Linnean Society

of London

Palynology Specialist Group
Autumn Meeting

Thursday 13th November 2014
Linnean Society, Burlington House, Piccadilly, London, W1J 0BF

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Arrival from 10:00am.

Please do not arrive prior to this time as Burlington House will be closed for fire alarm testing

Phillip Jardine 10:30 – 10:55

Recovering sporopollenin chemical information from processed palynological samples.

Phillip E. Jardine[1*], Wesley T. Fraser[2], Barry H. Lomax[3] and William D. Gosling[4]

[1] Department of Environment, Earth and Ecosystems, The Open University, Milton Keynes, UK (*correspondence: phillip.jardine@open.ac.uk)
[2] Geography, Department of Social Sciences, Oxford Brookes University, Oxford, UK
[3] The School of Biosciences, The University of Nottingham, Sutton Bonington Campus, Sutton Bonington, Leicestershire, UK.
[4] Paleo & Landscape Ecology, Institute of Biodiversity & Ecosystem Dynamics (IBED), University of Amsterdam, Amsterdam, The Netherlands

Sporomorphs (pollen and spores) have an outer wall composed of sporopollenin. Sporopollenin chemistry is responsive to levels of ultraviolet-B (UV-B) radiation exposure, which offers the possibility of using fossil sporomorph chemistry as a proxy for past UV-B and solar irradiance flux. However, it is currently unknown how sensitive sporopollenin chemistry is to standard palynological processing techniques, and in particular oxidation. Here, we test this by experimentally oxidising *Lycopodium* (clubmoss) spores using two common oxidation techniques: acetolysis and nitric acid. Using Fourier Transform infrared (FTIR) spectroscopy, we find that acetolysis removes labile, non-fossilisable components of sporomorphs, but has a limited impact upon the chemistry of sporopollenin under normal processing durations. Nitric acid is more aggressive and does break down sporopollenin and reorganise its chemical structure, but when limited to short treatments (i.e. ≤10 minutes) at room temperature sporomorphs still contain most of the original chemical signal. We also present preliminary pollen chemistry data from the late Pleistocene of Ghana, derived from samples that have undergone standard processing procedures, including acetolysis. This research suggests that when used carefully oxidation does not adversely affect sporopollenin chemistry, and that palaeoclimatic signatures contained within the sporomorph wall are recoverable from palynologically prepared fossil material.

Luke Mander **10:55 – 11:20**

On the taxonomic resolution of pollen and spore records of Earth's vegetation

Luke Mander[1*] and Surangi W. Punyasena[2]

[1] College of Life and Environmental Sciences, University of Exeter, Prince of Wales Road, Exeter, Devon, UK (*correspondence: luke.mander@gmail.com)
[2] Department of Plant Biology, University of Illinois, 505 South Goodwin Avenue, Urbana, Illinois, 61801, USA

Pollen and spores (sporomorphs) are a valuable record of plant life, and have provided information on subjects ranging from the nature and timing of evolutionary events to the relationship between vegetation and climate. However, sporomorphs can be difficult to classify at the species level, and classic examples of this include the pollen of *Pinus* (pine), *Quercus* (oak), and Poaceae (grasses). In cases such as these, the sporomorph fossil record suffers from limited taxonomic resolution and provides information about plant life at a taxonomic rank above species. In this talk, we use examples ranging from morphometric studies of *Picea* (spruce) pollen, to the computational classification of grass pollen, to outline how greater taxonomic precision may be attained in future palynological work. We also outline a comparison of human versus computational classification of grass pollen in order to provide context for algorithmic classifications of sporomorphs.

Hugh Dickinson **11:20 – 11:45**

Asymmetry in pollen mitosis 1; how does it work and is it important?

Hugh Dickinson[1]

[1] Department of Plant Sciences, South Parks Rd., Oxford , UK (hugh.dickinson@plants.ox.ac.uk)

The asymmetric division of the microspore nucleus in Pollen Mitosis 1 is arguably the most pivotal in plant development as it commits the smaller of its products to germline development (and the other to a 'companion cell' role). It may also signify the end of any competence for sporophytic development in the reproductive cell lineage.

Previous work, principally from the Twell Lab. in Leicester, has shown that the very asymmetry of the division is important - for symmetric divisions seemingly cannot result in germline development. However it is unclear to what extent this key developmental switch depends on the genetic and epigenetic landscape of the microspore itself, and indeed of the microsporocyte that preceded it. Data will be discussed from ongoing experiments to determine how these male meiotic products are committed first to gametophytic (rather than sporophytic) development and then to gametogenesis.

