# 3RD CROSSING THE PALAEONTOLOGICAL-ECOLOGICAL GAP (CPEG)

## Abstract book

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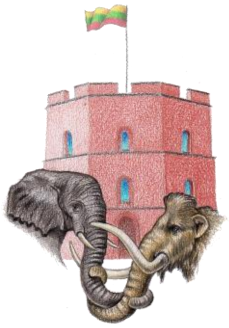


# Foreword

Dear colleagues,

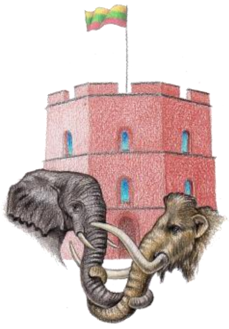
Welcome to the 3rd Crossing of the paleontological-ecological gap!

Lithuania is a country with a deep passion for Nature, past and present. The sedimentary succession of the Baltic Basin encompasses all Phanerozoic periods as well as  strata of the preceding Ediacaran period. The abundance and diversity of fossil material attracted the attention of paleontologists for more than two centuries and counting. Moreover, current biota occupying the territory of the state is probably one of the most pristine in Europe, with several megafaunal species existing as holdovers from much less anthropogenically affected Holocene epoch, spared by the Grand Dukes in Medieval times, and whose names are reflected in names of towns. The place of the conference—Vilnius itself was a sacred place in quite recent pagan times with an ancient forest called Šventaragio slėnis (the valley of the Holy Horn), whereas legend says the Iron Wolf howled on the Gediminas Hill. Some of you will enjoy this Nature in one of the excursions of the conference.

The conference is rich in a diverse array of approaches presenting data and models of ecological systems from the fastest to the slowest processes working at all time and space scales. Workshops will help the dissemination of some of the growing themes in spatio-temporal analyses of ecosystems, and beyond academia sides of scientists' life. Let's make the best of this meeting, and bridge the gap between ecology and paleontology together in order to appreciate, understand, and predict the biota!

Andrej Spiridonov

General Chair



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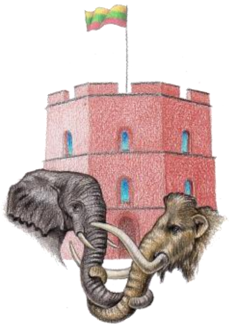

# Scientific programme

## Monday, August 28, 2023

| | | |
|---|---|---|
| 8:00 | | Registration desk open, hanging posters, uploading presentations etc. |
| 9:00 | 9:15 | **Opening Ceremony** |
| | | **Session 1: Biotic interactions and evolution** |
| **9:15** | **10:00** | **J. Bailey. Geodiversity as a common language across ecology and palaeontology (Keynote)** |
| 10:00 | 10:15 | **D. Hembry**. Integrating ecological interactions into macroevolution: a neontologist’s perspective |
| 10:15 | 10:30 | **I. Žliobaitė**. The Law of Constant Extinction Revisited: from the Living to the Fossilized |
| 10:30 | 10:45 | **K. Vanadzina**, Kenneth De Baets. Abiotic drivers of global parasite distribution throughout Holocene |
| 10:45 | 11:00 | **E. Budrys**. Simplified model for estimation of an evo-ecological niche of species |
| 11:00 | 11:30 | **COFFEE & TEA** |
| | | **Session 2: Functional ecology: traits, proxies, and processes** |
| **11:30** | **12:15** | **P. Novack-Gottshall. Bridging ecology and palaeoecology through functional diversity (Keynote)** |
| 12:15 | 12:30 | E. Berlioz, L. Lesage, A. Euriat, **G. Merceron**. Tree cover and dental microwear: A red deer model for deciphering paleoenvironmental variations |
| 12:30 | 12:45 | **J. A. Cooper**, C. Pimiento. How has shark functional diversity changed through geologic time? |
| 12:45 | 13:00 | **M. Krycki**, D. Bajnai. The investigation of the thermophysiology of *Parasuchus* sp. from the late Triassic of southern Poland using the methods of isotopic palaeothermometry |
| 13:00 | 14:00 | **LUNCH** |
| 14:00 | 14:15 | **A.K. Parker**, L. Liu, M. Tallavaara, I. Žliobaitė. The reconstruction of fossil mammal communities using recommender systems, and its effect on ecometric paleoenvironmental inference |

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|---|---|---|
| 14:15 | 14:30 | **A. Swain**, A. Woodhouse, W. F. Fagan, A. J. Fraass, and C. M. Lowery. Biogeographic responses in marine plankton functional groups to Cenozoic climatic and environmental changes |
| | | **Session 3: Past, present, and future extinction and survival** |
| 14:30 | 14:45 | **T. M. Khan**, H. J. Griffiths, A. Manica, R. J. Whittle, N. P. Stephenson, K. M. Delahooke, E. G. Mitchell. Benthic ecosystem complexity in the Weddell Sea |
| 14:45 | 15:00 | **K. Kocáková**, D. Silvestro, A. Gardiner, J.A. Villafaña, C. Pimiento. Neoselachian diversification dynamics and age-dependent extinction |
| 15:00 | 15:15 | **S. Carter McSherry**, L. J. Davies, M. Adesanya Adeleye. An ecological assessment of southern Alaska through observations of floristic change, fire regime and volcanism. |
| 15:15 | 15:30 | **R. Whittle**, E. Mitchell, T. M. Khan, J. Witts, A. Hunter, H. Griffiths. The evolution of Southern Ocean sea-floor ecology |
| 15:30 | 16:00 | **POSTERS, TEA & COFFEE** |
| 17:30 | | **Excursion in Vilnius Old Town** |

## Tuesday, August 29, 2023

| | | |
|---|---|---|
| 8:30 | | Registration desk open, hanging posters, uploading presentations etc. |
| | | **Session 4: Macroevolution, biogeography, and paleogeography** |
| **9:00** | **9:45** | **D. Fraser. The role of biotic interactions in the evolution of Cenozoic (66 Ma – present) mammal communities (Keynote)** |
| 9:45 | 10:00 | **S. Bekeraitė**, R. Stankevič, K.A. Haaga, I. Juchnevičiūtė, A. Spiridonov. Megaclimate caused transitions and multistability in macroevolutionary dynamics of large mammals |
| 10:00 | 10:15 | **L. Daumantas**, A. Spiridonov. The “hespdiv” R package: case study of Miocene mammal biogeography in US |
| 10:15 | 10:30 | **J. Hansford**, E. Saupe, S. Turvey, G. Varnham, M. Grace, H. Ma, I-Ting Tu, B. Li, P. Mannion. Reconsidering Range: Integrating Past Archives for Improved Projections of Species Future Distributions |
| 10:30 | 10:45 | **K. M. Magoulick**, E. E. Saupe, A. J. Farnsworth, C. R. Marshall. Testing hypotheses of migration in the fossil record with Ecological Niche Modeling: a case study using the Western Hemisphere megafaunal genus *Glyptotherium* |

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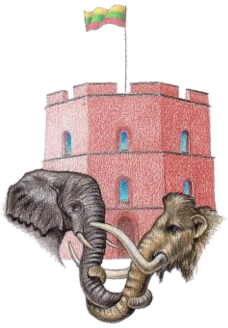
|---|---|---|
| 10:45 | 11:00 | **P. D. Mannion**, M. Kouvari, L. A. Jones, J. D. Carrillo, A. A. Chiarenza, G. L. Varnham, A. Farnsworth and J. F. Brodie. The complex interplay of factors shaping the evolution of the latitudinal biodiversity gradient |
| 11:00 | 11:15 | **A. Kowalewska**, D. Mazurek, E. Yazykova. Turonian scaphitid ammonites from the Opole city area (south-western Poland) |
| 11:15 | 11:30 | **J. Heath**, N. Cooper, P. Upchurch, P.D. Mannion. The evolutionary and palaeobiogeographic origin of the dinosaurs |
| 11:30 | 11:45 | **COFFEE & TEA** |
| | | **Session 5: Ecosystem processes across scales** |
| **11:45** | **12:30** | **E. Newman. What insights can macroecology provide paleoecology? (Keynote)** |
| 12:30 | 12:45 | **K. M. Delahooke**, A. G. Liu, N. P. Stephenson, Ch. G. Kenchington, E. G. Mitchell. Quantification of microbial textures to untangle the relationship between matground and macrofossils of the Avalonian Ediacaran |
| 12:45 | 13:00 | **A. N. Dabengwa**, L. Scott, W. Bond, S. Archibald, C. Lehmann, M. Bamford. Linking charcoal-fire relationships across space and time in African savannas: Implications for palaeoecological-paleontological reconstructions |
| 13:00 | 14:00 | **LUNCH** |
| 14:00 | 14:15 | **C. J. Reddin**, J. Landwehrs, G. Mathes, C. Ullmann, G. Feulner, M. Aberhan. Thermal preferences correspond to escalatory regional species responses during early Jurassic climate change |
| 14:15 | 14:30 | **E. Galli**, I. Menéndez, M. Hernández Fernández, S. Gamboa. Terrestrial biome dynamics during Quaternary glacial cycles |
| 14:30 | 14:45 | **E. O. Wilson**, A. Parker, J. Saarinen. The impact of reptilian predators on mammalian prey communities in La Venta, Colombia |
| 14:45 | 15:00 | **P. S. Nätscher**, G. Dera, C. J. Reddin, P. Rita, K. De Baets. Morphological response accompanying size reduction of belemnites during an Early Jurassic hyperthermal event is modulated by life history |
| 15:00 | 15:15 | **S. Sjosten**, S. Daines, T. Lenton. Modelling the life-environment interface in ancient shelf seas |
| 15:15 | 15:30 | **T. M. Frank**, C. R. Marshall. Investigating the trophic structure of early terrestrial ecosystems |
| 15:30 | 16:00 | **COFFEE & TEA** |
| **16:00** | **18:00** | **S. Lovejoy. The megaclimate biogeological regime: analysis and modelling (Workshop)** |
| **19:00** | | **Conference dinner** |



## Wednesday, August 30, 2023

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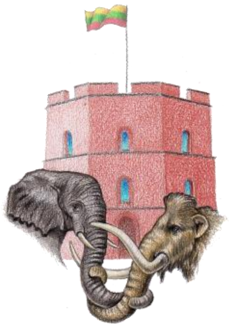
| 8:00 | | Registration desk open, hanging posters, uploading presentations etc. |
| **8:30** | **11:00** | **E. G. Mitchell. Spatial analyses of trace fossil and in-situ sessile communities (Workshop)** |
| 11:00 | 11:30 | **COFFEE & TEA** |
| | | **Session 6: Evolving role of humans as ecosystem agents** |
| 11:30 | 11:45 | **L. Gedminienė**, A. Spiridonov, M. Stančikaitė, Ž. Skuratovič, G. Vaikutienė, K. Stoof-Leichsenring. Impact of climate on Lateglacial and Holocene vegetation: a comparison of palynological and sedaDNA data. |
| 11:45 | 12:00 | **K. Ninard**, M. Stolarczyk, P. Łapcik, A. Uchman. Buried Podzols in the inland dune deposits of Poland record the warmth of medieval climate and anthropogenic impact on the local environment |
| 12:00 | 12:15 | **M. Tzortzi**, G. Iliopoulos, A. Darlas. Partridge for dinner? Taphonomical analysis of avian remains from Melitzia Cave, Mani Peninsula, Greece. |
| 12:15 | 12:30 | **N. Schafstall**, N. Kuosmanen, G. Florescu, J.L. Clear, P. Kuneš. Palaeo-reconstructions from Central Europe based on subfossil beetles (Coleoptera) |
| 12:30 | 12:45 | **R. Skipitytė**. Stable isotopes in palaeodietary reconstructions |
| 12:45 | 14:00 | **LUNCH** |
| | | **Session 7: Community assembly across time and spatial scales** |
| **14:00** | **14:45** | **A. Tomašových. Modeling and estimating temporal scale(s) of fossil assemblages and consequences for ecological analyses (Keynote)** |
| 14:45 | 15:00 | **A. Woodhouse**, A. Swain, W. F. Fagan, A. J. Fraass, C. M. Lowery. Late Cenozoic cooling restructured global marine plankton communities |
| 15:00 | 15:15 | **M. A.J.B. Whittingham**, D. Fraser, H. Maddin. Quantifying changes in Late Carboniferous palaeobotanical community structure: evidence for delayed “Rainforest Collapse” in Atlantic Canada |
| 15:15 | 15:30 | **C. Gibert Bret**, J. McGuire, B. Shipley. Do mammals track plants more than climate? |
| 15:30 | 15:45 | **COFFEE & TEA** |
| 15:45 | 16:00 | **C. Thabard**, J. B. Fourvel. Revision of the Plio-Pleistocene canid guild in Southern Africa: first insights for its paleoecology |
| 16:00 | 16:15 | **I. Juchnevičiūtė**, S. Bekeraitė, A. Spiridonov. Bayesian network analysis reveals the assembly drivers and emergent stability of Pleistocene large mammal communities |



