Roles of woodland birds in the transmission of emerging tree diseases

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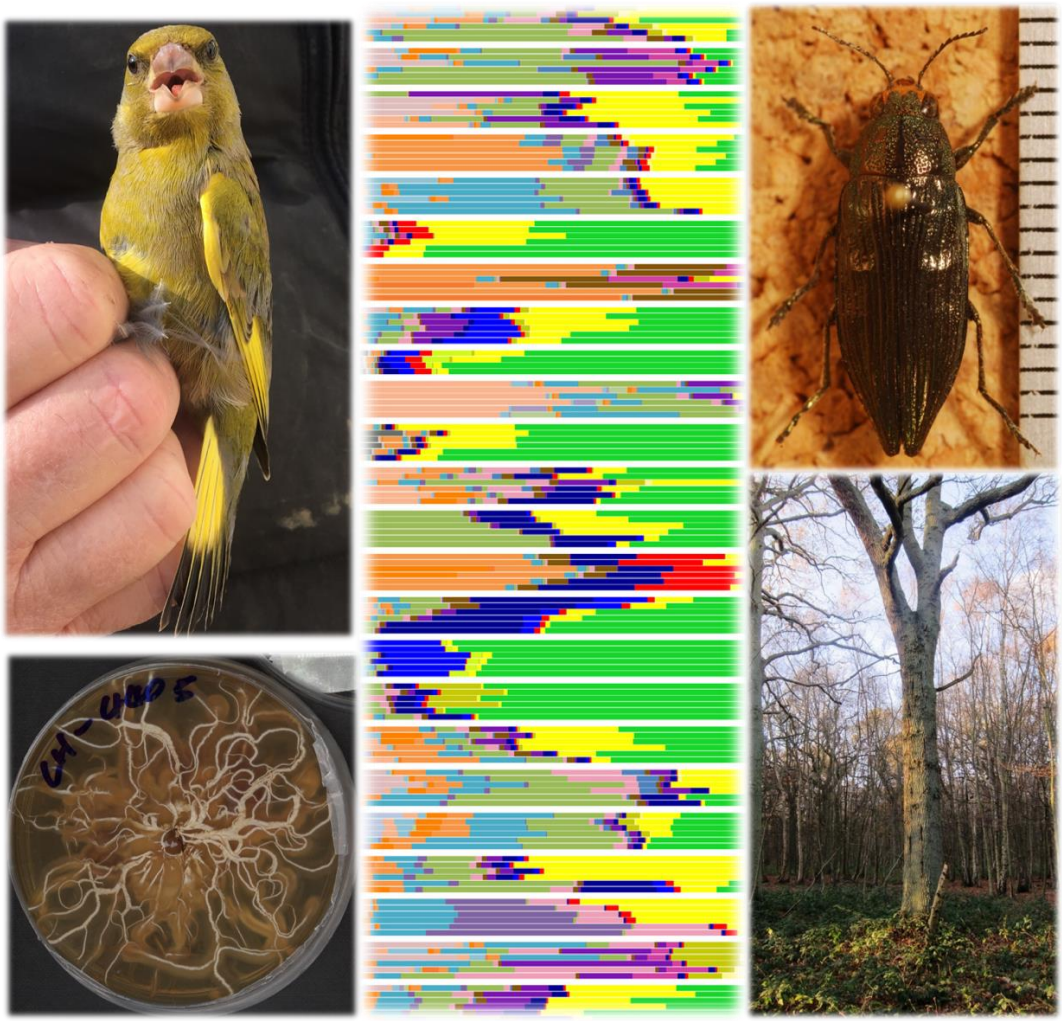
Ecologically important tree species in the UK are facing increased threats from invasive pests and pathogens, spurred on by climate change and globalization. Emerging and aggressive tree diseases, such as Acute Oak Decline, Horse-Chestnut Bleeding Canker and Ash Dieback, have gained considerable public, governmental and scientific attention in recent years. Under national emergency measures, several microbes known to be associated with these infections have been listed as quarantine pathogens. Tree experts predict that unless increased measures are put in place to study and control rampaging rates of infection, the face of the British countryside could be severely impacted and transformed forever. The scientific community, therefore, is challenged to address the uncertainty regarding the ecological and economic impacts of such diseases by developing rigorous monitoring and assessment programmes and providing solutions for mitigating impacts [1].