Mark Grosvenor **11:45 – 12:10**

Human-landscape interactions during the Mesolithic-Neolithic Transition in Cumbria

Mark Grosvenor[1]

[1] Geography, College of Life and Environmental Science, University of Exeter (M.J.Grosvenor@exeter.ac.uk)

The vegetation history of two contrasting locations in Cumbria are used to investigate how the relationship between humans and the landscape changed during a cultural shift. The Mesolithic-Neolithic Transition marks the shift from a hunter-gatherer lifestyle towards the development of agricultural techniques. In Britain, this occurs during the mid-Holocene. Archaeological investigations have been limited in their detail due to difficulties in dating artefacts, and reworking of sites. Here, we use lake sediments to investigate the environmental record, and from this infer changes in human activity. Pollen records from upland and lowland sites are used, alongside micro-charcoal and geochemistry to reconstruct the changes to the landscape. Radiocarbon dating is used to produce high resolution chronologies for each site. Key differences are highlighted in the nature of human impact during the Transition period with a temporal offset of around 200 years between similar events occurring in lowland and upland landscapes. Furthermore, the environmental evidence shows the scale of activity is far greater than archaeological evidence alone would suggest.

Guy Harrington **12:10 – 12:35**

The fate of pollen in soils in the Paleocene-Eocene Thermal Maximum (PETM): The terrestrial response to global warming

Guy Harrington[1,2]

[1] School of Geography, Earth and Environmental Sciences University of Birmingham, UK. (g.j.harrington@bham.ac.uk) ,
[2] Environmental Science Centre Nicker Hill Keyworth Nottingham British Geological Survey

The Paleocene-Eocene Thermal Maximum (PETM) at ≈56 Ma represents a ≈200 Ky perturbation in the carbon cycle that drove profound changes in terrestrial and marine systems. Global temperatures rose by >6°C and short-term responses included the geographic range changes to many plant species and unexplained removal of carbon from the soils. Permanent changes to community membership of animals and plants are a long-term feature. We know so much about many aspects of the PETM but the vast majority of our knowledge is derived from marine records only. Here I talk about continental drilling results from the Bighorn Basin in Wyoming, USA and outline the need to understand further taphonomic aspects of pollen and organic degradation in fossil soils under varying climatic conditions.

Lunch (Not provided) at various locations around Burlington House

Barry Lomax **14:00 – 14:25**

Episodic perturbations of end Permian atmosphere recorded in plant spore chemistry.

Barry H Lomax[1*] Wesley T Fraser[2,3*], David J Beerling[4], David I James[5], John A Pyle[67] Stephen Self[2], Mark A Sephton[7] and Charles H Wellman[4].

[1] The School of Biosciences, The University of Nottingham, Sutton Bonington Campus, Sutton Bonington, Leicestershire, UK. (*correspondence: Barry.lomax@nottingham.ac.uk)
[2] Geography, Department of Social Sciences, Oxford Brookes University, Gipsy Lane Campus, Oxford, UK
[3] Department of Environment, Earth and Ecosystems, The Open University, Milton Keynes, UK
[4] Department of Animal and Plant Sciences, University of Sheffield, Sheffield, UK.
[5] Thermo Fisher Scientific, Stafford House, Boundary Way, Hemel Hampstead, UK
[6] Department of Chemistry, Centre for Atmospheric Science, University of Cambridge, Cambridge, UK
[7] National Centre for Atmospheric Science, UK
[8] Department of Earth Science and Engineering, Imperial College, South Kensington Campus, London, UK

The end-Permian mass extinction, 251 Myr ago, is the largest of all marine Phanerozoic extinction events and is accompanied by a major reorganization of terrestrial vegetation and the destruction of Palaeozoic tropical rainforest ecosysytems. The event is temporally linked to the eruption and emplacement of the Siberian Traps large igneous province (LIP). The vast Siberian traps (areal extent of ~5million km2 and volume totaling ~4 million km3) were rapidly emplaced by flood basalt mechanisms, possibly enhanced explosive eruptions, through a sedimentary sequence of evaporites coal and rocks rich in dispersed organic carbon. When heated this would have facilitated the production of large quantities of organohalogens. These factors when combined with the high latitude location suggest that large quantities of ozone depleting chemicals could have been delivered into the atmosphere, resulting in a partial collapse of the stratospheric ozone layer and a commensurate increase in UV-B radiation at the Earth's surface. To date indirect evidence supports this chain of events but full elucidation remains elusive. Here we use a newly developed proxy for UV-B radiation and apply it to clubmoss (Lycophyta) megaspores to track changes in the UV-B flux over this interval. In contrast to recent hypotheses, our data show three episodes of marked relative decreases in ultraviolet screening compounds during the latest Permian and one large relative decrease in the earliest Triassic. When combined with evidence of spore and pollen mutations, our chemistry data evidence a highly dynamic system oscillating between episodes of high UV-B flux, and conditions more attuned to 'normal' background UV-B flux during the end Permian extinction.

