WHY: DO SOIL MICROBES MATTER?

BECAUSE: CROPS WOULD NOT GROW, AND ENVIRONMENTAL POLLUTANTS WOULD INCREASE

Microbes are central to all life on Earth, exhibiting huge diversity in form and function. One teaspoon of topsoil contains around one billion individual microscopic cells and around 10,000 different species.

These organisms perform many functions and are central to crop fertility, recycling nutrients, detoxifying pollutants, regulating carbon storage and controlling the production and absorption of greenhouse gases such as methane and nitrous oxides.

Soil microbial populations determine key soil functions, thereby directly affecting the value of land.

Future climate scenarios may affect microbial populations in soil with many potential consequences, including loss of soil carbon; changes in soil-borne greenhouse gas levels; and alterations to the important plant-soil feedbacks giving rise to soil fertility.

Microbes in soil ecosystems

- by making nutrients available are intimately associated with plant growth and productivity
- are the engine for cycling major nutrients such as nitrogen and potassium and phosphorus between organic matter, minerals and the environment
- are the start of food webs supporting invertebrates and higher life forms
- regulate soil-borne diseases of plants and animals
- provide balance to soil composition by adapting and purifying the chemical components and by detoxifying what would become pollutants

Microbes and climate change

- Bacteria and fungi recycle carbon in soils from living and dead plants
- Whilst plants are good CO_2 absorbers, it is the activity by soil microbes that determines whether the carbon is stored underground or released back into the atmosphere
- Different types of microbes produce and consume major greenhouse gases
- More than three times as much carbon is stored in soil than in the atmosphere
- Temperature rises are predicted to increase bacterial respiration, leading to release of CO_2 and methane into the atmosphere

CEH
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Microbial work at CEH

Despite the crucial role of microbes in ecosystem functioning and sustainable food production very little is known about their biodiversity, their exact functional roles and the interactions with other ecosystem components or even about the drivers that alter their population levels. CEH was the first to devise and implement a 'state of the art' DNA-based monitoring method to assess the distribution of microbial populations at UK-wide scale in order to understand basic concepts about the environmental factors determining microbial populations and their functions. Through this work the UK now has the world's first 'next generation' DNA-based monitoring network for bacteria. This work addresses fundamental concepts in microbial ecology and provides the basis for future monitoring networks aimed at understanding and predicting the effects of climate shifts and human influences.

Carried out as part of Countryside Survey, work at CEH has resulted in the first soil microbial map of the UK. The map shows that most soil bacteria belong to one of two lineages: alphaproteobacterial, whose function associations include nitrogen fixation; and acidobacterial, whose function in soil is still unknown. It has been suggested the ratio of these two groups will be related to the nutrient status of the soil. Measuring bacterial biodiversity is key to understanding the effects on soil functions and how that may be altered by shifts in composition.

The microbial work is part of a much larger research work on soils at CEH. It undertakes:

- **Monitoring** across Britain to observe how soils are changing and understand why
- **Experimentation** relating soil biodiversity to function and measuring the services they deliver
- **Modelling** to predict how soils may change in the future and explore options for managing the soil
- **Risk assessment and remediation strategies** to solve complex environmental problems

Future Impacts

The work of understanding microbial distribution at a national level is still an embryonic area of science. Yet it has the potential to greatly improve our understanding of how soil interactions affect and above-ground ecosystems. This could lead to significant impact for:

- Food security: could soil microbial solutions result in an increase food production?
- Water security: could microbial solutions result in more effective water purification or land remediation?
- Climate change: understanding microbial influence on soil carbon storage, other greenhouse gases and the balance of carbon in relation to bioenergy crops

Contact details

For more information please visit our website at **www.ceh.ac.uk** and search for 'soil biodiversity'
Or contact: Professor Bridget Emmett at **bae@ceh.ac.uk**

NATURAL ENVIRONMENT RESEARCH COUNCIL

enquiries@ceh.ac.uk
www.ceh.ac.uk