Cenozoic disparity based on the long history of the order and early diversity of all families. However, this hypothesis is difficult to test because of limited fossil preservation. Here we compare the disparity in neuropteran wing shapes over time using elliptic Fourier analysis to construct a theoretical morphospace of neuropteran wing shape. The result indicates a significant decline in wing shape disparity occurs in the Paleogene and Neogene. The Jurassic and Cretaceous witness the greatest disparity in neuropteran wing shape. Recent lacewings have evolved a rich morphological diversity of wings but still occupy a narrower range of morphological disparity than their Mesozoic counterparts. Lost wings shapes include the broad hindwings of two extinct families Aethrogrammatidae and Kalligrammatidae that fed on flowers. Declining disparity over time correlates with the loss of taxonomic diversity at the K-Pg mass extinction, implying selective extinction based on functional performance and feeding ecology.

Theft of Nature in Brazil: How can social media support the discussion about the repatriation of fossils?

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Biopiracy is the theft of biological material, from materials of medicinal interest to dinosaur fossils and is described as a practice in which indigenous knowledge of nature is used by others for profit, without authorization or compensation to the indigenous people themselves. Critics claim these practices contribute to inequality between developing countries rich in biodiversity, and developed countries hosting biotech firms. The paper answers the following research question: how do social networks can help to

debate the theft and repatriation of Brazilian fossils? It focuses on two major thefts of Brazilian dinosaur fossils and how social media may have had an educational role in forging a public debate on biopiracy. The research method was content analysis of posts and videos of the 4 main Brazilian social media profiles dedicated to science communication in Palaeontology. While some social media profiles did not mention the case, others helped to spread the #UbirajaraBelongsToBR, which was shared by many science educators and general users. A great support for the repatriation of the dinosaur was observed, which led to the removal of the Ubirajara article on 21 December 2020 until a legal investigation of the legal status of the fossil is completed. Although these two are not the first cases of theft of Brazilian biological material, they are the first cases that, with the support of social networks, have managed to reach the common public and gain strength so that the repatriation of the fossils is concluded in a legal and juridical way.

Soft sediment stabilisation via solvent replacement: a novel approach for preserving taphonomic experiments

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The taphonomic pathways of Ediacaran organisms remain contentious, with few decay experiments replicating proposed modes of Ediacaran-style preservation. Previous experimental protocols allowed carcasses to decay atop a substrate, in artificial seawater – allowing observation of character state loss – or within sediments that were later frozen and cleaved beside the carcass. Neither approach is particularly favourable for explaining Ediacaran-style preservation; decay within seawater is not analogous to organisms decaying beneath event beds, and thawing of frozen sediment impedes the quantitative analysis of authigenic mineral phases. Indeed, exhumation intrinsically results in trauma to the carcasses and introduces uncertainty to the spatial component of authigenic mineralisation. Here, we propose a novel, non-invasive method of "solid-state" porewater replacement, permitting stabilisation of the sediment by Paraloid B72 resin. Continual molecular sieve-driven regeneration of anhydrous acetone leverages Le Chatelier's principle, driving rapid replacement of porewater with acetone. Saturation of the sample with dilute Paraloid B72 solution stabilises the substrate, producing a stable specimen suitable for sectioning and quantitative analysis.

Ediacaran-style decay experiments on the anemone Actinia equina were stabilised employing this methodology. These demonstrate that sediment stabilisation via "solid-state" solvent replacement and Paraloid B72 impregnation is non-invasive and preserves the position of minerals within the substrate of taphonomic experiments, allowing quantitative interrogation of phases in multiple spatial dimensions. This approach provides a viable alternative to previous experimental procedures, allowing decay

under appropriate environmental conditions, whilst not sacrificing quantitative spatial data on authigenic mineralisation.

Redescribing the cranial osteology and reconstructing the neuroanatomy of the Scottish dicynodont Gordonia

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The dicynodonts were amongst the most resilient and globally widespread herbivorous synapsids of the Permian and Triassic. Despite their success, much is still unknown of the biology of a variety of species. Gordonia traquairi, a Late Permian taxon from the highlands of Scotland, is an example of such a species surrounded by uncertainty. This taxon is solely represented by moldic fossils contained within sandstone blocks that have previously been studied mainly through destructive techniques. As previous research of the genus has largely focused on examinations of external cranial anatomy, numerous aspects of the internal cranial anatomy and neuroanatomy have been largely undescribed. Here, descriptions are reported of these previously unstudied aspects gathered from research on a specimen of G. traquairi nicknamed "The Marvel". This research uses non-destructive techniques including µ-CT scanning followed by CT scan processing with Mimics to create digital 3D models of a skull and endocast. The skull is also compared to other dicynodont skulls, with a focus on internal cranial anatomy. Furthermore, the data collected from the description of the skull is utilised in phylogenetic analyses that clarify not only the evolutionary position of G. traquairi, but of Dicynodon-grade dicynodonts as a whole. Future work will utilise data gathered from the endocast to reveal intriguing trends in dicynodont brain evolution. More than just expanding our knowledge of this one species, this research significantly enhances our understanding of the Late Permian fauna of Scotland and the palaeobiology of the fascinating Dicynodontia.