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|---|---|---|
| 16:15 | 16:30 | **N. P. Stephenson**, K. M. Delahooke, Ch. G. Kenchington, A. Manica, E. G. Mitchell. Community development in the Avalonian Ediacaran |
| **16:30** | **17:00** | **Closing Ceremony** |
| **17:00** | **19:00** | **H. Saslis. The individual career: beyond the "job for life" model (Workshop)** |

## Thursday, August 31, 2023

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|---|---|---|
| **10:00** | **10:30** | **M. Stančikaitė**. Postglacial environmental dynamics in the marginal area of the Scandinavian Glaciation-multiproxy approach from Lithuania |

# Keynote speakers

# THE ROLE OF BIOTIC INTERACTIONS IN THE EVOLUTION OF CENOZOIC (65 MA TO PRESENT) MAMMAL COMMUNITIES

D. Fraser[1,2,*]

[1] Palaeobiology, Canadian Museum of Nature, Ottawa, Canada
[2] Earth Sciences & Biology, Carleton University, Ottawa, Canada

* dfraser@nature.ca

Biotic interactions occur when organisms living in the same communities directly or indirectly influence one another (e.g., predation, resource competition). They occur within or among species, can be positive, negative, or neutral and play important roles in community assembly over large spatiotemporal scales. The outcomes of biotic interactions include, for example, competitive exclusion, limiting similarity, and apparent limits to the accumulation of biodiversity, among others. Limits to biodiversity result from the accumulation of species during diversification, the saturation of niche space, and, thus, enhanced competition for resources and space. Potential outcomes include slowed rates of origination and increased rates of extinction, particularly among species with high niche similarity as well as changes in community assembly (e.g., changes in niche breadth, changes in geographic range size). However, the degree to which competitive interactions have shaped biodiversity patterns over long time scales remains a subject of contention. Thus, I will address biodiversity limits using two case studies, the first, the extinction of the “creodonts” (i.e., oxyaenids and hyaenodontids) and, the second, mammal diversity through the Paleocene-Eocene Thermal Maximum (PETM) in North America using trait and phylogenetic-based as well as macroecological approaches. I will demonstrate that competitive interactions may explain the extinction of the oxyaenids during the Eocene but do not appear to have driven PETM mammal community assembly, likely reflecting temporal, regional, and taxonomic differences in niche saturation. Studying the outcomes of biotic interactions in deep time will illuminate their relative role in shaping long-term trends in biodiversity relative to more thoroughly studied drivers of community assembly such as climate.

Keynote

# BRIDGING ECOLOGY AND PALAEOECOLOGY THROUGH FUNCTIONAL DIVERSITY

P. M. Novack-Gottshall[1,*]

[1] Professor of Biological Sciences, Benedictine University, Lisle, IL, USA

* pnovack-gottshall@ben.edu

Understanding the processes that drive ecological patterns remains a critical goal for ecology and palaeoecology. The emergence of functional ecology—using organismal functional traits as the focus of ecological studies—has done much to reinvigorate such questions. These ambitions also share parallels with those of palaeontology, and especially with our legacy of studying evolutionary disparity.

In this presentation, I demonstrate how our statistical metrics and analytical methods are mutually supportive. Because many organismal traits can be inferred for both living and extinct organisms, these perspectives allow for a seamless integration of understanding ecology through time. I summarize areas of active research in functional ecology, discuss best practices in building statistically powerful functional trait spaces (ecospaces), and recommend analytical methods that allow us to capitalize on palaeontology's vast knowledge of ancient life habits to answer these critical ecological questions.

Following these recommendations, I demonstrate a new functional trait database that is amenable to use with modern and extinct marine animals. Monte Carlo simulations using these traits can statistically distinguish the major hypotheses for community assembly and ecological and evolutionary diversification. At broader scales, these traits allow palaeoecologists to objectively measure how functional diversity has changed through time (both in terms of number of unique life habits and the ecological disparity of their differences), during the Cambrian and other radiations, and during mass extinctions. These and many other important questions are poorly studied, in large part because the necessary data on ancient functional traits needed to test them have been previously insufficiently available. Overall, I argue that the nascent discipline of functional ecology offers exciting opportunities to leverage paleontological knowledge across ecological disciplines, past and present.

# GEODIVERSITY AS A COMMON LANGUAGE ACROSS ECOLOGY AND PALAEONTOLOGY

J. Bailey[1]

[1]Faculty of Science and Engineering, Cambridge, United Kingdom

Geodiversity is the diversity of features and processes across the Earth's surface and sub-surface, encompassing the full range of spatial and temporal scale. Whilst the role of geology for biodiversity has been recognised for hundreds of years, it is only recently that we have begun to harness geodiversity's full potential in improving our understanding of biodiversity. This is because of novel data and techniques. These efforts have resulted in improved recognition of geodiversity in policy and protected area management worldwide, whilst providing a new mechanism to explore theoretical and applied ecology, all of which will be covered in this talk. This includes discussing the alignment of species traits in a mechanistic, cross-scale geodiversity framework, and the gaps that geodiversity can fill to enhance our understanding of patterns of life. Scanning the horizon, geodiversity will be discussed as a potential ground for collaboration between researchers studying different times, places, and taxa, as well as how it may be beneficial to all rally around the concept in the pursuit of nature recovery in a time of global environmental change.

Keynote

# WHAT INSIGHTS CAN MACROECOLOGY PROVIDE PALEOECOLOGY?

E. A. Newman[1,*]

[1] Department of Integrative Biology, University of Texas at Austin, Austin, Texas, USA
* newmane@berkeley.edu

MacArthur and Wilson's Theory of Island Biogeography (1967) provided a conceptual model for unifying species richness and area patterns for islands, launching the field of macroecology. In parallel to this major development, other core patterns of macroecology including relationships between species richness, abundance, and biomass were being formalized. Macroecological patterns often have the properties of being able to scale over space and time by design, and to describe law-like patterns in nature. Recent developments in macroecology include the Maximum Entropy Theory of Ecology (METE) (Harte, 2011; Harte and Newman 2014), which uses an information entropy framework to generate predictions for many of the known macroecological patterns, and its extension to an Ecological Equation of State (Harte et al. 2022), which describes the general relationship among species richness, metabolic energy rates of individuals, biomass, and abundance. The success of this equation opens up opportunities for estimating difficult-to measure state variables from measurements of others, and unites the Maximum Entropy Theory of Ecology with the Metabolic Theory of Ecology. In this talk I will address what we have learned about the "law-like" macroecological patterns, and how these patterns can be applied in paleoecological contexts where communities are necessarily incompletely sampled, and where a dataset may represent a "snapshot" of an ecosystem that spans thousands of years. With more complete data from extant ecosystems and general equations between variables representing species richness, abundance, and productivity, we can test these relationships with data from ecosystems of the present, and apply a new set of tools to better understand ecosystems of the past.

**Acknowledgements**: Dr. E. Newman thanks various coauthors including John Harte, Micah Brush, Kaito Umemura, and Meng Xu. She also acknowledges previous support from the National Science Foundation of the USA, and the Gordon & Betty Moore Foundation.

**References:** (1) MacArthur, R.H. and Wilson, E.O., 1967. *The theory of island biogeography* (Vol. 1). Princeton university press. (2) Harte, J., 2011. *Maximum entropy and ecology: a theory of abundance, distribution, and energetics*. OUP Oxford. (3) Harte, J. and Newman, E.A., 2014. Maximum information entropy: a foundation for ecological theory. *Trends in Ecology & Evolution*, *29*(7), pp.384-389. (4) Harte, J., Brush, M., Newman, E.A. and Umemura, K., 2022. An equation of state unifies diversity, productivity, abundance and biomass. *Communications Biology*, *5*(1), p.874.

# MODELING AND ESTIMATING TEMPORAL SCALE(S) OF FOSSIL ASSEMBLAGES AND CONSEQUENCES FOR ECOLOGICAL ANALYSES

A. Tomašových[1,*]

[1] Earth Science Institute, Slovak Academy of Sciences, Bratislava, Slovakia
* geoltoma@savba.sk

Temporal scale (temporal grain or time averaging, total time-series extent, and temporal spacing among samples) of the fossil record varies by several orders of magnitude, and if not accounted for, this variability will generates misleading eco-evolutionary inferences (e.g., diversity patterns are modulated by species-time relationship, temporal volatility in composition or spatial beta diversity are expected to be depressed by time averaging). This variability in temporal scale was extensively documented over the past two decades in the Holocene-Pleistocene fossil-assemblage records on the basis of amino acid racemization, $^{14}$C or U-Th dating of mainly marine invertebrates (mollusks, corals, brachiopods). However, the magnitude of the observational scale is difficult to estimate directly in the deep-time records (in contrast to neoecological studies), and temporal overlaps between adjacent assemblages in stratigraphic successions have no equivalent in neo-ecological studies. These studies empirically show that under slow sedimentation rates that are typical of continental shelves or deep sea (1) time averaging of fossil assemblages is frequently millennial or longer, (2) species co-occurring in cm-scale increments can be offset by centuries or millennia, and (3) age unmixing shows significant differences in the temporal patterns of species abundance between raw and unmixed time series. Modeling studies that use stochastic transition-rate matrices to estimate burial, exhumation and disintegration of fossil remains show that the null expectation under bioturbation is that time averaging will increase from the surface mixed layer towards the historical layers even in the absence of any temporal changes in sedimentation or mixing. The topmost increments located in the mixed layer of Holocene sediment cores can thus exhibit biotic trends that generated by scale changes rather than by true ecological changes. In the absence of dating, one approach how to detect the temporal scaling effect (in the deep-time fossil record) is to assess the abundance-diversity relation that is expected to be positive if net sediment-accumulation rates vary within successions or along a geographic gradient.

