PhD Project Advertisement

Project title: Modelling the impact of diseases on pollinator networks
Project No: FBS2024-044-Lo Iacono-sr

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Project description:

By 2050 the world's population will reach 9.1 billion, 34% percent higher than today. According to the FAO, to feed this larger population, food production must increase by 70%. How can we ensure food for everyone in a sustainable way? We need to feed the world and we need to leave a better world for future generations.

This is a formidable task, but your research can give a valuable contribution to this grand challenge.

Improving pollination is part of the solution. Pollination is a crucial ecosystem service, it facilitates fertilisation and the production of seeds, thus enhancing crop production and is a key function in ecosystems. In the UK alone, the economic benefit of pollination to crop production was estimated to be approximately £600m each year.

Unfortunately, managed pollinators (like honeybees) and wild pollinators (like bumblebees) are threatened. This is due to many factors, including climate change, habitat fragmentation/loss, agricultural intensification, incursion of predatory species and a variety of pathogens like deformed wing virus.

Your research will focus on pollinators and their diseases. You will develop novel mathematical approaches to address important questions in the field of ecology and epidemiology. You will apply the models you developed to identify strategies, possibly nature-based solutions, to alleviate the decline of pollinators.

Specifically, you will quantify the risk of disease spillover, i.e., when the disease is transmitted from one species to another, e.g., honeybee to bumblebee. You will investigate the important but elusive concept known as dilution effect. The dilution effect is an appealing idea, but not fully understood or proved. It is the idea that higher biodiversity can give protection against diseases. For example, in some communities in Africa people keep cattle or sheep near their houses in the belief that this will distract mosquitoes carrying malaria away from people. A similar principle might work with pollinators, if there is a large diversity of plants, then different species of pollinators might be attracted by different flowers (like in a meadow) reducing the possibility that the same bees feed on the same flower and thus reducing the risk of disease transmission. However, the opposite can happen, for example a lush meadow might attract diverse species of bees in the same area facilitating their contacts and thus the transmission of disease. By modelling this system, you will identify under which conditions dilution or amplification of diseases occur. Mathematical modelling will assist to address these important questions and set the path to translate the theoretical findings in practical management strategies.

You will be working in a truly multidisciplinary team, comprising an infectious disease modeller (Gianni Lo Iacono), an ecologist with expertise on the impacts of farming practice and land management on pollinators and pollination (Mike Garratt) and a veterinarian with expertise in bees who also runs a beekeeping business (Will Wilkinson).

Training opportunities:

The student will learn key transferable skills, such as scientific writing, presentation skills and time management. The multidisciplinary nature of the project will require the student to interact with a range of scientists with different backgrounds, such as modellers, epidemiologists, veterinarians, ecologist, allowing them to develop skills to communicate with different disciplines.

The student will develop a thorough knowledge of epidemiological and ecological modelling. This will include principles of epidemic modelling, deterministic and stochastic differential equations to model disease transmission, analytical methods to understand epidemic dynamics, and numerical techniques to implement the models.

The student will develop strong computer coding skills, including making sure this is done in a way that allows the model code to be shared with the wide scientific community in public repositories (e.g., GitHub), in line with Open Science principles. The student will also learn the statistical techniques to parameterise the models, including Bayesian methods, and uncertainty and sensitivity analyses to assess the most important parameters in the model.

Student profile:

The project is opened either to students from life-science willing to learn sophisticated mathematical modelling or students with a background in physics/engineering/mathematics interested in applying their skills and knowledge for epidemiology.

You need to have a strong interest in multidisciplinary research and familiarity with programming (e.g., R, Python).

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2023/24 this is £18,622 and it will increase slightly each year at rate set by UKRI.

Equality Diversity and Inclusion:

The FoodBioSystems DTP is committed to equality, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website.

In accordance with UKRI guidelines, our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

References:

References about pollinators:

Garratt, M. P. D., O'Connor, R. S., Carvell, C., Fountain, M. T., Breeze, T. D., Pywell, R., Redhead, J. W., Kinneen, L., Mitschunas, N., Truslove, L., Xavier e Silva, C., Jenner, N., Ashdown, C., Brittain, C., McKerchar, M., Butcher, C., Edwards, M., Nowakowski, M., Sutton, P., & Potts, S. G. (2023). Addressing pollination deficits in orchard crops through habitat management for wild pollinators. Ecological Applications, 33(1), 1–18. https://doi.org/10.1002/eap.2743

References about the type of mathematical modelling you will be expected to develop

Lo Iacono, G., Cunningham, A. A., Bett, B., Grace, D., Redding, D. W., & Wood, J. L. N. (2018). Environmental limits of Rift Valley fever revealed using ecoepidemiological mechanistic models. Proceedings of the National Academy of Sciences, 115(31), E7448–E7456. https://doi.org/10.1073/pnas.1803264115

Lo Iacono, G., Cunningham, A. A., Fichet-Calvet, E., Garry, R. F., Grant, D. S., Leach, M., Moses, L. M., Nichols, G., Schieffelin, J. S., Shaffer, J. G., Webb, C. T., & Wood, J. L. N. (2016). A Unified Framework for the Infection Dynamics of Zoonotic Spillover and Spread. PLOS Neglected Tropical Diseases, 10(9), e0004957. https://doi.org/10.1371/journal.pntd.0004957

Lo Iacono, G., & Nichols, G. L. (2017). Modeling the Impact of Environment on Infectious Diseases. In Oxford Research Encyclopedia of Environmental Science (Vol. 1, Issue September). Oxford University Press. https://doi.org/10.1093/acrefore/9780199389414.013.339

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.