Posters

A multidisciplinary approach to resilient woodlands in the lowland Anthropocene landscape of Leicestershire and Rutland, England

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British woodlands cover 13.2% of the UK land and have been reduced to fragments, often in poor ecological condition. Understanding woodland resilience is essential in rewilding and protecting woodland areas from future anthropogenic and natural environmental change. Ancient Semi-Natural Woodland sites in the heavily human-modified landscape of Leicestershire and Rutland have undergone various human disturbance, including extensive modification such as clear-felling in the 20th century, which allows for examination of past resilience to disturbances of current and future concern to ensure the persistence of these now rare, socially and ecologically important habitats. Adopting a multidisciplinary approach, we aim to examine resilient, biodiverse woodlands in lowland Britain, using Leicestershire and Rutland as a case study. Through the integration of information from the fossil pollen record, place-name evidence of past vegetation cover, LiDAR data, and recent botanical surveys, the project aims to reconstruct past vegetation change and identify long-term, stable woodland areas in order to elucidate how ecosystems have recovered after natural environmental or anthropogenic disturbances. This preliminary study aims to feed into the development of a spatiotemporal model for Leicestershire and investigate how resilient woodland ecosystems might be developed for the future, considering various UK climate projections, to inform rewilding and conservation efforts.

Ecosystem structure of benthic communities in eastern and western Weddell Sea, Antarctica

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The structure of modern Antarctic benthic marine communities is unique, with a predominance of sessile suspension feeders and limited predation. Despite the very speciose nature of Antarctica, biotic interactions within ecosystems and between different regions of Antarctica remain poorly understood. In order to investigate how

oceanographic regimes affect benthic ecosystem structure within the Weddell Sea, we used Bayesian Network Inference (BNI) to determine the ecological network structure of the benthic communities in the inflow region of the Weddell Gyre in the East and the outflow in the west. BNI is a technique to statistically infer the causal relationships or dependencies between different variables, such as taxa, substrate type, depth or location, creating a network representation of the ecosystem. We use seabed photographs taken by Ocean Floor Observation and Bathymetry System, Alfred Wegener Institute, from sites in the east and west Weddell Sea to form two Bayesian networks. Comparison of between the east and west networks enables investigation of how different oceanographic regimes affect both the ecological network structure, and which taxon dominates the two regions. Based on the modern ocean networks, we further investigate the ecological structure of fossil communities in the Antarctic.

Cranial topology of pseudosuchians: from evolution to development

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We compared cranial organization and organizational modularity in 50 pseudosuchian taxa and three non-archosaurian archosauriform taxa with the aim to closely explore cranial topological changes as a potential driver for evolution. Although pseudosuchians are more topologically similar to each other when compared to modern birds, the number of bones and their topological arrangement can (1) discriminate early-diverging pseudosuchians, non-crocodyliform crocodylomorphs, non-crocodylian crocodyliforms, and crocodylians, (2) differentiate extant modern crocodilians from extinct crocodilian species, and (3) track the first appearance and the pattern of fusion (i.e., unfused, partially fused, or completely fused) of the left and right frontals and parietals across crocodyliform phylogeny. The number of cranial bones progressively decreases from non-archosaurian archosauriforms to Crocodyliformes and then diversified within the Crocodyliformes. Using 1 basal pseudosuchian (one extinct subadult-adult pair) and 6 eusuchian ontogenetic pairs (2 late-staged embryo-adult pairs, 3 extant juvenile-adult pairs and one extinct juvenile-adult pair), we also found that ontogenetic pairs are topologically similar and they tend to form a more densely connected and more integrated skull during development. Thus, we show that the phylogenetically-dependent pseudosuchian cranial reorganization could be traced as early as the late embryonic stage or early juvenile stage.

Skull Remains from the British Early Cretaceous Ankylosaurian Dinosaur Hylaeosaurus armatus: Description and Phylogenetic Implications

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Hylaeosaurus armatus is a historically important genus of ankylosaurian dinosaur from the Early Cretaceous of southern England. First described in 1833 by Gideon Mantell, the taxon was the third dinosaur to be named, completing the original triumvirate of taxa from which Sir Richard Owen coined the term 'Dinosauria' in 1842. However, since its initial description Hylaeosaurus has remained an enigmatic taxon, with the holotype being the only specimen confidently referred to the genus. It has long been suspected that skull material was present, but such material has never been described in detail, mainly due to extremely poor preservation and logistical difficulties in manually preparing the specimen. This has meant that the phylogenetic placement of Hylaeosaurus within Ankylosauria has been a continuing source of controversy, with debate mostly surrounding whether the taxon is an early-diverging nodosaurid or an early-diverging ankylosaurid. Through the segmentation of micro-CT data obtained at the Natural History Museum, London, this work provides the first detailed description of the skull of H. armatus. Skull material is abundant in the anteriormost portion of the specimen, including: a large section of the left orbital region; tooth-bearing elements, consisting of both the left maxilla and dentary; a partially preserved palatal region; and a significant fragment of the left side of the braincase, containing partially preserved inner ear canals. From these descriptions character scores were added to two recent ankylosaur phylogenies; Hylaeosaurus is subsequently recovered herein as an early-diverging nodosaur in both analyses, further elucidating the phylogenetic placement of the taxon.