# Sessions

# Session 1: Biotic interactions and evolution

# INTEGRATING ECOLOGICAL INTERACTIONS INTO MACROEVOLUTION: A NEONTOLOGIST'S PERSPECTIVE

D. Hembry[1]

[1]Department of Biology, University of Texas Permian Basin, United States

For over a century, paleontologists, geologists, and biologists have debated whether or not ecological (biotic) interactions among different species play a role in driving evolution over geologic timescales (macroevolution). Many of the major figures in evolutionary biology have espoused opposing views on this issue, and the debate has long remained unresolved. In recent decades, advances in phylogenetics and phylogenetic comparative methods, as well as analyses of extensive fossil datasets, have shed new light on this old question. In this talk, I will provide an overview of the history of this debate, and then present a neontological perspective on what we have learned toward the resolution of this question. I will argue that recent advances in phylogenetic comparative methods and other approaches in evolutionary ecology reveal that ecological interactions do in at least some cases (adaptive radiation, and specialized mutualistic and parasitic interactions) act as macroevolutionary forces. I will also argue that the evolution of interactions themselves over macroevolutionary timescales must also be considered when asking questions about this topic. I will conclude by discussing the extent to which neontological and paleontological approaches to this issue provide mutually consistent or complementary perspectives.

# THE LAW OF CONSTANT EXTINCTION REVISITED: FROM THE LIVING TO THE FOSSILIZED

I. Žliobaitė[1]

[1] University of Helsinki, Finland

The Law of Constant Extinction (Van Valen, 1973) posits that the probability of extinction of species in the same ecological contexts does not depend on their age. The Red Queen’s hypothesis, a process-based theory to explain this pattern, implies exponential decay of species durations. Under this process many short-lived species and very few long-lived species are expected, and the expected duration a species is inverse of the decay rate. Here we ask what patterns, what species durations and what relative abundancies can be expected in the fossil record if the evolutionary process follows the Law of Constant Extinction, but only a realistically small fraction of species fossilize and those long-lived or widespread are more likely to appear in the fossil record. We analyse several scenarios of fossilization via probabilistic modelling simulations and compare the patterns to those observed in the mammalian fossil record globally throughout the Cenozoic.

# ABIOTIC DRIVERS OF GLOBAL PARASITE DISTRIBUTION THROUGHOUT HOLOCENE

K. Vanadzina[1,*], K. De Baets[1]
[1] Institute of Evolutionary Biology, University of Warsaw, Warsaw, Poland
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Parasitism is one of the most common survival strategies on Earth, with up to 40% of species characterized as parasitic[1]. While parasites are relatively well-protected when residing within the host, the early life stages in many species are released into the environment[2] rendering them sensitive to abiotic factors such as temperature. Recent studies have established that loss of parasite species can have a negative effect on food web structures in habitats affected by global warming, which highlights the urgency to learn more about parasitic systems[3,4]. A better understanding of shifts in parasite distribution in response to past environmental change could inform predictions about the future spread of parasites and associated diseases. We compiled information on parasite occurrences from paleoparasitological studies that document resistant parasitic remains found primarily in human settlements throughout Holocene at high spatial and temporal resolution but have rarely been used in evolutionary context. A dataset of more than 1000 parasite occurrences with a global distribution indicates that the majority of finds date within the late Holocene (4200 yBP onwards). Nematode helminths are the most common phylum of parasites documented in the archaeological record followed by platyhelminths. Small intestinal roundworms and whipworms (genera *Ascaris* and *Trichuris*) are particularly well-represented, which likely relates to the good preservation potential of their eggs. In line with model projections from the geographical distribution of modern parasites[5], which suggest that warmer climates might lead to low-latitude parasites invading temperate ecosystems, our preliminary analysis indicates that parasites shift to higher latitudes in warmer periods throughout late Holocene. We next aim to assess the impact of abiotic factors on parasite distribution using environmental modelling approaches. We will also estimate how biases in preservation and sampling – such as the overrepresentation of European, Andean and the Nile Valley finds in our dataset – might affect our findings.

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# SIMPLIFIED MODEL FOR ESTIMATION OF AN EVO-ECOLOGICAL NICHE OF SPECIES

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I propose to define the realized evo-ecological niche of a species as a part of the ecosystem's hyperspace with the dimensions of resources' productivity and predator/ parasite pressures, where the probability of resource conversion into biomass of the species' populations is higher than that of any other species competing for the resource. The model is derived from Holling's [1] equation of the type III functional response, reflecting either the consumer's population growth through consumption of a resource, or suppression of growth due to consumption by a predator or parasite, complemented by the Yan and Hunt [2] equation of functional response to temperature or other abiotic conditions. The resource productivity and the consumer's growth are estimated as change of mass per space per time, divided by the summarized biomass change of the populations of all competing species of the guild. The resource productivity may be considered as a spatial scale of productivity distribution, or as a temporal scale of its change during a succession. The model includes species-specific parameters: (1) gross growth efficiency (*GGE*), representing a ratio between growth of biomass and the consumed resource; (2) space-time efficiency (*STE*), estimated as space and time needed for growth of a biomass unit; it may be considered as a product of exploited space and handling effort; (3) the power, reflecting a non-linearity of dependence of the growth of biomass on resource productivity; and (4) three parameters (min, opt and max) of Yan and Hunt equation, depicting the dependence of the *GGE* and *STE* on temperature or other abiotic conditions. The model quantifies, how generalists with low *GGE* may outcompete specialists at high resource productivity in case of low *STE*, i. e. low search and handling effort needed. At equal *STE*, the generalists may outcompete the specialists at low resource productivity, despite their lower *GGE*, due to a weaker dependence on single resource. At equal *GGE*, the generalists with low *STE* may win competition at high resource productivity, if their dependence on it is non-linear, e. g. they are able to learn and switch to the most abundant resource.

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# Session 2: Functional ecology: traits, proxies, and processes

# TREE COVER AND DENTAL MICROWEAR: A RED DEER MODEL FOR DECIPHERING PALEOENVIRONMENTAL VARIATIONS

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Among others, dental microwear texture analysis (DMTA) is a proxy of dietary niches [1]. Applied on herbivores, it allows to describe vegetal resources and assess environmental changes. However, up to now, there is no study correlating tooth microwear and tree cover. Here we propose to fill this gap by modelling this relation. As the diet of red deer (*Cervus elaphus*) varies from grass to browse depending on resource availabilities [2], it is an ideal candidate to test such a model, which would be helpful in deciphering tree cover in the past.

On the one hand, we created vector layers with QGIS for the habitats of nine European populations of extant wild-shot red deer [3] (N=283 adults). In each area, we randomly generated 5-km² circles assessing individual home ranges. We then superimposed these circular batches with the CORINE land Cover data (2018 update). DMTA was done using Scale-Sensitive Fractal Analysis [4] on the lower second molars of these deer. We found low pseudo-R² between DMTA and land cover when zooming in at the individual scale. At the population scale, we found that the textural fill volume is negatively correlated with the percentage of open habitats, wherein herbaceous dicots and monocots are more abundant than in forested habitats. Applied to early Pleistocene European cervids, notably the genus *Eucladoceros*, our results suggest similarities in tree cover between site of Chilhac with the forested area of Białowieża, Poland [5] and between the site of Senèze with the southern Iberic populations occupying open habitats [6].

The land cover should be considered with caution, however. It does not directly reflect the preferred food resources of the red deer, but instead natural and agricultural landscapes, the categories of which need to be adapted to better address (palaeo)ecological issues. These preliminary results, however, provide interesting perspectives.

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# HOW HAS SHARK FUNCTIONAL DIVERSITY CHANGED THROUGH GEOLOGIC TIME?

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Modern sharks have a long evolutionary history, during which they have persisted through numerous environmental changes and played key ecological roles such as predation-induced top-down control of prey populations. Here, we assess how shark ecological functions have changed over time by quantifying their functional diversity throughout the Cenozoic (66-0.01 Ma) using their well-preserved and abundant fossil teeth. To do so, we compiled a dataset of over 8,500 shark teeth from museum collections and scientific literature and took different dental measurements previously demonstrated to be proxies of ecological traits such as body size and diet. We found functional richness (FRic, volume of trait-space occupied, representing range of functions) to be generally high, with >60% of trait-space being consistently occupied over time. While maximum FRic was reached in the Eocene, the minimum took place in the Pleistocene. Interestingly, based on species-richness, we found the FRic of the last ~10Ma to be generally lower than expected. Despite these changes in FRic, functional redundancy (number of taxa sharing trait-values and hence functions) remained generally stable, with 3-4 species/function over time. Overall, our results indicate that shark functional diversity experienced important changes over the Cenozoic, notably a trait-space reduction from the Miocene onwards.

# THE INVESTIGATION OF THE THERMOPHYSIOLOGY OF *PARASUCHUS* SP. FROM THE LATE TRIASSIC OF SOUTHERN POLAND USING THE METHODS OF ISOTOPIC PALAEOTHERMOMETRY

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The methods of isotopic palaeothermometry can be successfully applied in palaeobiology to study body temperature and thermophysiology, as well as related aspects of lifestyle and palaeoecology of extinct animals. In recent decades, the thermophysiology of non-avian dinosaurs (among other groups) has been investigated with the help of these methods. However, until now relatively limited attention was paid to the second evolutionary lineage of archosaurs – pseudosuchians. Although for years the members of Pseudosuchia were considered to be typically ectothermic animals, modern data obtained by different methods infer the endothermy of the basal groups of this clade. The classic $\delta^{18}O$ method was applied to study the thermophysiology of the Late Triassic phytosaur *Parasuchus* sp., whose remains had been found in Krasiejów in southern Poland. The ectothermic temnospondyl amphibian *Metoposaurus krasiejowensis*, which had been found in the same geological strata in Krasiejów, was chosen as a reference due to a large degree of similarity in the diet, habitat and lifestyle of both animals. The results of isotopic measurements of the parameter $\delta^{18}O$ reveal the ectothermy of *Parasuchus* sp., with the range of body temperature estimated to be from 20 to 29 °C. Such thermoregulation mechanism could probably be a consequence of the transition from endothermy, caused by the change in lifestyle from terrestrial to semi-aquatic or mostly aquatic during the evolution of Phytosuaria. Additionally measured parameter $\delta^{13}C$ indicates a possible difference in the diet of *Metoposaurus krasiejowensis* and *Parasuchus* sp., with the latter being either a piscivore-specialist or a generalist, whose diet apart from fish included the meat of terrestrial vertebrates.

# THE RECONSTRUCTION OF FOSSIL MAMMAL COMMUNITIES USING RECOMMENDER SYSTEMS, AND ITS EFFECT ON ECOMETRIC PALEOENVIRONMENTAL INFERENCE

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Paleoecological studies investigating variation in the trait structure of communities across time, climate, and geography face a persistent challenge: they are limited to comparing localities with similar completeness in their sampling. Such comparable sampling is rare due to varying biases in preservation and collection between fossil sites, especially for terrestrial communities. Here, we present a method to correct for those biases by building a computational model of co-occurrences across a wide range of sites. This approach, recommender systems modelling, outputs taxa likely to have been present at each site based on which taxa have been discovered there. We applied recommender systems to the Pleistocene mammal fossil record of Eurasia, approximating total community composition at the genus level for 913 sites with occurrence records in the NOW database[1].

We then evaluated the effects of the recommender systems' community reconstructions on ecometric estimates of paleoenvironment at these sites. Ecometric models link the distribution of traits within a community to the climate where that community lives, allowing paleoenvironment to be inferred from the occurrences of fossil taxa with known traits. For these Pleistocene Eurasian sites, we tested ecometric models based on the dental traits of large mammals[2] and the body mass distributions of mammal communities, the latter of which we trained using range data from the PHYLACINE dataset[3]. These ecometric models, when applied to raw occurrence data for these sites, produce estimates of paleo-precipitation and temperature with high prediction anomalies relative to independent paleoclimatic estimates. The recommender system's output communities yield more realistic ecometric climate estimates. Recommender systems modelling effectively smooths the trait distributions for fossil sites by filling in missing taxa and, thereby, improves prediction of paleoenvironments based on faunal traits.

