

**Project title:**

Functional characterisation of Geminiviral-induced DNA recombination in infected plants

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**Deadline:** 7<sup>th</sup> January 2026

**Project Description:** Plant viruses are major agricultural pathogens, causing nearly half of crop losses due to disease. Climate change is expected to exacerbate these losses by altering pest and pathogen dynamics, making sustainable crop production increasingly challenging. Traditional virus management strategies, such as chemical control or breeding for resistance, are often ineffective or slow, while transgenic approaches, though promising, face technical, economic, and social barriers. This project seeks innovative, nature-inspired solutions to viral resistance by exploring **natural genetic exchanges between viruses and plants**.

Viruses occasionally integrate genetic material into plant genomes, and vice versa, through **horizontal gene transfer (HGT)**. Geminiviruses (GVs), small circular single-stranded DNA viruses, are prime candidates for such exchanges because they replicate in plant nuclei via double-stranded intermediates, mimicking minichromosomes, they evolve through recombination and rolling-circle replication, enabling genetic reshuffling and GV-related sequences are frequently found integrated in plant genomes, suggesting historical HGT events.

Recent findings by the project team revealed **frequent recombination events during GV infection**, producing **minicircles (MCs)**, small circular DNA molecules (~1.2–1.5 kb) composed of viral and host DNA fragments. MCs were discovered in beet plants infected by *Beet curly top Iran virus* (BCTIV) and can be replicated by the virus in unrelated species (e.g., tobacco, Arabidopsis). Moreover, MCs were detected in viral particles transmitted by leafhoppers, implying their potential spread across species and ecosystems.

MCs may influence virus-host interactions by acting as defective molecules that reduce disease severity or by altering host gene expression via transcription from viral promoters or small RNA-mediated epigenetic changes. Understanding MC biology could lead to **cost-effective strategies for virus control** and novel tools for **synthetic biology**, such as virus-induced gene silencing (VIGS) or heterologous protein expression in crops.

**Objectives:**

- Identify and characterize minicircles (MCs) across diverse plant-virus systems using advanced sequencing approaches, and analyse factors influencing their formation.
- Determine the biological impact of MCs on virus replication, disease severity, and host responses, including epigenetic and transcriptomic changes.
- Develop artificial MCs as biotechnological tools, leveraging their structure for virus-induced gene silencing, gene expression, and synthetic biology applications.

**References:** Catoni, M., Noris, E., Vaira, A.M., et al. (2018) Virus-mediated export of chromosomal DNA in plants. *Nature Communications*, 9 (1): 5308. doi:10.1038/s41467-018-07775-w.

**Funding note:** This project is funded by competitive application to the [Darwin programme](#) and it is available only to **international students**. Interested students must apply to the [Birmingham PhD programme](#) and **clearly indicate the source of funds as the Darwin Trust**. In your application please include the [Darwin Application Form](#) by the set deadline. Please check the [selection criteria](#) before applying. Contact [m.catoni@bham.ac.uk](mailto:m.catoni@bham.ac.uk) if you have question related to this programme.