Trees are foundation species in many habitats, providing overarching structure, important ecosystem services (*e.g.* carbon sequestration, water retention and soil stability) and conservation of biodiversity in both natural and man-made landscapes. Due to this critical role in shaping and maintaining the biological integrity of diverse habitats, emerging tree diseases have the potential to cause cascading effects through ecosystems, negatively impacting associated fauna. Woodland birds, in particular, are especially vulnerable due to their intimate association with trees as sites for forage, shelter, breeding and nesting.

Outbreaks of tree disease are attributed to several members of the Enterobacteriaceae, yet still very little is known about the vectoring of these pathogens between sites and individual trees. Previous studies have speculated that insects, especially wood-boring beetles, may be transporting the pathogens between sites and delivering them directly into the living tissue of new host trees [2]. Other insects including those from the Cicadellidae and Ceropidae families are known to spread *Xylella fastidiosa*, an extremely aggressive bacterial pathogen, between a range of host plant species including English Oak [3].

The contributory role of woodland birds in controlling insects, acting as vectors of disease in trees, remains largely under-studied. Birds themselves, however, may be inadvertently acting as vectors of disease transmission and delivering the bacteria via the oral route to sites of infection through such activities as wood-boring and active foraging in cracks along the trunks. Survival of passage through the bird intestinal tract by said pathogens is feasible, opening further possibilities of spread via faeces.

We propose to investigate the intricate associations between trees, their diseases, insect vectors and their bird predators. A multi-disciplinary approach involving studies in plant pathology, molecular ecology, entomology and micro and molecular biology will be used to (1.) analyse dietary habits and feeding ecology of wild birds in woodland ecosystems; (2.) address impacts of tree disease on insect communities and abundance; and (3.) assess contribution of woodland birds to spread of tree diseases. Disentangling these complicated interactions will involve trapping, tagging and sampling from wild birds in the field and run these alongside high-throughput microbial and mitochondrial DNA sequencing analysis techniques in laboratories both at CEH and the University of Reading.



Transmission of diseases in forest ecosystems is highly complex. Understanding these interactions will require an interwoven multi-faceted approach involving tree pathology (bottom right), traditional microbiology and mycology (bottom left); entomology and insect ecology (top right); bird trapping, sampling and biometrics (top right); and high-throughput DNA sequencing (centre).

Training opportunities:

The student will receive specialist training in fieldwork methods, including bird capture and tracking techniques. Strong field survey and project management training will be provided, from design of protocols/methods through to data collection and handling, analytical skills for DNA meta-barcoding, basic bio-informatic analyses and statistical analyses (e.g. multivariate modelling in R). Access to skills training at CEH include GIS and statistical methods, conference presentation and writing skills.

At Reading, the student will receive a strong training in microbiology, molecular biology and molecular ecology techniques, and attend a range of training courses supplied by the graduate school. There is also the potential to learn applied aspects of knowledge transfer (e.g. through Reading's contacts at Forest Research) to inform forestry practitioners and policy makers of evidence-based research into the impacts of AOD on biodiversity.

Student profile:

The project is suitable for a graduate of ecology, biology or zoology, with a strong and passionate enthusiasm for scientific research, both in the field and in the lab. The candidate must have good interpersonal skills for working within a lab environment, but also be able to work responsibly and independently in the field. Ideally, the candidate will have strong numerical literacy. Desirable attributes would be skills in ecology, bird handling, entomology, forest/tree science or general botany, and molecular biology. We would also hope the candidate has good writing and oral presentation skills.

References

1 . Boyd, I.L.; Freer-Smith, P.H.; Gilligan, C.A.; Godfray, H.C.J. The consequence of tree pests and diseases for ecosystem services. *Science* **2013**, *342*, 1235773–1235773.

2 . Wong, C.M.; Daniels, L.D. Novel forest decline triggered by multiple interactions among climate, an introduced pathogen and bark beetles. *Glob Chang Biol* **2017**, *23*, 1926–1941.

3 . Baldi, P.; La Porta, N. *Xylella fastidiosa*: Host range and advance in molecular identification techniques. *Front Plant Sci* **2017**, *8*, 944.