Matthew Pound **14:25 – 14:50**

No evidence for a large-scale global change in vegetation and terrestrial climate at the Eocene-Oligocene transition

Matthew J.Pound[1*] and Ulrich Salzmann[1]

[1] Northumbria University; Newcastle upon Tyne; UK (*correspondence: matthew.pound@northumbria.ac.uk)

The Eocene–Oligocene transition is a key step from the greenhouse to the icehouse world. Geochemical marine records show both surface and bottom water cooling, associated with the expansion of Antarctic glaciers. However, the global response of the terrestrial biosphere is less well understood. We present a new global vegetation and climate reconstructions of the Priabonian (late Eocene; 38–33.9 Ma) and Rupelian (early Oligocene; 33.9–28.45 Ma) to explore the terrestrial response.

By synthesising 215 pollen and spore localities into an ArcGIS–Microsoft Access database it has been possible to investigate global vegetation changes in response to the Eocene – Oligocene transition. Using presence/absence data of pollen and spores with multivariate statistics has allowed the reconstruction of vegetation groups without relying on modern analogues; such as biomes. The reconstructed vegetation groups show no geographic change from the Priabonian to the Rupelian. Reconstructions of mean annual temperature show no statistically significant difference between the Priabonian and the Rupelian. Our new reconstructions differ from previous global syntheses and our terrestrial based climate reconstructions are in stark contrast to marine based climate estimates. Our results raise new questions on the nature and extent of global climate change at the Eocene–Oligocene transition.

Peter Mark **14:50 – 15:15**

The effect of heat stress on wheat pollen development: a multi-faceted approach to a better understanding of a potentially serious issue

Peter Mark[1], Zoe Wilson[2], and Hannah Jones[1]

[1] School of Agriculture, Policy and Development, University of Reading, UK (*correspondence: petethebotanist@hotmail.co.uk).

[2] The School of Biosciences, The University of Nottingham, Sutton Bonington Campus, Sutton Bonington, Leicestershire, UK.

With wheat contributing about 20 % of the total, worldwide, dietary calories and proteins (Shiferaw et al., 2013), and the UN anticipating that the global population could reach 9.6 billion by 2050, there is an ever increasing desire to maintain wheat yield stability in changing abiotic environments. With one of these environmental changes being the increasing of ambient temperatures, and those, such as Saini & Aspinall (1982) extoling the disproportionately negative effect that heat stress has on eventual yield, when targeted towards those stages associated with pollen development, this work aims to clarify, and build upon such findings.

The findings presented here today are threefold: There are stages of pollen development, even if different from what was reported in the past, which are significantly ($p=<0.05$) more sensitive to heat stress than others. There are wheat varieties, recommended for growing in Great Britain, that are significantly ($p=<0.05$) more sensitive to heat stress, inflicted at the same gross developmental stage. There are pollen related reasons behind this. The potential for inter-ear pollen movement, from an unstressed ear to a stressed ear, does not mitigate yield loss, largely due to such ears having a predominantly cleistogamous nature.

With the future addition of the analyses of changes in pollen related gene expression, due to heat stress, the potential for a somewhat holistic appreciation of the challenges facing the agronomic community, during this window of wheat development, is hoped for.

Saini H. S., Aspinall D., 1982, Abnormal Sporogenesis in Wheat (*Triticum aestivum* L.) Induced by Short Periods of High Temperature, *Annals of Botany*, **49** (6), 835-846.

Shiferaw B., Smale M. Braun H.-J., Duveiller E., Reynolds M., Murichp G., 2013, Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security, *Food Security*, **5** (3), 291-317.

Sam Salter **15:15 – 1540**

Micro vs. Mega: A quantitative comparison of dispersed spores/pollen and plant megafossil assemblages from a Middle Jurassic plant bed from Yorkshire, UK.

Sam M. Slater[1*] and Charles H. Wellman[1]

[1] Department of Animal and Plant Sciences, University of Sheffield, Sheffield, UK
(*correspondence: bop11sms@sheffield.ac.uk).