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# BIOGEOGRAPHIC RESPONSES IN MARINE PLANKTON FUNCTIONAL GROUPS TO CENOZOIC CLIMATIC AND ENVIRONMENTAL CHANGES

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The latitudinal biodiversity gradient (LBG) is a key feature of global biodiversity, but its origin, maintenance, and future prospects remain relatively murky. Paleontological LBG studies typically adopt a genera- or species-based-perspective, rather than a functional or trait-based one. Unlike species, which are evolutionarily ephemeral, functional groups can be consistent across an entire clade's history, providing broader perspectives. To adopt a novel viewpoint on Cenozoic marine LBG drivers, we apply network analysis to Triton, a global dataset of Cenozoic macroperforate planktonic foraminiferal occurrences. We contextualized changes in functional diversity, paleo-latitudinal specialization, and community equitability, identifying: 1. specialized morphological communities in the aftermath of the Cretaceous-Paleogene (K-Pg) extinction, 2. ecological specialization of communities during the Early Eocene Climatic Optimum, 3. a severe loss in morphological community specialization due to Antarctic glaciation across the Eocene-Oligocene Transition (EOT) preceding the loss of morphological diversity by millions of years, and 4. a synchronous change in morphological specialization and richness ~19 Ma, coeval with shark extinctions. We find that the global biogeographic responses of functional communities and richness are disentangled from one another during large-scale Cenozoic climate events, revealing novel changes necessary for understanding marine ecosystems responses. Importantly, during intervals associated with global perturbations in ocean structure, such as the K-Pg and EOT, we identify multi-million year lags between functional metrics, where community-scale modifications often precede richness change. These observations highlight the need for quantifying global marine communities as detrimental changes in ocean structure continue to manifest through anthropogenic climate forcing.

# Session 3: Past, present, and future extinction and survival

# BENTHIC ECOSYSTEM COMPLEXITY IN THE WEDDELL SEA

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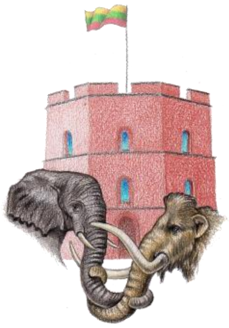
Southern Ocean benthic marine communities provide a unique setting to investigate ecosystem structure and complexity, as they are ecosystems with relatively little direct anthropogenic disturbance. Benthos are the richest elements of the ecosystem in terms of the number of macro-taxa, with over 10,000 described, and thousands more undescribed species present. We investigate how different taxonomic groups and environmental variables shape community dynamics in two regions of the Weddell Sea: shallow (~450m) systems on soft, muddy substrates in NE Antarctic Peninsula, and deep (~2000m) communities on hard substrate pillow lavas on the Powell Basin. We quantify the observable macrobenthos and the substrate through photographs from the Ocean Floor Observation and Bathymetry System (OFOBS) collected by the RV *Polarstern* in March-April, 2019. We subset our data to 100 photographs, taken roughly every 500m from two transects. We use networks to depict the ecosystems as a series of nodes, which represent taxa and environmental variables, and the interactions and associations between them, as edges. BNI is a technique to statistically infer the primary dependencies between nodes, helping to tease apart causal dependencies from indirect correlations. Hardgrounds play host to ~50 differentiable taxa, of which 29 are abundant. Many communities are mainly brittle star dominated, with other communities dominated by different sponges, hard and soft corals. They have a complex network of associations, whereas on mudgrounds, network edges are sparse, with only dropstone-mediated edges. Mudgrounds contain ~60 differentiable taxa, of which 21 are abundant. The lack of edges in the network implies that any interactions and associations operate at much larger spatial scales. This large scale could mean that they could be more vulnerable to distant perturbations, unlike the hard-substrate communities, whose complexity at a smaller spatial scale provides more capacity to adapt.



# NEOSELACHIAN DIVERSIFICATION DYNAMICS AND AGE-DEPENDENT EXTINCTION

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Neoselachians - modern sharks, rays, skates, and their extinct relatives - have an abundant fossil record and long evolutionary history. Previous studies suggest that after the K/Pg extinction event (~66 Ma), they did not suffer any other significant extinctions, except for the current human-driven decline. Here, we compiled a comprehensive global dataset of neoselachian occurrences spanning the last 145 Myr, and used a Bayesian framework accounting for sampling and preservation biases to assess their diversification dynamics and test for age-dependent extinction. We identify three hitherto unknown global extinctions in the upper Cretaceous (73.2 – 71.8 Ma), the Eocene-Oligocene (37.8 – 32.9 Ma), and from Pliocene onwards (5.3 Ma - Recent). Speciation rates were found to increase around times of elevated extinction suggesting high turnover, except during the last 13 Myr, when there is prolonged negative diversification. We further found age-dependent extinction, with young species persistently displaying higher extinction rates than old species. Taken together, our results uncovered new patterns in the evolutionary history of neoselachians, suggesting that this group is more vulnerable to extinction than previously thought, especially as they approach the Recent. Importantly, species' age seems to be a key predictor of extinction, with short-lived species being particularly vulnerable.

# AN ECOLOGICAL ASSESSMENT OF SOUTHERN ALASKA THROUGH OBSERVATIONS OF FLORISTIC CHANGE, FIRE REGIME AND VOLCANISM

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Defining patterns of environmental or ecological change on different spatio-temporal scales is key to tracking and addressing present and future biodiversity changes, which is particularly important considering the rapidly changing climate scenarios. Climate change in the arctic means shrinking glaciers, drying out of peatland and carbon release, more frequent forest and peatland fires, and thawing permafrost. Alaska hosts some of the largest Boreal peatlands and forests; however, little is known about the fine-scale dynamics of these ecosystems particularly over the last millennia, which is key to making effective management decisions into the uncertain future. In this talk/poster, I will be presenting the results from research that employs different lines of evidence (pollen, non-pollen palynomorphs, charcoal, and tephra) from two peatland sites in southern Alaska to reveal interactions between vegetation, fire and climate in the area during the last millennia, as well as the potential influence of humans and volcanic eruptions on these interactions.

# THE EVOLUTION OF SOUTHERN OCEAN SEA-FLOOR ECOLOGY

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Assessing ecological change in fossil communities provides crucial insights into how modern communities will react to environmental change.

Modern Southern Ocean sea-floor invertebrate communities are described as having an archaic retrograde ecology, as they are dominated by epifaunal suspension feeding organisms. The current understanding is that these patterns started to develop in the Eocene, with cooling decreasing durophagous predation. However, our data show that not all Antarctic fossil occurrences follow this pattern.

The Southern Hemisphere fossil record (and particularly Antarctica) is not studied in as much detail as the rest of the world, but it represents a huge area of the globe. We show that Southern Hemisphere evolutionary ecological patterns can differ to the Northern Hemisphere. Additionally, more factors may have affected ecological evolution, including water depth and environmental setting of fossil sites, and a greater degree of cooling potentially into the Pliocene.

There is a long way to go to understand Southern Ocean ecology. The timing of community structure origin, and even the distribution of modern predator and prey organisms, and their relative proportions underpinning community structure, are still in need of study. This hinders our understanding of how polar ocean communities will adapt to anthropogenic environmental change.

# Session 4: Macroevolution, biogeography, and paleogeography

# MEGACLIMATE CAUSED TRANSITIONS AND MULTISTABILITY IN MACROEVOLUTIONARY DYNAMICS OF LARGE MAMMALS

S. Bekeraitė, R. Stankevič, K. A. Haaga, I. Juchnevičiūtė, A. Spiridonov

On multi-million-year timescales, the climate system of the Earth exhibits complex wandering behaviour. We investigated the evolutionary impacts of long-term climate change by analysing the dynamics of Cenozoic mammal evolution, looking for the presence of state transitions, multiple stable equilibrium states and their association with long-term climate evolution.

We performed Bayesian modelling of Artiodactyla, Carnivora and Perissodactyla evolutionary histories. Then we used causal inference methods in order to test the information-theoretic extent of associations between the climate and mammal diversity levels. We then employed recurrence plot analysis of the species richness time series, identifying the main transitions and regimes in large mammal evolution. Joint recurrence plots of diversity-Cenozoic oxygen isotope record as well as recurrence quantification analysis were used to further investigate the coupled dynamics of climate and mammal evolution.

We found that several transitions between different states of the long-term climate evolution correspond to subsequent transitions and multistable states of diversity. The evidence for the main climate transitions is recovered from joint recurrence states of diversity time series alone, indicating coordinated phase space behaviour of three different mammalian orders and climate. The diversity fluctuations increased in amplitude during the Coolhouse regime in Oligocene and Miocene, with the diversity evolution entering an unprecedented trajectory during the Icehouse climatic state of Plio-Pleistocene.

Phase space-based analyses suggest that mammal diversity evolution has been coupled with the dynamical state of paleoclimate on multi-million-year timescales. The presence and stability of transient diversity equilibrium states depends on the underlying climate regime.

# THE “HESPDIV” R PACKAGE: CASE STUDY OF MIOCENE MAMMAL BIOGEOGRAPHY IN US

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The "hespdiv" R package is a newly developed toolkit designed specifically for conducting biogeographical studies using occurrence data. This package uses an algorithm that hierarchically subdivides both the study data and study area into homogeneous units, based on predefined subdivision criteria and optimization functions. The result is a spatial hierarchy tree consisting of polygons representing distinct data clusters. When taxa occurrences are used as input data and the bioregionalization method is applied, these polygons can be interpreted as bioregions. In addition to the subdivision algorithm, the "hespdiv" package offers many visualization options and functions to assess the significance and stability of the obtained subdivisions.

To illustrate the application of the package, we conducted a case study using terrestrial Miocene mammal species occurrence dataset from the contiguous United States. This study demonstrates the capabilities of the "hespdiv" package in unravelling the biogeographical patterns of species distribution. The results deliver insights into the spatial arrangement of distinct Miocene mammal assemblages and allows to hypothesize about the underlying environmental and biotic factors driving their distribution.

Further applications of the tools provided by the "hespdiv" package, as well as the development of new tools, hold great potential in enhancing our understanding of spatial biodiversity dynamics in both past and present ecosystems.

Session 4

# RECONSIDERING RANGE: INTEGRATING PAST ARCHIVES FOR IMPROVED PROJECTIONS OF SPECIES FUTURE DISTRIBUTIONS

J. Hansford, E. Saupe, S. Turvey, G. Varnham, M. Grace, H. Ma, I-Ting Tu, B. Li, P. Mannion

Species distribution models (SDMs), crucial in conservation planning and predicting impacts of climate change on biodiversity, typically depend on recent data. However, given that current species' distributions likely reflect long-term anthropogenic disturbances, the use of only present-day and recent (last ~50 years) data is likely to lead to misunderstood ecological niches and erroneous conservation directions. Here, focusing on the Critically Endangered Chinese alligator (*Alligator sinensis*) as a key case study, we promote a multi-temporal approach to address this issue by incorporating past archives into SDMs. Presently, the Chinese alligator's distribution is constrained to a single province in China. However, archival, zooarchaeological, and fossil remains, including sightings, gazetteer records, and museum specimens, record an extensively broader past spatial distribution. Our newly compiled dataset has resulted in an order of magnitude increase in spatially independent available records for the Chinese alligator. As this record spans the mid-Holocene into the modern era, it is necessary to implement a multi-temporal calibration of the SDM to account for range shifts associated with climatic changes. Importantly, this augmented range enhances our understanding of the species' ecological niche, significantly improving the accuracy of our predictive SDMs through improving spatial and niche completeness. Moreover, it helps mitigate a common pitfall associated with SDMs, especially with range-retracted species: a tendency to overfit when data representing niche completeness is sparse. By providing a more accurate depiction of the species' niche breadth, our approach effectively prevents the mischaracterisation of the Chinese alligator as an ecological specialist unduly susceptible to climate change. Our findings underscore the critical importance of leveraging past archives in the development of recovery baselines for species. This is a first step in developing a robust method for incorporating past records into SDMs as part of the IUCN's Green Status of Species assessments.