Redescribing the cranial osteology and reconstructing the neuroanatomy of the Scottish dicynodont Gordonia

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The dicynodonts were amongst the most resilient and globally widespread herbivorous synapsids of the Permian and Triassic. Despite their success, much is still unknown of the biology of a variety of species. Gordonia traquairi, a Late Permian taxon from the highlands of Scotland, is an example of such a species surrounded by uncertainty. This taxon is solely represented by moldic fossils contained within sandstone blocks that have previously been studied mainly through destructive techniques. As previous research of

the genus has largely focused on examinations of external cranial anatomy, numerous aspects of the internal cranial anatomy and neuroanatomy have been largely undescribed. Here, descriptions are reported of these previously unstudied aspects gathered from research on a specimen of G. traquairi nicknamed "The Marvel". This research uses non-destructive techniques including µ-CT scanning followed by CT scan processing with Mimics to create digital 3D models of a skull and endocast. The skull is also compared to other dicynodont skulls, with a focus on internal cranial anatomy. Furthermore, the data collected from the description of the skull is utilised in phylogenetic analyses that clarify not only the evolutionary position of G. traquairi, but of Dicynodon-grade dicynodonts as a whole. Future work will utilise data gathered from the endocast to reveal intriguing trends in dicynodont brain evolution. More than just expanding our knowledge of this one species, this research significantly enhances our understanding of the Late Permian fauna of Scotland and the palaeobiology of the fascinating Dicynodontia.

A three-dimensional reconstruction of the skull anatomy of the Oligocene tortoise Stylemys.

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Investigating the animal skull structure can enhance understanding on how it once thrived and adapted to its surroundings, or which senses were the most predominant for its survival. For instance, the certain shape of the triturating surfaces of turtles are associated with feeding ecology, and detailed understanding of anatomy may therefore assist in reconstructing ancient ecologies in fossils. Hence, the availability of skull anatomy description of a fossil tortoise improves the understanding of evolutionary morphology of the recent decedents tortoise of a particular genus. The Oligocene tortoise Stylemys sp. was the first found in Nebraska, North America, and initially described by Joseph Leidy in 1952. After its initial description, this genus that belongs to the family of Testudinidae was fallen into disuse, leading to an absence of detailed description as a reference genus. The ongoing work involves reconstructing the 3D skull anatomy of Stylemys sp. via Mimics, an image processing software. Using the attained CT scans of its cranium and mandible, I'd achieve the following aims: 1. develop a high-resolution skull anatomy illustration and description for Stylemys sp. 2. Establish descriptive comparisons for the skull anatomy of three different but likely closely related tortoise species (Stylemys sp., Gopherus sp. and Manouria sp.), to permit a sharper overview of the individuality of skull morphology of Stylemys sp., which may help in understanding the evolution of North American tortoises.

The affinity of embryo-like fossils: new evidence from Mongolia

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The timing of the origin of animals remains unresolved, largely due to inconsistencies between the fossil record and molecular clocks. Animal embryo-like fossils pre-date the appearance of animal body fossils and have the potential to provide the first evidence for metazoans but their taxonomic affinity is unclear. The embryo-like fossils of the Ediacaran Weng'an Biota have been the subject of greatest scrutiny, showing differences in preservation to unequivocal animal embryos from the Cambrian Kuanchuanpu Biota. Do these differences occur due to biology or taphonomy? To begin to answer this question, we have characterised animal embryo-like fossils from the Ediacaran-Cambrian boundary of Mongolia using Synchrotron X-ray Tomographic Microscopy (SRXTM). Initial results from the Mongolian assemblage reveal a broad range of preservation states, from decayed and collapses outer membranes, through to cellular - but not subcellular - level preservation. This is comparable to the lower end of the preservation spectrum in both the Weng'an and Kuanchuanpu biotas, suggesting a common suite of preservation states. This similarity, however, may reflect shared primitive characteristics of multicellular eukaryotes rather than providing evidence of a common animal affinity.

The eyes and vision of ichthyosaurs.

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Ichthyosaurs were dolphin-like marine reptiles that inhabited the world's oceans for most of the Mesozoic. Famously, ichthyosaurs had incredibly large eyes, even rivalling those of the giant squid in size – considered to be the largest in the animal kingdom. However, the function of these large eyes has remained unclear; with suggestions they either increase low-light sensitivity at depth or improve acuity. We use CT scans of two three-dimensionally preserved sclerotic rings from the early Toarcian (Lower Jurassic) Strawberry Bank Lagerstätte, referred to Hauffiopteryx typicus, to create the first complete model of an ichthyosaur eyeball. We demonstrate that H. typicus, and likely other ichthyosaurs, had asymmetrical eyeballs with flattened outer corneal portions.

