

Use of eDNA Analysis in the Conservation of Grassland Fungi

RESEARCHERS

Professor Gareth Wyn Griffith
Dr Andrew Detheridge

THE OVERVIEW

Fungi are vital components of the world's biodiversity, performing critical roles in nutrient cycling and delivering nutrients for plant growth. Surveying is essential for conservation, to understand where species exist, their functions, and to raise awareness of their importance.

Researchers at Aberystwyth University (AU) developed a novel DNA metabarcoding method using soil environmental DNA (eDNA), deployed for rapid assessment of fungal biodiversity in grassland habitats. The method has been used in commercial and legal contexts, providing evidence and enabling faster decision making. Examples include: the designation of a site in Birmingham as a Site of Special Scientific Interest (SSSI), decisions in planning applications, and sanctioning landowners who contravened land-use regulations.

Increased public understanding and participation was achieved through several citizen science projects by training citizen scientists in DNA barcoding, and TV programmes, films and apps raising awareness of fungal conservation.



THE RESEARCH

The new DNA metabarcoding method provides species richness and abundance, and has been validated by comparison with 'standard' fruitbody (mushroom) surveys. In addition, the developed method can be conducted at any time of year and can deliver results within a matter of weeks.

Two strands of research have permitted this development. First, the use of DNA barcoding to define fungal species via DNA sequences (Internal Transcribed Spacer (ITS) and Large Sub-Unit (LSU) barcodes. Second, the advent of NextGen sequencing (NGS) methods led to the development of DNA metabarcoding. The relative abundance of sequences linked to particular species allows the relative abundance of each species to be assessed. For fungi which are not visible to the naked eye, this method transforms the assessment of fungal communities.

THE IMPACT

IMPACT ON POLICY

By identifying where rare fungi are present via eDNA, AU researchers have been successful in deploying targeted fruitbody surveying to subsequently locate these species. Six additional species were located at The Leasowes site in Birmingham, which has over 150,000 visitors a year, enhancing the species count at the site by 20%. This was instrumental in the notification of The Leasowes SSSI, which will be the first global instance of eDNA being used in the legal protection of a site of conservation concern. The technique targets the areas for field mycologists, saving time and financial cost. The eDNA work at The Leasowes has highlighted the potential for the use of this technology in conservation. AU researchers have subsequently been commissioned to write a number of other eDNA site reports by Natural England and Natural Resources Wales.

IMPACT ON THE ENVIRONMENT AND CONSERVATION

The research team have undertaken work for land developers (at the request of local planning officers/council ecologists) seeking to ascertain whether land proposed for development has conservation value in terms of the fungi present. The primary benefit to the developer is that a decision can be obtained rapidly and at any time of year. In the four cases undertaken to date (Greenacres, Crumlin, Purton Road and Dolygaer), apparently promising grassland sites were subject to eDNA analysis. In three cases, grassland fungal populations of only moderate diversity were identified, and the developments were granted permission to continue. However, in the fourth case (Purton Road, Swindon), planning was refused, in part due to our discovery of the presence of two waxcap species present on the IUCN's Red List, including *Hygrocybe Citrinovirens*.

The team are continuing to work with SES Ltd at the former Severalls Hospital site redevelopment in Essex using eDNA to determine whether waxcap populations can survive such translocations.

The research team have also used the method to provide land use assessment to the Welsh Government EIA unit in the prosecution of landowners who change use of land, for example through ploughing of permanent pasture without necessary permission.

IMPACT ON PUBLIC AWARENESS OF GRASSLAND FUNGI

The research team interact extensively with citizen scientists. The team supply specimens of rare fungi which the citizen scientists use as reference specimens to improve their eDNA metabarcoding databases. They have provided training for groups of citizen scientists, notably Pembrokeshire Fungus Recording Network, to allow them to set up their own DNA barcoding labs, in association with Bentolab and The Lost and Found Fungi Project by the Royal Botanic Gardens, Kew. This collaboration has led to the publication of taxonomic keys supplied free-of-charge to field mycologists.

Contributions to TV programmes, the recent Plantlife app WaxcApp used at 362 sites throughout the UK and the Isle of Man, and a short film about the novel eDNA methodology have also helped to raise the public profile of grassland fungi.

