OU STEM EEES Project Proposal Form – 2024 entry

Project Title	Vegetation dynamics through the late Paleocene and early Eocene in southern England
Key words	Plants, Palaeoecology, Biogeography, Diversity
Supervisory team (including email address	**PI:** Dr Luke Mander (The Open University, Luke.Mander@open.ac.uk) **Co-I:** Dr Tom Stubbs (The Open University, Thomas.Stubbs@open.ac.uk) **Collaborator:** Prof. Margaret E. Collinson (Royal Holloway, University of London)
Is the PhD suitable for part time study?	Yes ☒ No ☐

Project Highlights:

- Investigation of how plants respond to global warming
- Blend of primary taxonomic work with broad biogeographic analysis
- Fieldwork in southern England

Overview: The late Paleocene to early Eocene was marked by an overall warming of global climate, and was characterized by a number of hyperthermal events such as the Paleocene–Eocene Thermal Maximum (PETM) (Collinson et al. 2009). During the early Eocene, southern England is thought to have been situated at around 40°N and was characterised by a hot and humid climate (Barnet 2023). Vegetation in southern England responded to rapid warming at the PETM by changing composition rather than diversity, with late Paleocene vegetation characterised by ferns and woody angiosperms (flowering plants) disturbed by fires, and PETM vegetation characterised by fewer ferns, an increase in wetland plants and an absence of fire (Collinson et al. 2009).

The response of vegetation in this region to long-term climatic change from the late Paleocene to the early Eocene is recorded by plant macrofossils (leaves, woods and reproductive structures). These fossils indicate that vegetation in the late Paleocene and Paleocene–Eocene transition was mixed, containing indicators of paratropical to subtropical forest vegetation, while vegetation in the early Eocene had a distinctly tropical aspect with warm growing condition confirmed by the presence of plants such as palms and numerous lianas (Collinson and Hooker 2003).

In tropical latitudes, vegetation response to late Paleocene–early Eocene climatic change has been recorded by fossil pollen and spores. These data show that the early Eocene was a major period of diversification for plants growing in ancient rainforests in both the Neotropics (Jaramillo et al. 2006) and the Afrotropics (Mander et al. 2023). However, although macrofossils certainly indicate major vegetation change through the late Paleocene and early Eocene in southern England, the absence of comparable pollen and spore data means that it is currently unclear whether the early Eocene was a major period of plant diversification in tropical latitudes only, or whether this time period records diversification over a wider geographic area.

In order to address these issues, this project aims to: (1) reconstruct the late Paleocene–early Eocene vegetation of southern England using fossil pollen and spores; (2) quantify the nature and timing of any changes in vegetation diversity and composition across this time interval; (3) generate

a biogeographic comparison of the late Paleocene–early Eocene vegetation of southern England and the African tropics, building on recent primary taxonomic work in this region (Mander et al. 2023).

Figure: An example of a Paleocene–Eocene sedimentary succession the UK: Alum Bay, Isle of Wight (from Wikipedia)

Alt-text: Photograph shows a small bay (Alum Bay) on the Isle of Wight, with the sea in the foreground, and cliffs made of Paleocene–Eocene rocks rising in the centre of the photograph.

Methodology: Initially, fossil pollen and spores will be examined in existing slide collections prepared by collaborator Prof. Collinson (see Collinson et al. 2008) taken from key stratigraphic intervals in the Poole Formation and Cobham Lignite. This will allow a student to begin examining fossil material immediately. Results from this dataset will inform the planning of fieldwork to collect additional samples (~40) at key locations in southern England later in the project. Fossil pollen and spores will be examined, classified and counted using light microscopy. The diversity and composition of late Paleocene–early Eocene vegetation will be quantified by using statistical analysis of pollen and spore count data using techniques such as richness estimation, rarefaction, and multivariate ordination. Statistical analyses will be undertaken using software such as PAST and packages such as 'vegan' in R.

Training and skills: Training will be provided on the taxonomy and practical classification of Paleocene–Eocene pollen and spores and on the statistical methods used to reconstruct vegetation diversity and composition. Training in the geological techniques needed to establish a stratigraphy and palaeoenvironments, and in the laboratory methods used to chemically macerate sediment samples to release fossil pollen and spores, will be provided as necessary. Training will also be

provided in project management, professional networking, and science communication, including conference presentation, public speaking and popular science writing.

Partners and collaboration: This project benefits from collaboration with Prof. Margaret Collinson at Royal Holloway, University of London.

Possible timeline:

Year 1: Examine fossil pollen and spores in existing slide collections from the Poole Formation and Cobham lignite. Generate a classification scheme for pollen and spores encountered, formally describing new species where necessary. Plan and undertake additional fieldwork as necessary, and process additional samples in the laboratory.

Year 2: Generate count data on the relative abundance of pollen and spore taxa encountered, and analyse count data statistically in order to reconstruct the diversity and composition of pollen and spore assemblages. Present results at the Palaeontological Association Annual Meeting.

Year 3: Generate a biogeographic comparison of the late Paleocene to early Eocene vegetation in southern England and West Africa. Produce a manuscript and present results at the Geological Society of America Annual Meeting. Write up PhD thesis.

Further reading:

Barnet J. (2023) Geological evolution of the Hampshire Basin (southern England) during a global climate transition from 'hothouse' to 'coolhouse' in the Palaeogene. *Geology Today*, 39, 54–61.

Collinson M.E. & Hooker J.J. (2003) Paleogene vegetation of Eurasia: framework for mammalian faunas. *In*: Reumer J.W.F. & Wessels W. (eds.) Distribution and Migration of Tertiary Mammals in Eurasia. A Volume in Honour of Hans de Bruijn. *Deinsea*, 10, 41–83.

Collinson M.E., Steart D.C., Harrington G.J., Hooker J.J., Scott A.C., Allen L.O., Glasspool I.J. & Gibbons S.J. (2009) Palynological evidence of vegetation dynamics in response to palaeoenvironmental change across the onset of the Paleocene-Eocene Thermal Maximum at Cobham, Southern England. *Grana*, 48, 38–66.

Jaramillo C., Rueda M. & Mora G. (2006) Cenozoic plant diversity in the Neotropics. *Science*, 311, 1893–1896.

Mander L., Jaramillo C. & Oboh-Ikuenobe F. (2023) Descriptive systematics of Upper Paleocene–Lower Eocene pollen and spores from the northern Niger Delta, south-eastern Nigeria. *Palynology*, 47, 2200525.

Further details:

Please contact Luke Mander (Luke.Mander@open.ac.uk) for further information and informal discussion about this project.