With this, we calculate minimum f-number estimates – a measure of the light-gathering capabilities of an optical system – for H. typicus and 20 other ichthyosaur species. We find that f-numbers were more variable in the Triassic (0.93–4.43 at 55% aperture diameter), then decreased in the Jurassic (0.99–2.51 at 55% aperture diameter). This follows a pattern of decreasing morphological disparity and ecological focus across the boundary as a result of open water specialization, supporting both the sensitivity and acuity hypotheses.

A new artiopodan from the lower Cambrian Sirius Passet Lagerstätte (North Greenland) and its phylogenetic implications

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Artiopoda is a diverse and important group of Palaeozoic euarthropods yet to be fully understood. Here we describe a new non-trilobite artiopodan from the Lower Cambrian Sirius Passet Lagerstätte, North Greenland. The new taxon is a large species with an ovoid outline, a broad, domed cephalon, followed by fifteen trunk tergites and a small pygidium. Preliminary cladistic analyses recover it as the sister-taxon to Squamacula, a genus found in the Chengjiang and Emu Bay Shale biotas which has previously been recovered as the sister to all other artiopodans. The new taxon is shown to be distinct from Squamacula because the anterior trunk tergites bear articulating half-ring-like structures and the pleural tips and genae are rounded. Posteriorly, the half-ring structures are absent, and the pleura form short spines. Its phylogenetic position means it is potentially important for understanding the ancestral states of Artiopoda and the groups origin.

Cynodont brain morphology: a case of natural or modeller variation?

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Mammalian brains are the complex culmination of biological experimentation over millions of years, with distinct pulses in brain development associated with improved olfaction (sense of smell), tactile sensitivity from body hair and neuromuscular coordination of limbs. CT-scanned skulls of mammal ancestors, non-mammalian cynodonts, provide evidence of morphological changes, either from rarely preserved fossilised brains or more commonly, digital reconstructions of the endocranial (brain) cavity. Through visualising soft tissues lost to the fossil record, it is possible to understand more about the morphological changes during the evolution of cynodonts toward their mammalian descendants.

However, these inferences rely upon digital reconstructions being accurate representations of the original internal anatomy. It is assumed that cynodont brains largely filled the cranial cavity, as in modern mammals, but the brain would have been surrounded by additional tissues that are not accounted for during the reconstruction process, hence highlighting an important bias within virtual palaeontological techniques.

To further understanding of the biases imparted during the reconstruction process, a modeller variation study was conducted using the most prolifically discovered cynodont, Thrinaxodon liorhinus, from the Triassic of South Africa. Significant variation between the 3D models highlighted specific brain regions at greatest risk of subjective reconstruction within basal cynodonts. Identifying these areas is imperative for making more reliable inferences about cognitive and sensory capabilities, alongside behavioural patterns, using digital reconstruction techniques in cynodonts and many other taxa.

Investigating the implications of museum collection bias on palaeocommunity reconstruction: a case study of the Eocene bony fish of the London Clay Formation, UK

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Early Cenozoic community and ecosystem responses of bony fish to elevated sea temperatures hold insights for present and future marine impacts of global warming. Fossil fish have been collected from the UK's early Eocene (Ypresian, 56 – 47Ma) Lambeth and Thames Groups, particularly the London Clay Formation (~50 – 47Ma), for nearly two centuries, with much research confined to taxonomic monographs over 50 years old. A lack of body fossil record integration coupled with poor fossil fish representation in online databases and published literature means these fossils are not fully utilised for taxonomic, functional and ecological diversity. Whilst otoliths

(biomineralised inner ear structures) are a valuable taxonomic resource, their identification to species level can be more complex than that of relatively complete skeletal remains, making them an underutilised resource in palaeocommunity reconstructions. Yet, they are generally more common in the geological record, with large collections housed in museums globally. Here we present preliminary findings assessing early Eocene bony fish diversity and ecology in a greenhouse world from the Natural History Museum's, London (NHMUK), uncatalogued collection, as well as environmental, preservational and sampling biases that impact studies focused on museum collections and subsequent palaeocommunity and palaeoecology reconstructions. The NHMUK collection contains 8215 otoliths from the Ypresian identified to species level. Diversity indices suggest a distinct fauna arises in the London Clay Formation, compared to preceding Thames Group strata with dominance of tropical fauna, some of which are known today and could signal expansion of these families as climate change warms oceans.

Diverse Ediacaran microbial surface textures from the Longmyndian Supergroup, England: business as usual or a case for Precambrian anactualism?