# TESTING HYPOTHESES OF MIGRATION IN THE FOSSIL RECORD WITH ECOLOGICAL NICHE MODELING: A CASE STUDY USING THE WESTERN HEMISPHERE MEGAFAUNAL GENUS *GLYPTOTHERIUM*

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The fossil record can serve as an ecological time machine to help us determine how and why species move across the landscape. In this study we use Ecological Niche Modeling (ENM) to determine the extent to which climatic factors can account for migration patterns in deep time. One such migrant is *Glyptotherium*, a giant extinct relative of armadillos that originated in South America and migrated to North America as a part of the Great American Biotic Interchange (GABI), a series of dispersal events between North and South America that peaked approximately 2.5 million years ago after the formation of the Isthmus of Panama. Specifically, we use ENM to construct niche models for *Glyptotherium* to test the plausibility of the hypothesis that the genus migrated from North America back to South America during the Rancholabrean (12,000-250,000 years ago). The resulting niche models show a corridor of suitable habitat through Central America during this time, supporting the hypothesis that *Glyptotherium* could have traveled back through Central America in the last 250,000 years. Our model results also indicate that the Antilles, which has been proposed as an avenue for migration during GABI, may have been a possible corridor for migration for *Glyptotherium*.

# THE COMPLEX INTERPLAY OF FACTORS SHAPING THE EVOLUTION OF THE LATITUDINAL BIODIVERSITY GRADIENT

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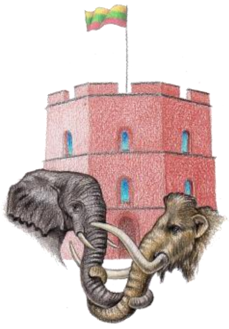
Today, species richness is highest in the tropics and declines toward the poles. First recognized by Alexander von Humboldt over two centuries ago, understanding the mechanisms that underlie this latitudinal biodiversity gradient (LBG) remains one of the great challenges of biodiversity science. Dozens of hypotheses have been proposed, pertaining to a broad suite of climatic, environmental, geographical, and historical variables, but the answer remains elusive, in part because the proposed drivers covary in space today. Turning to the fossil record removes the latter obstacle, although the use of past archives comes with its own suite of problems. Application of sampling-standardization approaches to diversity reconstruction demonstrates that the present-day pattern has not always characterized the distribution of Earth's biodiversity. Here, we present new results based on an analysis of a comprehensive dataset of South American Cenozoic terrestrial eutherian mammal fossil occurrences. These suggest that the present-day LBG first appeared in South America in the Plio-Pleistocene, at a similar time as proposed for North American mammals. This appears to have been driven by a decline in mean annual temperatures at higher latitudes in South America, in tandem with an increase in precipitation at lower latitudes that might have been accentuated by Andean uplift. Although the Great American Biotic Interchange may have played a role, Andean uplift appears to have been the primary underlying mechanism driving eutherian diversity patterns in the Cenozoic, radically reshaping the continent's climate and habitats. Combining these results with patterns from other taxonomic groups, environments, and time intervals, there appears to be a hierarchy of broad factors that predict the gradient: (1) over geologically long time spans, the distribution of biodiversity is largely predicted by climate; (2) when climatic gradients are shallow, biodiversity tracks habitat area; and (3) historical contingencies linked to niche conservatism have geologically short-term, transient influence.



# TURONIAN SCAPHITID AMMONITES FROM THE OPOLE CITY AREA (SOUTH-WESTERN POLAND)

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Upper Cretaceous (Cenomanian – lower Coniacian) marine strata are well exposed in the city of Opole and its vicinity (south-western Poland), at the Odra I and II, Bolko and Folwark quarries, where they unconformably rest on Triassic rocks. They comprise mostly marl deposits and contain numerous fossils. A significant amount of these are ammonites, especially in middle-upper Turonian limestones and calcareous marls. A great number of these relate to heteromorph ammonites, in particular representatives of the family Scaphitidae, which in fact occur at different levels within the whole section. However, in the upper Turonian an abundance of scaphitids might be referred as the *Scaphites* radiation bioevent. *Scaphites* facies (Scaphiten-Schichten or Scaphites Beds) have been described from upper Turonian deposits in different regions of the world, e.g. Germany, the UK, the Czech Republic. In the Opole area, the complex is characterised by the occurrence of a single species only - *Scaphites geinitzii*. However, sexual dimorphism in this species is well exposed and at the same levels both micro- and macro-conchs can be found. Thus, *Scaphites* bioevent is very important for biostratigraphical correlations as well as for palaeoecological interpretations and palaeogeographical reconstructions.

# THE EVOLUTIONARY AND PALAEOBIOGEOGRAPHIC ORIGIN OF THE DINOSAURS

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Dinosaurs were a major component of Mesozoic terrestrial ecosystems until the extinction of all non-avian species at the Cretaceous/Paleogene boundary, 66 million years ago (Ma). Whilst their extinction has been a long-standing topic of public fascination and intense research, the evolutionary and biogeographic origin of this iconic group of animals remains much more poorly understood. The earliest unequivocal dinosaurs first appear in the fossil record in South America and southern Africa, approximately 230 Ma, leading most authors to support a southwestern Gondwanan centre of origin. However, the taxonomic and morphological diversity of these fossil assemblages suggests a more ancient evolutionary history that is currently obscured by spatiotemporal sampling bias in the fossil record. Dinosaurs also appeared on northern landmasses early in their evolutionary history, further complicating apparent biogeographic scenarios. Here, we reconstruct the early distribution of the dinosaurs and their archosaurian relatives using historical biogeographic methods. Time-calibrated informal supertrees based on several competing hypotheses of early dinosaur evolutionary relationships were constructed and analysed alongside global fossil occurrence data in the R package BioGeoBEARS. Potential barriers resulting from the break-up of Pangaea, and information on sampling biases (i.e. whether areas preserve suitable sedimentary rocks for preserving dinosaurs) were also incorporated into the biogeographic models. Preliminary results suggest a southwestern Gondwanan origin for dinosaurs, although there is also support for a Northern Hemisphere radiation in some tree topologies once missing data are incorporated. Subsequent analyses will focus on incorporating palaeoclimatic data into the models, which will be used to assess the role that climatic barriers and corridors might have held in constraining the distribution of the dinosaurs in their early evolution. This will aid in assessing the impact that Earth system processes and environmental change have had on the distribution of biodiversity following an evolutionary radiation.

# Session 5: Ecosystem processes across scales

# QUANTIFICATION OF MICROBIAL TEXTURES TO UNTANGLE THE RELATIONSHIP BETWEEN MATGROUND AND MACROFOSSILS OF THE AVALONIAN EDIACARAN

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The Avalonian Ediacaran fossils of Newfoundland comprise some of the oldest examples of macroscopic metazoans exceptionally preserved *in situ* as near-census communities. The Ediacaran seafloor was often bound by microbial mats, which are preserved as a disparate range of microbially induced sedimentary structures (MISS) alongside these fossils. In younger Ediacaran assemblages, these matgrounds have been argued to exert an important influence on ecological dynamics.

Here, we quantify MISS textures in a novel way, using surface metrology and persistent homology, allowing us to map matground heterogeneity and thus directly test the existence of fine-scale habitat associations between matground and macrofossils using distribution models. Surface metrology consists of calculating a suite of parameters, each describing a certain aspect of surface topography such as maximum peak height and skewness. Persistent homology is a topological method that instead describes shape through changes in connectivity of structures across multiple spatial scales.

These texture analyses were applied to high-resolution (15 micron) 3D scans of 5.97$m^2$ of the Pigeon Cove surface in Mistaken Point Ecological Reserve, Newfoundland, Canada (~574Ma). Surface metrics were calculated via a moving window from elevation models derived from the scans. We then used ordination techniques on these metrics to produce maps of textural, and therefore matground, heterogeneity over the surface. The spatial position of small rangeomorph fossils (n = 68) could therefore be correlated to the mapped matground heterogeneity using inhomogeneous Poisson models, random forest and maximum entropy models. This novel technique thus enables us to evaluate the influence of microbial mats on Avalonian ecological dynamics.

Session 5

# LINKING CHARCOAL-FIRE RELATIONSHIPS ACROSS SPACE AND TIME IN AFRICAN SAVANNAS: IMPLICATIONS FOR PALAEOECOLOGICAL-PALEONTOLOGICAL RECONSTRUCTIONS

A. N. Dabengwa, L. Scott, W. Bond, S. Archibald, C. Lehmann, M. Bamford

Although fire is considered an evolutionary driver of savanna ecosystems across space and time, the representation of fire dynamics in savanna ecosystems is poor. Charcoal from depositional environments used to reconstruct fires generally selects for coarser woody compared with fine grassy fuels that dominate landscapes. And despite high fire frequencies, determining past fire regimes from savannas remains difficult because of high fuel flammability and the presence of large herbivores that influence charcoal production and accumulation. To better understand this problem, we compared abundances of different sizes of charcoal fragments from modern long-term fire experimental sites and surface sediments in Kruger National Park, South Africa. We compared these sites to three South African grassland and savanna charcoal sedimentary records from the last 2 000 years. Our analyses show that while charcoal abundances indicated biomass burning and fire prevalence, abundances of larger charcoal fragments suggest recent fire activity. When time is held constant, charcoal area concentrations separated contrasting spatial fire regimes. In contrast, in space over varying timescales, charcoal abundance separated contrasting temporal fire regimes. The presence of herbivores increased charcoal production, presumably by stimulating compensatory vegetation regrowth. Also, our findings suggest the potential of using small versus larger charcoal fragments as a proxy for state-dependent flammability. Our findings of charcoal-fire relations in savannas appear generalizable over much longer timescales.

# THERMAL PREFERENCES CORRESPOND TO ESCALATORY REGIONAL SPECIES RESPONSES DURING EARLY JURASSIC CLIMATE CHANGE

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Marine assemblages are expected to undergo substantial reorganization under anthropogenic climate change but some species may be better situated to track their preferred conditions. Assemblage vulnerability can thus be indicated by the thermal niches of its component species. However, the link between this vulnerability and extinction risk of its species is unclear and cannot yet be tested with modern species since widespread climate-driven extinctions are not yet manifest. To address this gap, we inferred fossil species' thermal niches based on observed distributions on paleoclimate maps over the hyperthermal pulses of the Late Pliensbachian to Early Toarcian. We show that species extirpated from fossil invertebrate assemblages after warming, alongside those species that went extinct, were most likely from the pool of species that were above their thermal optima, in contrast to assemblage immigrants. Further response details are explored. The fossil record has the potential to reveal unique and potentially unexpected information about natural system responses to climate change.

