OU PhD Project Proposal Form – 2020 entry

<table>
<thead>
<tr>
<th>Project Title</th>
<th>OU20: Siliceous wood: does silicon matter to plants beyond leaves?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key words</td>
<td>Plant silica, ecological strategies, phylogenetic patterns, functional ecology, wood, plant traits</td>
</tr>
<tr>
<td>Supervisory team (including institution &amp; email address)</td>
<td>Dr Julia Cooke, The Open University, <a href="mailto:julia.cooke@open.ac.uk">julia.cooke@open.ac.uk</a>; Dr Philip Wheeler, The Open University <a href="mailto:philip.wheeler@open.ac.uk">philip.wheeler@open.ac.uk</a></td>
</tr>
<tr>
<td>Is the PhD suitable for part time study?</td>
<td>Yes ☒ No ☐</td>
</tr>
</tbody>
</table>

Project Highlights:

- Join a dynamic and growing global research community studying plant silicon
- Compile a broad-scale database of silicon concentrations for wood to undertake the first phylogenetic and comparative trait analyses to determine if wood Si is part of the ‘world-wide wood economics spectrum’
- Learn and use the latest field, laboratory, phylogenetic and statistical analysis skills to explore ecological strategies in plants

Overview:

All plants require light, water, air and micronutrients to survive and thrive, but in recent years plant biologists have begun to understand the importance to plants of another element: silicon. Silicon (Si) accumulation in non-woody shoots and leaves is now recognised as an important plant trait, with some species accumulating very little while in others Si comprises up to 10% of their dry mass. The use of Si by leaves as a resource for defence against herbivory, and a strengthening component and to alleviate the impacts of a range of biotic and abiotic stresses is increasingly well understood and appreciated by physiologists and ecologists. There are phylogenetic patterns in shoot/leaf Si accumulation, with some families, such as the Poaceae (grasses) and Equisetaceae (horsetail), high accumulators. New data suggests that Si could also be important in the roots of herbaceous plants as a defence against herbivores.

However, we know almost nothing about the functions of Si accumulation in wood, despite the enormous ecological, practical and commercial importance of this plant tissue. Some recent papers and a few vintage reports suggest there may be substantial variation in wood Si concentration across species, but the significance of this variation is unclear.

Si in wood may act as a defence: high Si woods were selected for making piers due to higher resistance to marine wood borers and the same may be true for terrestrial borers, with potential implications for managing emerging tree pests. It may also be important structurally since wood mechanically supports above-ground tissue. Leaf Si accumulation is negatively correlated with leaf longevity suggesting Si could replace carbon in some ecological strategies (Cooke and Leishman 2011). This project would test if the same pattern occurs in wood. Wood varies in density, mechanical strength, anatomy and secondary chemistry, and large databases for wood traits exist (eg. Chave et al. 2009 and https://www.try-db.org/). This project would be the first to look at how widespread high Si accumulation is in wood, and test specific hypotheses about Si relationships with key wood traits.
This project aims to answer the following questions:

- Does Si accumulation in wood follow phylogenetic patterns, and if so, do they mirror the patterns in leaves?
- Do species resistant to wood borers have high wood Si?
- Is high wood Si correlated with mechanical strength and density?
- Do trait trade-offs suggest wood Si is part of the ‘world-wide wood economics spectrum’?

Figure 1: We know little about the accumulation or function of silicon in wood. Photo: Thin-section of ring porous woody stem, courtesy of Amy Zanne.

Methodology:

Wood samples will be collected from over 250 species of woody plant, making use of botanic gardens and collections by colleagues to increase the phylogenetic diversity of the dataset. Si concentrations in wood will be analysed at Lund University, Sweden. A phylogenetic tree will be developed for the sampled species using current phylogenetic methods. Existing databases of wood traits will be mined for relevant species data. The project will test hypotheses using several key wood traits, with phylogenetic comparisons. Finally, this project will determine if Si accumulation in wood mirrors that of leaves in the same species, and will consider the ecological implications for uptake and allocation of Si in plants.

Training and skills:

For this project the student would be trained in chemical analysis at the Department of Geology, Lund University, Sweden. Dr Julia Cooke would oversee training in making field collections, the collation of trait data from the literature and accessing and mining existing databases. The student will receive training in statistical analysis in R and be supported by weekly in-house R-Club meetings run by both main supervisors. In addition, the student would have the opportunity to attend at least one international conference, such as the British Ecological Society Conference, (the biggest ecology conference outside North America).

Partners and collaboration:

The student will develop international contacts by liaising with colleagues of Drs Julia Cooke and Philip Wheeler to obtain wood samples from across the globe, including Australia, mainland Europe, South East Asia and the USA. Wood trait experts and silicon biogeochemists will be informal advisors.
Possible timeline:

**Year 1:** Literature review, identify known or hypothesised functions for Si in wood. Assemble existing Si data for wood. Obtain collection permits. Identify plant families to target. Develop and optimise Si analysis method for wood. MS1. literature review/opinion piece.

**Year 2:** Wood collections, determine Si concentration. Prepare phylogenetic tree for species collected and conduct statistical analyses. Begin wood trait database extraction/compilation. MS2. Phylogenetic patterns of Si accumulation in wood.

**Year 3:** Interrogate database to test hypotheses about wood traits. MS3. Relationships between Si accumulation and traits of wood. MS 4: Phylogenetic comparison of wood and leaf/shoot Si accumulation.

Further reading:


Further details:

Students should have a strong background in ecology and enthusiasm for fieldwork and laboratory analyses. Experience of statistical analysis is desirable, and with R advantageous. The student will join a well-established team researching plant ecology and tree biology at The Open University.

Please contact Julia Cooke (julia.cooke@open.ac.uk) for further information.

Applications should include:

- a cover letter outlining why the project is of interest and how their skills match those required,
- an academic CV containing contact details of three academic references
- and an Open University application form, downloadable from (UK/EU students): [http://www.open.ac.uk/students/research/system/files/documents/Application%20form%20-%20uk-eu_0.docx](http://www.open.ac.uk/students/research/system/files/documents/Application%20form%20-%20uk-eu_0.docx)
  
  (International Students): [http://www.open.ac.uk/students/research/system/files/documents/Application%20Form%20-%20Overseas_0_0.docx](http://www.open.ac.uk/students/research/system/files/documents/Application%20Form%20-%20Overseas_0_0.docx)

Applications should be sent to STEM-EEES-PHD@open.ac.uk by 12pm (noon) on Friday 7th February 2020.