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Avalonian Ediacaran macrobiota from Charnwood Forest (UK) and Newfoundland (Canada) include some of the earliest known large and complex multicellular eukaryotes. The Longmyndian Supergroup (Shropshire, UK) was deposited coevally with these fossils and at a similar palaeolatitude. Despite this, the Longmyndian succession has so far yielded no macrofossils, but does host abundant and diverse surface textures within a variety of environments, many of which can be confidently linked to active matground communities at the time of deposition. This study aims to: 1) better constrain Longmyndian depositional environments, with the succession overdue a detailed sedimentological analysis; and 2) characterize the delicate surface textures and comment on their possible formation mechanisms. This combined approach, bolstered by observations drawn from both modern and Phanerozoic systems, will permit assessment of the anactualistic (or actualistic) nature of these ancient palaeoenvironments and taphonomic pathways. Our initial interpretations include two surface textures never before described from the Longmyndian Supergroup: discoidal impressions with diameters up to 3 cm; and circular rims linked in a chain-like fashion. Idiosyncrasies regarding morphological attributes of particular fabrics persist, with tectonics, palaeoflow direction, and the behaviour of the microbial community itself invoked as additional mediating mechanisms. Despite these challenges, a better understanding of these delicate surface textures promises important insight into the

palaeoecology and evolution of an Ediacaran palaeocommunity that lacks classic Avalonian macrofossils.

Testing melanosome chemistry and formation: evolutionary implications of the casing model

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Melanins are vertebrate pigments that occur in organelles termed melanosomes. The chemistry and abundance of the two melanin types – eumelanin and phaeomelanin – within different tissues in fossil and modern animals has been characterized in previous studies. The spatial distribution of melanins within individual melanosomes, however, remains largely unknown. The casing model proposed that the internal structure of melanosomes is comprised of a phaeomelanin core surrounded by a eumelanin shell; but evidence for the presence of both types of melanin within a single melanosome is scarce, and whether the core or shell forms first remains unknown. Resolving these issues will inform on the biosynthesis of melanin and will enhance our understanding of melanin evolution. For this purpose, we studied melanosomes from European sea bass (Dicentrarchus labrax) retinal pigmented epithelium using synchrotron-X-Ray Fluorescence nanoprobe analysis. We mapped melanosomes at nanoscale resolution to study the distribution of the melanin-chelated metals Zn, Ca and Cu in these organelles. Our results show a Zn- and Ca-rich core and variable distribution of Cu in the melanosomes, with some melanosomes showing enrichment in all three metals. These results support the coexistence of both types of melanin within an individual melanosome, but clear evidence for a eumelanin-rich shell was not detected. Further analyses using synchrotron Fourier Transform Infrared spectromicroscopy at nanoscale resolution will help characterize the distribution of functional groups within melanosomes.

Osteology of Crocodylus palaeindicus from the late Neogene of Indo-Pakistan and the phylogenetic relationships of crocodyloids

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Crocodylus palaeindicus is a well-sampled lineage of extinct crocodilian from the late Miocene to Pliocene of Indo-Pakistan. First described in 1859, this species has been suggested to be ancestral to the extant mugger crocodile, C. palustris. At the end of the 19th century, several fossil skulls from India were assigned to Crocodylus sivalensis; however, later studies suggested that C. palaeindicus and C. sivalensis were synonymous. Here, we provide an anatomical and systematic revision of C. palaeindicus that supports its validity, including synonymization of C. sivalensis. We present phylogenetic data matrix of Crocodylia, comprising 154 taxa scored for 337 characters, with emphasis on improved sampling of crocodyloids. Crocodylus palaeindicus is consistently recovered as the sister taxon of C. palustris, although their relationship with other Crocodylus species varies with character weighting strategy. Phylogenetical analyses with the molecular topology of extant Crocodylia species constrained as a backbone show that trees recovered with this constraint are significantly less supported than those without it. Orientalosuchina is a recently erected clade of Asian crocodylians that was included within Alligatoroidea, but is here recovered as an early diverging clade within Crocodyloidea or Longirostres. Astorgosuchus bugtiensis, from the Oligocene of Pakistan, is included in a phylogenetic analysis for the first time, and clusters with basal crocodyloids from the Paleogene of Europe and North America. One of the skulls previously assigned to C. sivalensis appears to show closer affinities with C. palustris, providing tentative evidence that the two species were sympatric at least during the Pliocene.

Predictability of tooth form in lizards: a phylogenetic or dietary signal?

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With >7000 species, lizards form the most speciose group of reptiles alive today. Recent studies have found that the tooth surface complexity of herbivorous lizards is greater than carnivorous ones, indicating a difference in tooth morphology. Here we investigate whether this is true for gross tooth morphology using 2D geometric morphometrics. We looked at two groups of lizards, those that have frequent tooth replacement (majority of

lizards) and those with permanent teeth (the iguanid clade Acrodonta), in addition we also compared them to their largely extinct sister-group Rhynchocephalia. We found that diet explained occupation of dietary morphospace poorly, with a lot of overlap between different guilds, suggesting that inferring diet based on tooth shape alone is problematic. Phylogeny better explained morphospace occupation, which is true for all three categories, though Acrodonta shows a greater amount of overlap that reflects the close relationships of members of this clade. Interestingly, we find more similarity between the teeth of lizards and rhynchocephalians with permanent teeth (e.g., crowns are lower, and teeth are more mesio-distally elongated, than with taxa where the teeth are regularly replaced, suggesting morphological adaptations to increase tooth longevity.