# TERRESTRIAL BIOME DYNAMICS DURING QUATERNARY GLACIAL CYCLES

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Terrestrial biomes, large-scale ecosystems characterized by their biotic assemblage and the seasonal distribution of climatic factors, have exhibited substantial fluctuations in their geographic distribution over geologic time. This includes latitudinal shifts, contractions, expansions, and fragmentation due to climate change. Understanding the spatiotemporal changes in biomes distribution is crucial for framing palaeoecological and macroevolutionary studies concerning species and their environmental interactions. Nevertheless, reconstructions of past global biome configurations remain scarce. Recent advancements in Geographic Information Systems (GIS) and the availability of high-resolution past climate emulators have enabled the assessment of historical biome distribution. Here, we modelled the distribution of biomes during the Pleistocene using the PALEO-PGEM-Series, a global spatiotemporal dataset covering the last 5 My with a temporal resolution of 1 ky and a spatial resolution of 0.5º degrees. The Pleistocene was characterized by significant climatic fluctuations, and our aim was to explore the impact of glacial-interglacial cycles on large-scale terrestrial ecosystems. By comparing biome configurations of the Last Interglacial (LIG) and the Last Glacial Maximum (LGM) with present-day ones, we observed substantial differences in biome distributions among all these episodes. In addition to latitudinal shifts, certain biomes expanded during the LIG and experienced significant fragmentation during the LGM, while other biomes underwent contrasting dynamics. These findings confirm that Pleistocene climatic fluctuations, representative of Quaternary cycles, strongly shaped Earth's ecosystem configuration.

# THE IMPACT OF REPTILIAN PREDATORS ON MAMMALIAN PREY COMMUNITIES IN LA VENTA, COLOMBIA

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As a consequence of a long history of continental isolation, the predator guild of South America during the Neogene was unusually depauperate of mammalian carnivores. Non-mammals have been proposed as the dominant predators in many localities during this period. At the Middle Miocene locality of La Venta, there was a hyperdiverse reptile guild with at least six pseudosuchians and seven testudines. We here test the hypothesis that the reptiles of La Venta were the dominant predators using both a novel method of community composition analysis and predator competition models. Our community composition analysis produced estimates of paleoenvironment at La Venta based on modern South American mammal communities with the most similar community structures. Including reptiles in the community increased estimates of tree cover (but not other environmental variables) closer towards those of other studies and consistent with our estimates from herbivore tooth morphology. We found that alone, the demanded prey biomass of mammalian predators was far lower than the available mammalian biomass. The demanded biomass of carnivorous reptiles accounted for the majority of the available prey biomass, but, even including reptiles, competition within the predator guild was lower than in functionally equivalent communities today. This lack of predation pressure is supported by a population-level assessment of enamel hypoplasia in *Pericotoxodon platignathus*. The population of *P. platignathus* in La Venta had a rate of hypoplasia much higher than most ungulates, and the incidence of hypoplasia is consistent with high population-level stress as a consequence of the relatively low predation rate. Collectively, these results suggest generally low predation pressure at La Venta, but that reptiles, especially large pseudosuchians, accounted for a high proportion of predation on mammals, a non-analogue condition for the modern world.

Session 5

# MORPHOLOGICAL RESPONSE ACCOMPANYING SIZE REDUCTION OF BELEMNITES DURING AN EARLY JURASSIC HYPERTHERMAL EVENT IS MODULATED BY LIFE HISTORY

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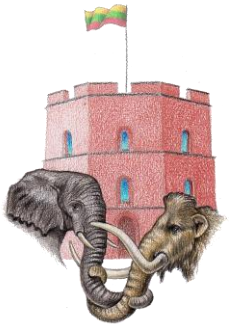
One of the most common responses of marine ectotherms to current and past global warming is a decrease in adult body size through an increased developmental rate in early life. However, changes in morphology that presumably emerge from such changes in early ontogenetic growth are not frequently studied in palaeontology, even though they can indicate details of an organism's ecological response to environmental crises, such as changes in resource acquisition or function.

The Pliensbachian–Toarcian (Pli–Toa) environmental crisis (~183 Mya) is the first pulse of the Early Toarcian Ocean Anoxic Event, and is driven by rapid warming and acidification of oceanic waters, triggered by volcanic activity of the Karoo-Ferrar Large Igneous Province. We use 3D geometric morphometrics to study morphological changes of 144 belemnites (extinct coleoids) from five consecutive subzones across the Pli–Toa crisis in Peniche, Portugal.

Our results show that two belemnite species (*Catateuthis longiforma* and *Passaloteuthis bisulcata*), which decrease in body size also significantly increase in robustness during the Pli-Toa crisis. While adults drive the change in *C. longiforma*, the increasing robustness of *P. bisulcata* is driven by juveniles, indicating varying ecological tolerances among the species and ontogenetic stages. The morphological change in the juveniles of *P. bisulcata* is significantly correlated with seawater pH, eluding to similarities with stress-induced hypercalcification of extant cuttlefish in response to climate-related stressors, such as acidification and starvation. These results stress the importance of taking life history into account, when studying impacts of environmental stressors on fossil marine organisms, to facilitate the comparability to extant organisms.



# MODELLING THE LIFE-ENVIRONMENT INTERFACE IN ANCIENT SHELF SEAS

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The co-evolution of life and environment is a dynamic system of feedback loops. Yet studying events through a series of stratigraphic horizons reduces dynamic feedback loops to proxy correlations and invites speculation as to the cause-and-effect relationships. Models can suggest hypotheses to test ecosystem dynamics and the effects of changes to life or the environment on the other. Much of the evolution of life took place in localised shelf sea environments. Evolving biota and redox conditions created feedbacks which are hypothesized to have increased the ecospace for life to radiate - and sometimes perhaps brought about its own demise. A particular modelling challenge is to connect these localised environments to global Earth system dynamics over long timescales. A hierarchy of models is needed to separate spatial and temporal scales and allow for the construction of models specific enough to be supported by limited geological data. We introduce a 1D column model of an ocean shelf sea in the PALEO framework to represent the ecological dynamics of important early life forms such as plankton, sponges, and early burrowers together with their effects on redox conditions, sediment burial and diagenesis. This model demonstrates that ecological dynamics and nutrient cycling can be modelled at the finest scales while being computationally viable over geological timescales. Ongoing work integrating this model with data from critical time intervals in the Ediacaran and Cambrian can provide specific hypotheses for the local behaviour of the life-environment interface and can be connected to broader models for global investigations.

Session 5

# INVESTIGATING THE TROPHIC STRUCTURE OF EARLY TERRESTRIAL ECOSYSTEMS

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Terrestrial ecosystems underwent remarkable development through the Devonian Period, from stands of water-restricted short-statured plants in the Lower Devonian to forests populated by insects and tetrapods by the latest Devonian. To understand the drivers of this transition we need to know the nature of the trophic interactions and nutrient fluxes in these early terrestrial communities. Based on the record of plant damage and terrestrial arthropods it is generally thought that herbivory was limited throughout the Devonian, with animal consumers supported almost exclusively by decomposing vegetation. This raises the questions of how detritivory-based communities were structured, and if the lack of herbivores would have significantly limited the energy available to support larger animals. Additionally, there is the potentially important but overlooked role aquatic communities may have played by energetically subsidizing terrestrial habitats with organic material. To investigate the potential interplay of detritivory, herbivory, and aquatic subsidies in early terrestrial ecosystems, we introduce an energy flow model to explore how the relative balance of these factors may have affected ecosystem stability and the energy available to higher trophic levels. To supplement this mechanistic approach with an empirical model of an early terrestrial and freshwater community, we have also developed a food web for the Lower Devonian Rhynie Chert Lagerstätte. The Rhynie Chert network shows a highly dispersed path length distribution, but most other structural properties are similar to those of modern communities. Of note is the well-documented diversity of fungal interactions, which play a key role defining cohesive trophic levels that are missed if fungi are collapsed into a single trophic species. Many food web analyses of modern and past ecosystems homogenize (or completely overlook) fungal and microbial taxa, but these results suggest that their specific interactions are structurally important and should be considered.

# Session 6: Evolving role of humans as ecosystem agents

# IMPACT OF CLIMATE ON LATEGLACIAL AND HOLOCENE VEGETATION: A COMPARISON OF PALYNOLOGICAL AND SEDA-DNA DATA

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Determining the effect of climate change on vegetation is an important task in understanding and management of ongoing drivers of ecosystem change. In this study, we reconstruct plant diversity and possible changes in landscape at Dūkštelis Lake located in southern Lithuania during the Lateglacial and the Holocene, intending to explore the relative contribution of climate and possible anthropogenic effects in shaping the present vegetation and environmental patterns. We produce the first palaeolake sedimentary ancient DNA (sedaDNA) dataset of Lithuania, consisting of plant metabarcoding applied to 72 sediment samples. The application of sedaDNA provides unique possibilities to analyse vegetation also in the absence of any visible remains. Combining sedaDNA metabarcoding data with palynological data we obtained a reconstruction of specific plant assemblages that were not recognised in palynological research such as *Dryadoideae*, *Saxifraga,* etc.

Using modern pollen datasets and our site's fossil pollen data we reconstructed temperature and precipitation. Reconstructed precipitation and temperature curves in comparison with changes in lithological composition also helped us to disentangle the effects of climate, and its influence on the plant species composition. During Lateglacial, winter temperatures were 5-10ºC colder than modern winter temperatures (-4,5 ºC), while the average summer temperatures were lower only 5ºC or similar to modern ones (+20ºC). On the other hand, during the Mid-Holocene winters were much milder in comparison with modern and ranged between -4ºC to 0ºC. Differences between winter and summer temperatures impacted vegetation growth dynamics. Precipitation during the winter season decreased in comparison with summer rainfall during the Late Holocene. Warmer winters triggered the expansion of thermophilous vegetation during Early and Middle Holocene. Finally, higher summer precipitation, during the Late Holocene resulted in a notable rise in forbs.

SedaDNA content reveals a slowly increasing trend in plant richness since the GI-1, reaching highest values during Holocene. Both analyses revealed several shifts in dominant vegetation types, mostly delineating periods dominated by tree species with periods dominated by forbs. Highest shrub and bushes concentrations were detected at time period older than 13,000 BP, and the highest *Poaceae* concentrations were found between 8,000 and 2,000 years ago BP. A notable rise in plant richness was detected in a period starting from 5,000 years ago BP.

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Session 6

# BURIED PODZOLS IN THE INLAND DUNE DEPOSITS OF POLAND RECORD THE WARMTH OF MEDIEVAL CLIMATE AND ANTHROPOGENIC IMPACT ON THE LOCAL ENVIRONMENT

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Buried paleosols documented in the aeolian dunes of the eastern European Sand Belt are mostly incipient Arenosols of the Late Glacial-Early Holocene age. Well-developed Podzols are uncommon, and even more rarely such paleosols preserve ichnological record of the past land use. Nevertheless, podzolic paleosols were found in ten inland dune sites of Eastern and Central Poland, which this study aims to document.

Pedological and sedimentological studies were conducted in the sand pits. Grain size distribution, carbon and nitrogen content, and pH were measured in the collected samples. The age determination was based on the radiocarbon dating of charcoals.

In all ten sites, podzolic palaeosols occur below sandy overburden of thickness ranging from tens of centimeters to 2 m. In four sites, cattle hoofprints and human footprints are observed in the topmost interval of the buried soil and in the overlying sandy deposits. Most notably, all the occurrences display similar properties, geomorphologic setting and age in the 5th–15th century AD range of the historical Middle Ages. Well-developed eluvial and illuvial horizons, as well as measured pedological indices, allow us to classify all the studied paleosols as proper Podzols.