Detailed quantitative data has previously been collected from plant megafossil assemblages from a Middle Jurassic (Aalenian) plant bed from Hasty Bank, North Yorkshire, UK. We conducted a similar analysis of palynological dispersed sporomorph (spores and pollen) assemblages collected from the same section using the same sampling regime: 66 sporomorph taxa were recorded from 50 samples taken at 10 cm intervals through the plant bed. Basic palynofacies analysis was also undertaken on each sample. Both dispersed sporomorph and plant megafossil assemblages display consistent changes in composition, diversity and abundance through time. However, the dispersed sporomorph and plant megafossil datasets provide conflicting evidence for the nature of the parent vegetation.

Combined multivariate analysis (correspondence, principal components and nonmetric multidimensional scaling) of sporomorph occurrence/abundance shows that temporal variation in sporomorph/plant megafossil assemblages is the result of depositional change through the plant bed. The reproductive strategies of parent plants are considered to be a principal factor in shaping many of the major abundance and diversity irregularities between dispersed sporomorph and plant megafossil data sets that seemingly reflects different parent vegetation. Preferential occurrence/preservation of sporomorphs and equivalent parent plants is a consequence of a complex array of biological, ecological, geographical, taphonomic and depositional factors that act inconsistently between and within fossil assemblages, which results in significant discrepancies between data sets.

Tea in Linnean Society Library

Carina Hoorn **16:00 – 16:25**

Evidence of past marine conditions in Amazonia

Carina Hoorn[1]*, Melanie Boonstra[1], Maria Ines Ramos[2], Emmy Lammertsma[1], Pierre-Olivier Antoine[3]

[1] Paleoecology and Landscape Ecology, Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, P.O. Box 94248, 1090 GE Amsterdam, The Netherlands (*correspondence: M.C.Hoorn@uva.nl).
[2] Museu Paraense Emílio Goeldi, Campus de Pesquisa, CCTE, Av. Perimetral, 1901, CEP 66077-830, Belém, PA, Brazil.
[3.]Antoine, P.-O.: Institut des Sciences de l'Évolution, CC064, CNRS, IRD, Université Montpellier 2, Place Eugène Bataillon, F-34095 Montpellier, France.

The nature and extent of past marine conditions in Amazonia are debated, but undeniably left their imprint in modern species composition. Aquatic fauna such as the pink river dolphin and a variety of marine related fish taxa are all relicts of a time when Amazonia was connected to the sea. When these marine connections existed and what facilitated them, is of high interest as it is relevant for understanding modern biodiversity patterns in this region. In recent years a combination of different geological disciplines, such as palynology, paleontology, sedimentology, and geochemistry partially elucidated the timing and nature of the marine conditions that affected Amazonia during the Paleocene and the Miocene.

Here I will present data from a collaborative study on Miocene deposits from selected sites in Peru and Colombia. At these sites layers containing marine palynomorphs and foraminifera tests are intercalated in an otherwise fresh water sedimentary succession. The new data are related to the wider context of Neogene geological history of the Amazon region.

Wesley Fraser **16:25 – 16:50**

Towards a unified cross-taxa sporopollenin composition

Wesley T. Fraser[1,2*] Phillip E. Jardine[2], Alison Foster

Barry H. Lomax[4] and William D. Gosling[5]

[1] Geography, Department of Social Sciences, Oxford Brookes University, Oxford, UK (*correspondence: wfraser@brookes.ac.uk)
[2] Department of Environment, Earth and Ecosystems, The Open University, Milton Keynes, UK
[3] Oxford Botanic Gardens, University of Oxford, Oxford, UK.
[4] The School of Biosciences, The University of Nottingham, Sutton Bonington Campus, Sutton Bonington, Leicestershire, UK.
[5] Paleo & Landscape Ecology, Institute of Biodiversity & Ecosystem Dynamics (IBED), University of Amsterdam, Amsterdam, The Netherlands

Sporopollenin constitutes the major component of the exine of pollen and spores (sporomorphs), but detailed knowledge of the structure of sporopollenin remains elusive. This is in part due to the highly resistant nature of sporopollenin, resistant to all but the most vigorous of chemical and physical attack. As a result, analytical interrogation of the chemical nature of sporopollenin has long posed a substantial challenge.

Technological advances have enabled us to gain greater insights into the chemical nature of sporopollenin through the combination of non-destructive microspectroscopic and vigorous pyrolytic methods. With these new insights we have identified ancient (c.310 Ma) sporopollenin that closely resembles extant sporopollenin within the same lineage (Lycopsids), suggesting long-term evolutionary stasis of sporopollenin chemical composition. The data presented here move a step forwards from investigating a single plant group and apply our analytical techniques to a range of taxa of varying degrees of phylogenetic proximity. We demonstrate a strong commonality of sporopollenin composition across taxa, with some subtle differences identifiable at the Order level.