Characterisation of internal and external melanin across the fish phylogeny

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Melanins are pigments that are synthesised within cell-bound organelles termed melanosomes, occupying both integumentary and internal body tissues. In vertebrates, melanins play important roles in communication through the generation of colours and colour patterns, however, they also express putative functions in UV protection, crypsis, mechanical stiffening, thermoregulation, anti-predator defence, metal homeostasis and immunity. While our current understanding of the geometry, anatomical distribution and function of melanin derives largely from studies on higher vertebrates, the characterisation of melanin in lower vertebrates and their close relatives is considerably more limited. This has constrained our understanding of the origin of melanin and its functional evolution within the vertebrate clade. Of particular interest is the internal melanin of bony fish, with purported function in immunity and evidence of synthesis in-situ within extracutaneous tissues. Here, we will resolve these issues by sampling ten tissues in twelve species of extant fish, comprising a wide phylogenetic spread of early-diverging vertebrates. By applying SEM, HPLC-AHPO and synchrotron-XRF analyses, we will identify the trends in melanosome chemistry, morphology and anatomical distribution of fish tissues. This new dataset will be tested against known trends in these melanosome characters in extant amphibians and reptiles, informing on the role of melanin across the transition to life on land.

Billabong Beauties – mid-Cretaceous freshwater molluscs as palaeoenvironmental indicators in the Griman Creek Formation, Australia

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The Griman Creek Formation (GCF) of eastern Australia is a taxonomically diverse mid-Cretaceous (100-96 Mya) fossil deposit containing high-latitude vertebrate and invertebrate fauna, living on a near-shore, fluvial floodplain. Whilst the vertebrate fauna enjoys prominence, little attention has been paid to the invertebrate molluscan fauna, apart from a handful of taxonomic descriptions, and no detailed palaeoecological reconstruction has been carried out.

Bivalve fauna are considered keystone taxa in both extant and extinct freshwater ecosystems; oxygenating substrate, filtering water, engineering habitats, and nutrient cycling, while their shell shape informs both life habit and environmental conditions. The GCF preserves two classes of freshwater molluscs: bivalves and gastropods, indicating the region had a dynamic and diverse ecosystem, supporting a range of aquatic and terrestrial taxa. The largest and most abundant mollusc deposits contain benthic bivalves from the superfamily Unionoidea. Several gastropod taxa from the aquatic Viviparidae and Thiaridae families have been identified, together with a terrestrial Succineidae snail.

I present preliminary data on the freshwater mollusc faunal assemblages (>21,000 specimens from 5 families), illustrating abundance, diversity, and mapping distribution across the region. This data is an invaluable addition to informing the palaeogeographical reconstruction, differentiating between flowing river channels and brackish backwaters, all supporting future research. Presented results are preliminary, as project is due for submission end September 2022.

Testing hypotheses on heterostracan feeding using computational fluid dynamics (CFD) and finite element analysis (FEA)

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Teeth constitute a key innovation underpinning the evolutionary and ecological development of jawed vertebrates. As the earliest jawed vertebrates already possess teeth, we must study tooth-like structures in stem gnathostomes to learn more about their

evolutionary origin of teeth. Heterostracans are a group of extinct, jawless vertebrates, that possess tooth-like structures (oral plates). These oral plates have been hypothesised to perform a diversity of functions, from filter-feeding to predation.

We tested the suspension-feeding hypothesis using computational fluid dynamics (CFD). We compared flow patterns of different models with forward-facing denticles to alternative models with rear-facing denticles. Independent of denticle orientation, similar velocity and turbulence patterns develop in the spaces between the denticles and on their upper surface. Formally rejecting the suspension-feeding hypothesis is challenging, but we can at least reject the hypothesis that the forward-facing oral plate denticles are an adaption to suspension-feeding.

To test the predation hypothesis, we used finite element analysis (FEA) and microstructural analysis to test whether the plates are adapted to a mechanical function. FEA stresses in the shaft of the oral plate are negatively correlated with bone volume fraction; the smaller the compressive or tensile stress, the higher the bone volume fraction. The anterior part of the oral plate shows the highest bone volume fractions. This indicates a specific adaption of the microstructure to a mechanical function. Thus, we reject a filter-feeding function for heterostracan oral plates, instead concluding that they performed a mechanical feeding function.