The intensity and prevalence of podzolization during the Medieval period were presumably caused by an interaction between anthropogenic influence and conducive conditions of the Medieval Climatic Optimum (ca. 10th-14th centuries AD). Prevalent dune remobilization, accounting for the soil burial, was derivative of anthropogenically-induced vegetation depletion. These included not only the indirect impact of agriculture and deforestation but also the pasturage of the cattle, which could lead to overgrazing and destabilization of the dune surface. Considering the consistent development and age of the Medieval podzolic paleosols, we propose to distinguish their occurrences as a new marker horizon in the dune deposits of the European Sand Belt under the name Grębociny soil.

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# PARTRIDGE FOR DINNER? TAPHONOMICAL ANALYSIS OF AVIAN REMAINS FROM MELITZIA CAVE, MANI PENINSULA, GREECE

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The Mani peninsula is regarded as a key area of Greece for Palaeolithic studies due to the large number of known excavated sites containing deposits with artifacts and skeletal remains from the Middle and Upper Palaeolithic, revealing the abundance of human occupation in the wider area during the Middle-Late Pleistocene. Melitzia Cave is one of several karstic cavities found on the western coast of Mani peninsula, used as a shelter by Late Pleistocene humans. The Upper Palaeolithic avifauna assemblage recovered from Melitzia Cave has been studied both taxonomically and taphonomically to identify the agent of accumulation, as each predator hunts and consumes its prey in a particular way. The results point to extensive human hunting of rock partridges. A broadening of the dietary sources for humans, known as the Broad-Spectrum Revolution hypothesis, occurred in the Mediterranean after the Last Glacial Maximum and is marked by the hunting of small game such as rabbits and birds. Surface modifications, such as cut marks, peeling and percussion marks, as well as fragmentation patterns indicating the disarticulation of bones, point to human occupants being involved in the modification and disposal of the remains, as they captured the Aves for consumption. Only a few of the bones, bearing digestion or tooth marks, were brought into the cave by non-human predators, indicating that carnivores played a small role in creating and modifying the assemblage as well. This phenomenon enchanted the fact that intensive human occupation and carcass processing lead to a deficiency of carnivores. This study provides further evidence of the exploitation of avian resources by humans during the Upper Palaeolithic in the Eastern Mediterranean.

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# PALAEO-RECONSTRUCTIONS FROM CENTRAL EUROPE BASED ON SUBFOSSIL BEETLES (COLEOPTERA)

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In palaeoecology, plant and faunal macrofossils can reconstruct the local (<500 m) landscape and environmental conditions. Subfossil beetle remains are a valuable proxy in this regard because they preserve extremely well under anoxic conditions, can be identified to the genus or species level most of the time, and inhabit specific environments and climatic niches. In Western Europe and North America, fossil beetle assemblages have been used to reconstruct changes in landscape composition, forest cover, relative humidity, and air temperatures for the Holocene, Late Glacial, and much further back in time. For example, the Late Glacial temperature reconstructions from beetle assemblages proved extremely valuable, showing vegetation lags after climatic changes. Palaeoecological research involving beetle remains has been largely absent in Central Europe, but recent publications demonstrate its potential as a proxy for reconstructing past ecosystems/landscape change and environmental conditions. The results from several natural sites in the Czech Republic and Slovakia will be presented here. In these studies, beetle remains contributed greatly to e.g., demonstrate the local presence of certain tree species, disturbances in the landscape, and (the effect of) human activity on insect populations. Based on these first studies on beetle remains in this region, we discuss the potential of such future studies in Central and Eastern Europe.

# STABLE ISOTOPES IN PALAEODIETARY RECONSTRUCTIONS

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Stable isotopes such as carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulphur ($\delta^{34}S$) in human tissues are related to individual dietary habits as well as environmental and physiological factors. Typically, carbon provides information on the primary energy source, while nitrogen allows discrimination among trophic levels. In areas where there are clear $\delta^{34}S$ differences between marine, freshwater and terrestrial ecosystems sulphur isotope ratios can be used to distinguish the consumption of these food sources. As individuals' isotopic values reflect local environment, they can be used to identify the region where an individual normally resides, and therefore identify migratory individuals. In palaeoecological studies stable isotopes enabled for the estimation of the proportions of different dietary inputs (e.g. marine versus terrestrial; $C_3$ versus $C_4$ plants), allowed study of individual diets and intra-community variation, and opened the way for assessment of mobility through geospecific isotope ranges. Stable isotopes can be used as tracers of the elements and their pathways, thus they were widely applied in the fields of ecology, archaeology, forensics and many others.

In this presentation, the potential of stable isotope ratio method will be illustrated with isotopic research results of Lithuanian bioarchaeological material. Isotopic study carried out in human and animal bone collagen and bioapatite samples of the last I – II millennium helped to better understand the dietary change during the time, differences between males and females, significance of social and cultural factors and animal husbandry. Thus, the stable isotope analysis of bioarcheological material of humans collected in Lithuania made it possible to get deeper into their lifestyles in the past.

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# Session 7: Community assembly across time and spatial scales

# LATE CENOZOIC COOLING RESTRUCTURED GLOBAL MARINE PLANKTON COMMUNITIES

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Marine organisms, such as planktonic foraminifera, diatoms, dinoflagellates, copepods, and fish, are already experiencing poleward range shifts due to human-induced climate change. However, the extent of these movements and whether they signal the precursor to extinction remain uncertain. To comprehend these ongoing trends, it is crucial to understand the historical development of marine biodiversity patterns and the underlying factors influencing them. The fossil record of macroperforate planktonic foraminifera offers a valuable dataset that provides unique insights into the dynamics of marine biogeography and species responses to past climate changes. In this study, we utilize a bipartite network approach to analyze planktonic foraminifera over the past 8 million years using Triton, a recently developed high-resolution global dataset of their occurrences. We quantify group diversity, latitudinal specialization, and latitudinal equitability. Our findings reveal a global and clade-wide equatorward shift in both ecological and morphological community equitability over the last 8 million years. This shift can be attributed to temperature changes associated with the formation of bipolar ice sheets during the late Cenozoic period. Interestingly, the Triton data indicate the presence of a "latitudinal equitability gradient" (LEG) among functional groups of planktonic foraminifera. Notably, this gradient is only coupled to the latitudinal biodiversity gradient in the relatively recent past (~2 million years to the present). Prior to this timeframe, the LEGs suggest that higher latitudes promoted community equitability across ecological and morphological groups. The observed range shifts among marine planktonic microorganisms in both recent and geological timescales suggest a significant expansion of marine communities towards the poles, even under conservative future global warming scenarios. These findings emphasize the importance of considering historical patterns and dynamics when assessing the potential impacts of climate change on marine biodiversity.

# QUANTIFYING CHANGES IN LATE CARBONIFEROUS PALAEOBOTANICAL COMMUNITY STRUCTURE: EVIDENCE FOR DELAYED “RAINFOREST COLLAPSE” IN ATLANTIC CANADA

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The Late Carboniferous and Early Permian saw a major global transition in floral diversity, commonly referred to as the “Carboniferous Rainforest Collapse;” one of the few major extinction events in the palaeobotanical record. This event is broadly associated with the emergence of global icehouse conditions and widespread aridification. The peak of floral turnover is globally observed from the Middle Pennsylvanian, but there were significant regional differences in the tempo of community change. Herein we examine fossil plant community structure at the regional scale, focusing on Pennsylvanian and Lower Permian localities from Atlantic Canada, to determine the pace and timing of community change within the region. We compiled fossil macrofloral occurrences from museum repositories and published literature records, representing plant fossils spanning the Lower Pennsylvanian through the Lower Permian. We used occurrences of foliar taxa at the species and genus levels to conduct multivariate analyses of similarity among localities. Our results from species occurrences show minor, progressive shifts in average community structure between successive time bins, consistent with predicted background extinction rates and the common use of macroflora as index fossils. Analysis of community composition at the genus level revealed less regular change than at the species level through the Pennsylvanian, but significantly reduced variation in composition among localities in the latest Pennsylvanian (Stephanian). At both taxonomic scales, the most dramatic changes were observed at the beginning of the Permian, associated with a major shift in depositional environment. Sites with compositions similar to those from the Lower Pennsylvanian persisted throughout the Pennsylvanian record, showing that total loss of Lower Pennsylvanian community structure did not occur until the end of the Carboniferous. We therefore show that turnover in Atlantic Canadian plant communities was delayed with respect to the global trend, with indications of major community structure loss only beginning in the Stephanian.

# DO MAMMALS TRACK PLANTS MORE THAN CLIMATE?

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Climate tracking is a central concept which lies at the heart of many models and disciplines. It supports the use of species distribution and niches models (SDM/ENM), especially in the context of assessing conservations priorities and policies in the light of ongoing climate change. Nevertheless, estimating the robustness of this concept is a complex task given that modern data offer limited temporal hindsight. In this context, paleontological data can be used to circumvent this issue. Using paleoclimate simulations and North American mammal and plant occurrence data since the last deglaciation, we estimate species' ability to follow their climatic niches (or climatic fidelity) through the last 12.000 years. Based on this dataset, we can (i) compare the climatic fidelity of plants and mammals, (ii) estimate the impact of European arrival and industrialization on plants and mammals climatic niches, and finally (iii) observe the temporal evolution of relationships between plants and mammals. The combined analysis of these two groups could reveal whether mammals primarily follow climate or plants when climate changes and landscape use increases. Using a wide range of analyses, we illustrate how the arrival of Europeans in North America and industrialization profoundly altered the relationship between plants and mammals, to a greater extent than the climatic changes induced by the last deglaciation.

Session 7

# REVISION OF THE PLIO-PLEISTOCENE CANID GUILD IN SOUTHERN AFRICA: FIRST INSIGHTS FOR ITS PALEOECOLOGY

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The Plio-Pleistocene of Southern Africa is a key period for understanding the evolution of early hominins (*Australopithecus, Paranthropus*, early *Homo*), and their interactions with predators (human and non-human) is a recurring issue for these sites. While the felid and hyenid guilds are often identified as their main competitors, canids are rarely mentioned despite their significant generic and specific diversity, and the abundance of remains in fossil assemblages. This diversity, covering size classes as diverse as jackal-like canids to wild dogs and large-sized *Canis*, raises questions about the taxonomic reality of particular forms: would it be a reflection of past biodiversity or a significant intraspecific variability?

A taxonomic review of Southern African canids, including a revision of historical collections from the Cradle of Humankind (South Africa) and the study of unpublished specimens from Gcwihaba Cave (Botswana), allow us to revise the composition of the guild, estimate their occurrence on the sites (quantification), and specify their ecomorphological characteristics and paleoecological implications. Our study leads us to reduce the number of taxa making up the guild (from 9 to 6), while confirming the fundamental role played by canids in Southern African sites. The evaluation of these different components over time (from 3.4 Ma up to 0.9 Ma) enables us to identify structural evolutions and re-evaluate competitive relationships within the guild itself, but also in relation to other predator communities. The role of jackals as secondary (opportunistic) predators is highlighted, while the role of large canids (e.g. *Canis atrox*, *Canis hewitti*, *Lycaon* ssp.) as primary predators, and therefore direct competitors of human communities, is demonstrated. Reassessing the ecological niche and paleoecological status of canids within trophic webs opens the way to a new vision of the relationships-interactions between these carnivores and ancient hominins, an aspect that has been too often undervalued.