Stellate bosses from the Diabaig formation: 3D preservation of reticulate microstructures in a 1Ga lake system

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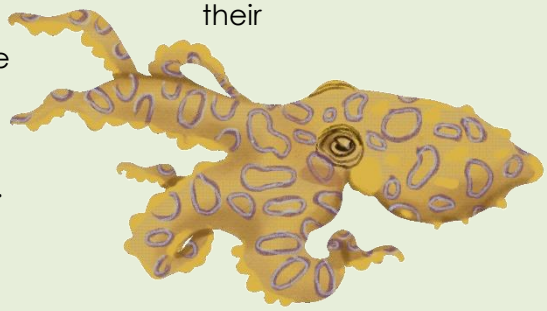
The Diabaig Formation of Northwest Scotland is well known for its microfossils and microbial sedimentary structures (MISS) and was deposited in a lacustrine environment around 1 Ga. Previous authors have reported abundant and varied forms of reticulate MISS on bed surfaces. Some of these contain stellate bosses; polygonal, three-dimensional pipe-like structures 1-4mm across intruding at least 2-3mm into the sedimentary horizon below its ridge junction. These bosses have a distinct sediment composition to the host sediment. Here, the first detailed description of the stellate bosses is presented and they are examined in terms of their morphology, distribution and depositional context to provide insight into their possible origins. It is most likely these represent macroalgal holdfasts, with implications for the stability of depositional surfaces within late Proterozoic lakes.



Invertebrate Trace Fossil Associations with Mesozoic Marine Reptiles

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Invertebrate assemblages have been recovered in association with whale carcasses in both the present day and in the fossil record. These whalefall communities are highly specialized for exploiting the nutrient influx produced by large vertebrate falls. A few instances of organisms occupying this type of environment have been described from Mesozoic marine reptiles. Although it is possible that marine reptile falls provided a similar environment to whalefalls for specialist invertebrate taxa, there has been little focus on these Mesozoic faunas. Several whalefall taxa likely originated in the Cretaceous, raising questions of how the community of invertebrates associated with vertebrate falls changed across the Jurassic-Cretaceo us and Cretaceous-Paleogene boundaries. In this study, marine reptile fossils from three major UK collections were examined for traces of bioerosion. A variety of borings and surface traces were consistently identified on these fossils. Echinoid and gastropod grazing traces are present through the Jurassic and Cretaceous, and boreholes emerge in more oxygenated Jurassic formations, with bivalve borings more common in the Cretaceous. CT scanning will be used for identifying borehole morphology to a more precise level and determining whether worm borings are present. This preliminary identification of ichnotaxa associated with Mesozoic marine reptiles lays the groundwork for describing and identifying taxonomic assemblages associated with marine reptile dead falls more widely. This study will provide a snapshot of the invertebrate taxa present at a Mesozoic marine reptile fall and inform future work on the ecological niche occupied by these specialist taxa through deep time.

A palaeoenvironmental and palaeoclimatic analysis of plant fossils from the Paleocene Naujat flora of Nuussuaq Peninsula, central West Greenland

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The Naujat formation in western Greenland, is Selandian in age (ca. 60 mya) and consist of mainly leaf's deposited in mudstone. The depositional environment is a syn-volcanic lacustrine environment, resulting in excellent preservation of the specimens. The assemblage has however remained poorly studied since its discovery and collection by Oswald Heer in the late 1800s.

The assemblage consists of 100s of detailed leaf fossils, with mainly dicot angiosperms dominating. This study is focusing on the palaeoenvironment of the depositional area with LMA analysis and potentially insect damage. Categorizing the fossils into morphotypes is also one of the primary objectives, as the species seen by O. Heer might not hold up to modern scrutiny.As this assemblage is from shortly after the massive upheaval of the K-Pg mass extinction, it can give a good view into a recovering world in the polar regions of our globe. This area is normally less studied than other parts of the world, due in part to its inaccessibility.

The Late Oligocene to Late Miocene (Chattian-Tortonian) in the British Isles: A 20-million-year record of vegetation and climate change

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[6]*Newcastle University, Newcastle Upon Tyne, UK* As a Cenozoic peninsula on the edge of Europe, the British Isles has a uniquely placed record of environmental and climatic change though time as influenced by North Atlantic ocean currents. By compiling all palynological and palaeobotanical data, both published and newly derived, from Chattian-Tortonian-date deposits – palaeoenvironnmental and palaeoclimatological changes in the British Isles are reconstructed. We note that frost-free wetland palaeoenvironments were present during the Chattian in the Lough Neagh (Northern Ireland), Stanley Bank and Bovey Basin. Recent age revisions of the solution pipe complex of ?Langhian-age Trwyn y Parc, Wales, suggest post-Middle Miocene Climatic Optimum (MMCO) conditions were subtropical, potentially influenced by the proto-Gulf Stream. The Brassington Formation was used to reconstruct Serravallian-Tortonian palaeoenvironments, which ranged from warm-temperate mixed mesophytic forest biomes with local wetlands, in the Serravallian, to warm-temperate mixed forests in the Tortonian, suggesting, progressive cooling and drying in advance of the Late Miocene Cooling event. This is the first study to demonstrate the evolution of the flora of the British Isles during this interval of Cenozoic climate change, and to provide an oceanic perspective on knowledge of Eurasian palaeoclimates and palaeoenvironments.