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# BAYESIAN NETWORK ANALYSIS REVEALS THE ASSEMBLY DRIVERS AND EMERGENT STABILITY OF PLEISTOCENE LARGE MAMMAL COMMUNITIES

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The nature of community assembly is one of the oldest questions in ecology. The structure of fossil communities is driven by a number of environmental, biogeographic, ecological and taphonomic processes acting at different spatial scales and timescales. A Bayesian network is a directed acyclic graph that specifies a joint probability distribution between the entities of interest (nodes) in a modular way, as a product of local conditional distributions at each node. The graph structure determines the qualitative dependences between the variables, whereas the local conditional distributions allow quantitative inference of relationships. Using Bayesian network inference methods we determine the degrees of association between 12 large mammal families and their local environment, global temperature, locality age and large-scale geographical extent throughout the Pleistocene. With an exception of Hominidae, we do not find significant associations between external variables (latitude, age, mean surface temperature) and the families analysed here, demonstrating that the majority of families showed remarkable resilience to extreme climatic variability of the Pleistocene. The associations between the mammal families themselves seem to be structured by the degree of generalism in carnivores and omnivores, and by similar environmental preferences in herbivores. To our knowledge, this is the first Bayesian network inference study of motile land animal palaeocommunities. We also discuss possible further applications of this method.

Session 7

# COMMUNITY DEVELOPMENT IN THE AVALONIAN EDIACARAN

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Bedding planes from the Avalonian Ediacaran (~580–560 Ma) record some of the first animals as near-census deep-sea, benthic communities. Community composition is highly variable, yet the drivers behind this variability are not well understood (Mitchell *et al.* 2019). Prior models of Avalonian succession have suggested that community composition changes systematically driven by competitive tiering, similar to modern systems (Clapham *et al.* 2003). We calculate the degree of community succession by comparing the relative abundance and areal coverage (a proxy for biomass) using the W-statistic, where early-stage communities have relatively high abundance, whereas late stages have relatively high areal coverage (Clarke, 1990; Durden *et al.* 2015). We mapped out 20 Avalonian communities from Newfoundland, Canada and Charnwood Forest, UK, using a combination of laser-line probe, LiDAR, and photogrammetry, covering a total 795 $m^2$, with 18,060 specimens, and 42 taxa. We quantified community composition using NMDS and LDA to determine how community composition and tiering metrics were correlated to degree of succession. We found 4 early, 11 middle, and 5 late-stage communities with a variety of community compositions at each successional stage. Our results suggest multiple different successional pathways in the Avalon driven by metacommunity dynamics and reproductive processes over and above the impacts of competitive tiering.

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# Poster presentations

# INVESTIGATION OF SILURIAN (WENLOCK-LUDLOW) DEEP-MARINE FACIES IN THE BALTIC BASIN THROUGH ORGANIC-WALLED MICROPHYTOPLANKTON ANALYSIS

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This study presents a comprehensive characterisation and analysis of Palaeozoic microphytoplankton, specifically focusing on organic-walled microfossils such as acritarchs and prasinophyte phycomata. The study aims to provide insights into the diverse microphytoplankton assemblages from the Silurian (Wenlock – Ludlow) deep-marine sedimentary facies recorded in Viduklė-61 and Baubliai-2 boreholes in Lithuania. In the Wenlock section of Viduklė-61 core, 24 genera of organic-walled phytoplankton were identified, including 7 prasinophyte phycomata and 17 acritarch genera. The Baubliai-2 core comprising the uppermost Wenlock - lower Ludlow section, yielded a total of 45 genera of organic-walled phytoplankton, with 10 prasinophyte phycomata and 35 acritarch genera. The greatest number of acritarch and prasinophyte taxa was observed in Baubliai – 2 samples from interval 1631.7-1628.7 m, corresponding to the beginning of the *scanicus* graptolite biozone. The analysis reveals the dominance of *Leiosphaeridia* spp., other frequently encountered genera include *Cymbosphaeridium*, *Cymatiosphaera*, *Dictyotidium*, *Diexallophasis*, *Gorgonisphaeridium*, *Helosphaeridium*, *Micrhystridium*, *Multiplicisphaeridium*, *Oppilatala*, *Salopidium*, *Tasmanites*, *Veryhachium* and *Visbysphaera*. The research also represents the distribution patterns of specific acritarch and prasinophyte species within the Baltic Basin, as observed in the Baubliai-2 and Viduklė-61 boreholes. Additionally, the study offers visual representations including photomicrographs and SEM images of selected acritarchs and prasinophytes. This study offers valuable insights into the organic world and environment of the Wenlock and Ludlow periods on the Baltica palaeocontinent. Despite the absence of typical index species, the observed diverse and stratigraphically long-ranging taxa contribute to biostratigraphic and paleoecological analyses. This research enriches both local-scale understanding and the broader global perspective of Paleozoic phytoplankton.

**Acknowledgement:** This research is a part of the project titled "Shifts in the paleoenvironments during the early Paleozoic – tracking the turning points in climate and insight into the depositional environments" (no. S-MIP-23-33), which was supported by the Research Council of Lithuania.

# NEW PRELIMINARY PALAEONTOLOGICAL STUDIES ON LATE SILURIAN FOSSILS BASED ON THE CORE OF MILAIČIAI 103 WELL (SW LITHUANIA)

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The distribution of Silurian rocks in Lithuania is a good example of multifacial sediments with a marine deep shelf in the western part and a marine shallow shelf and lagoonal in the eastern and easternmost parts (Valiukevičius 2005). Meanwhile, the studied Milaičiai 103 well is located in the transition from open to deep shelf in the southwestern part of Lithuania (55° 15' 48.09'' N, 22° 38' 11.96'' E).

The 400 carbonatic samples were collected from the core of Milaičiai 103 well. These samples are spanning four local geological formations (Ventspilis, Minija, Jūra, and Tilžė formations) of the uppermost part of Wenlock through the entire Pridoli. As a result, the new palaeontological investigation revealed: the scales of thelodonts, teeth and scales of the acanthodians, scolecodonts fragments as well as gastropods, extremely rare finds of coprolites and chitinozoans, poorly-preserved ostracods, and other groups in the studied material. This diverse assemblage of newly discovered fossils will provide a better understanding of their reactions to the Šilale Even (early Pridoli) which was caused by significant and prolonged changes to a colder and more arid climate, and previously established based on conodonts and brachiopods taxa by Spiridonov et al. (2020).

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Poster

# PRELIMINARY RESULTS OF CHIRONOMIDAE RESPONSES TO YOUNGER DAYS ENVIRONMENTAL CHANGES IN THE ČEPKELIAI BOG

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Fossilised larvae of Chironomidae (order: Diptera) have become increasingly valuable as a biological object in palaeoecological research. These fossils together with other micro-fossils (Diatoms, Cladocera and Ostracods) provide important insights into past aquatic environments and ecological conditions.

Subfossil chironomid analysis was applied to a sediment core from Čepkeliai, a raised bog surrounded by a strip of birch and a forest dominated by pine trees. Investigated site is in the southern part of Lithuania and in the south-eastern part of Čepkeliai reservation. A detailed multi-proxy analysis, e. g. pollen, plant macrofossil, radiocarbon data (14C), geochemistry and loss-on-ignition measurements, was used. Chironomid remains were analyzed in the sediment interval 1229 – 1323 cm. and cover 11 900 - 12 400 cal yr BP which is related to the Younger Dryas period. 89 head capsules belonging to 38 different morphotypes were identified. Some changes in Chironomidae fauna composition were noticed throughout the analysed sediment section. In the lower part of the analyzed core the most abundant morphotypes were *Ablabesmyia* genus, *Chironomus plumosus*-type and *Chironomus anthracinus*-type as well as *Dicrotendipes nervosus*-type. This species composition is indicative of quite warm environment conditions since these taxa thrive in water where floating macrophytes are abundant. In the uppermost part of the section the warm water midges larvae decreased and the number of cold-adopted and cool water Chironomidae increased. The most abundant taxa were *Corynocera ambigua*, *Psectrocladius sordidellus*-type and *Procladius* taxa. These changes in the species composition noticed a climate cooling that was observed in many European sites.

It should be noticed that recent Chironomidae studies are not complete, and further investigations will give more detailed information on environmental changes.

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# TEN SIMPLE RULES FOR PUBLISHING YOUR RESEARCH OUTSIDE OF THE PREFIX "PALAEO"

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Most fields of paleosciences are becoming more and more interdisciplinary, but studies that produce paleo-data are often limited to publishing their results as scientific articles in journals with a so-called “paleo”-prefix. While it is important to reach wider audiences with your publications, many early-career researchers do not receive any advice on how to publish outside their own field of research. Publishing your research in journals outside of the prefix "paleo" requires special strategies and can be very challenging, especially for early-career researchers. These challenges include the contrasting nature of methods used, specific terminology, and the diverse background of palaeoscientists (e.g., geologists, ecologists, oceanographers), all hampering the crucial scientific cross-fertilization among disciplines that have time in its core approach.

Here, we present the results from a community-based effort to gather the ten most important tips or rules to successfully publish your research in journals outside your research field, with a focus on the field of Ecology. In the Spring of 2021, we sent out a call to different online platforms (e.g., PAGES community, BESpalaeo community) to receive community-based input with the best strategies and how to publish your research in broader journals, specifically outside of the prefix “paleo”. Responses from more than 40 people were summarized and turned into ten simple rules which apply to anyone who wants to publish outside their own sub-field.

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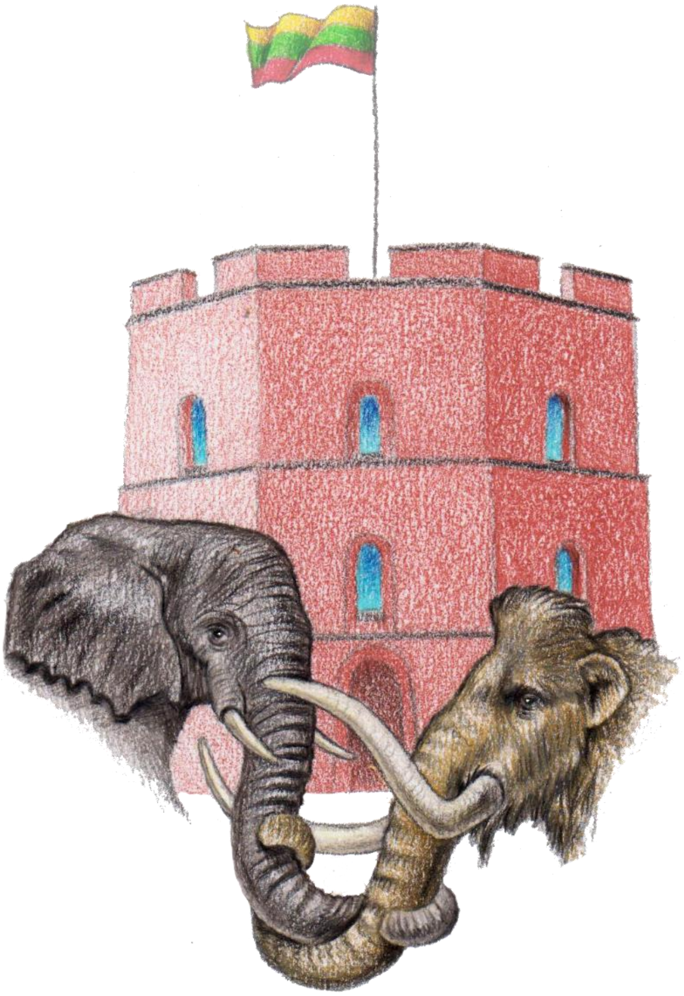

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