Finite element analysis of kangaroo astragali: A new angle on the ankle

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Sthenurinae is an extinct subfamily of kangaroos which existed from the middle Miocene until the late Pleistocene. Differences in the anatomy of this group from extant kangaroos, subfamily Macropodidae, have led to the hypothesis that the sthenurines would have employed a striding gait. This stride would have been at slower speeds instead of the quadru/pentapedal gait observed in extant species and possibly as a replacement for hopping at faster speeds for the species which were likely too large to hop at around 140 – 160 kg. While many studies have been done on the postcranial anatomy of these kangaroos, one understudied critical bone is the astragalus; the more medial of the proximal tarsals, articulating with the tibia. Using Finite Element Analysis, I compared the load-bearing capacities of two taxa, the sthenurine Procoptodon browneorum and macropodine Macropus giganteus, to determine if they showed any differences in the stress patterns on their astragalus under different locomotor scenarios, emulating the load experienced at the midstance of the gait when walking bipedally and hopping respectively. The results show clear differences in the observed stress patterns and indicate that both species have different load-bearing capacities, which could support the prior hypothesis of different locomotor strategies. This study helps highlight the diversity that exists within kangaroos and helps with our wider understanding of the past ecology of Australia as the modern continent is much different than it was even compared with the late Pleistocene, being much more arid and less forested.

Three-dimensional anatomy of derived South American cynodonts and homoplasy in the evolution of the mammalian jaw joint

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The acquisition of the mammalian jaw joint and middle ear was a key event in synapsid evolution. Previous research has described morphological changes to the jaw joint and postdentary bones across the cynodont/mammaliaform transition, but more recently discovered non-mammaliaform probainognathian cynodonts from South America have

thus far not been integrated into comparative anatomical studies, despite being represented by numerous specimens including ontogenetic series. In this study, micro-CT data from nine specimens of Brasilodon quadrangularis, the sister taxon to mammaliaforms, and ten specimens of Riograndia guaibensis were segmented to produce an updated description of the jaw articulations of these taxa in three dimensions for the first time. Our findings indicate that the jaw joint of Brasilodon has more plesiomorphic traits than in previous interpretations, lacking a clear squamosal-dentary contact/articulation and instead relying on a main quadrate-articular joint. By contrast, Riograndia possesses a more developed squamosal-dentary contact to reinforce the plesiomorphic jaw joint, formed by a robust postdentary bone complex. These findings suggest that the dentary-squamosal jaw joint evolved convergently in separate cynodont lineages, and that the cynodont/mammaliaform transition was characterised by homoplasy, similarly to the independent acquisition of the definitive mammalian jaw joint and middle ear in Mesozoic mammals.

An Application and Adaptation of k-gonal Numbers Format to Growth Styles in the Inarticulate Brachiopod Lingula and the Main Articulate Groups.

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The exterior of Lingula Bruguière 1797 is 1cm-3cm in length, biconvex, approximately equivalve, sub-oval to spade-like in outline, elongate with lateral margins gently convex to sub-parallel. The ornament consists of numerous extremely fine sub-equal ribs and concentric growth lines (Murray, 1985).

Polygonal numbers are 2-dimensional figurate numbers represented as dots arranged in the shape of a regular polygon, where p(n,k) denotes the k-gonal number with n-sides. e.g. a triangle has k=3, a square, k=4, and a pentagon, k=5 etc., so k represents the number of sides in each polygon. Now, an n-side represents the figurative number in a sequence. e.g. a triangle has the sequence 1,3,6,10,15…, and the third number in this sequence gives n=6.

In a similar fashion, square numbers form a series 1,4,9,16,25 etc., producing a regular lattice. Polygons with more sides, e.g. pentagons and hexagons can also be mapped this way but do not form regular lattices. Pentagons form a series 1,5,12,22,35 etc., and hexagons form a series 1,6,15,28,45 etc., producing irregular lattices.

In this instance, the outline of Lingula is approximated by k, and relative edge size and number of growth lines by n. Thus, we compare these attributes of shape for a Lingula valve against the closest lattice. We find different species of Lingula display a range of irregular lattices due to variations in the elongation of shells, resulting in different k-gonal representation, n-sides, and position along a number sequence. Furthermore, we consider that there is scope to apply this method to articulate groups.

Community development in the Ediacaran of Avalonia

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Community composition varies over time in response to differential patterns in biotic and abiotic variables. Pathways of succession in the benthic communities in the Avalonian Ediacaran (~580-560 Ma) have been suggested with certain taxa associated with different phases of community development; e.g. Fractofusus is often associated with early succession, whereas large frondose taxa are placed in later stages of community development. In order to investigate how Avalonian communities mature, we mapped

out the position of specimens using laser-scan and photogrammetric data from 10 bedding planes from Newfoundland, Canada. The in-situ preservation of these sessile organisms provides a near census of communities at this time, enabling modern ecological methods to be used to investigate their community ecology. These maps were used to calculate species densities and aerial coverage, as a proxy for biomass. Rank abundance and k-dominance curves of abundance-aerial coverage comparisons were calculated to estimate relative levels of disturbance and community succession. Early successional communities are expected to show a steep biomass-density-based k-dominance relationship which becomes less steep later in succession. The W-statistic was applied to determine demonstrable differences between communities. These analyses enabled us to establish how community development contributes to observed variation in these Avalonian benthic communities.

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