

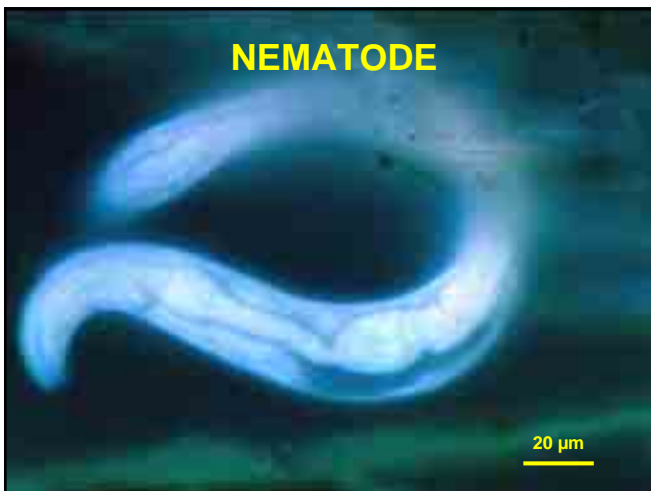
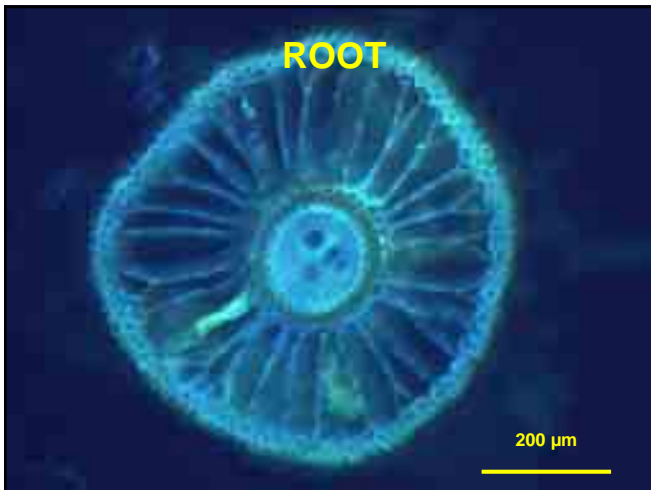
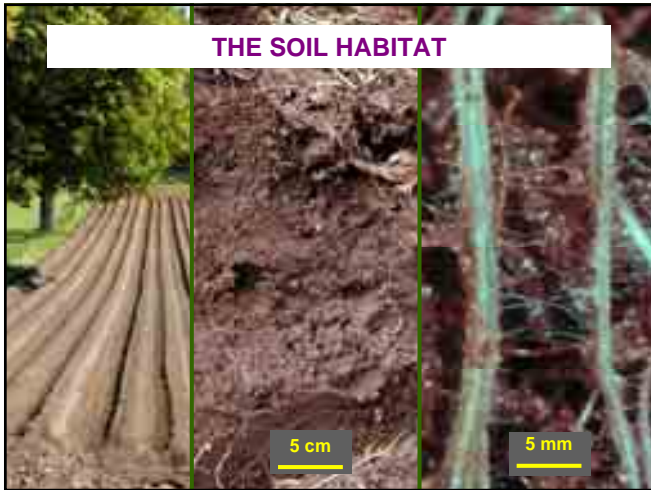
SOIL FERTILITY: SOIL AS A LIVING BIOLOGICAL ENTITY

Karl Ritz*

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A vast quantity and range of life resides in most soils, often exceeding the aboveground biomass. A handful of arable soil contains billions of micro-organisms, hundreds of thousands of miniscule animals and some of the most extreme levels of biodiversity on the planet. Since most of this life is microbial, it is generally invisible and largely “out of site, out of mind” to the uninitiated. Whilst living organisms constitute only a tiny fraction of the total mass of soils, they are a fundamentally important part of the system and arguably one of the most important resources available to land managers. The soil biota can be viewed as the biological engine of the earth, and is implicated in the majority of the key functions demanded of soils by the farmer, the wider ecosystem, and society. These include carbon and nutrient cycling, soil structural dynamics, degradation of pollutants, regulation of plant communities and provision of a biotechnological resource. This talk will review some of the latest perspectives on soils as living systems and explore some of the mechanisms that explain why effective management of the biota is best achieved by managing the architecture of the soil, focussing on the primary factors that govern biotic activity belowground, notably food and living-space.


Karl Ritz is Professor of Soil Biology at the National Soil Resources Institute, Cranfield University, with considerable experience in researching many aspects of the interactions between soils and the organisms that reside within them. He has a particular interest in the functional consequences of soil biodiversity, the spatial organisation of soil communities and the interactions between soil structure and belowground life. An author of more than ninety scientific papers and hundreds of other contributions, he is an editor of the journals FEMS Microbiology Ecology and the Mycologist, and an editorial board member of Soil Biology Biochemistry, Soil Science and Plant Nutrition, and the Encyclopedia of Soils in the Environment.



HANDOUT Cranfield University

SOIL FERTILITY – SOIL AS A LIVING BIOLOGICAL ENTITY

Karl Ritz



Microscopic view of soil organisms

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SOIL BIOTA


Life in earth...



Life on Earth...



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ROLES OF SOIL BIOTA

“BIOLOGICAL ENGINE OF THE EARTH”

- Carbon and nutrient cycling
- Crop production and sustainability
- Regulation of plant communities
- Environmental quality
 - degradation of pollutants
 - production of pollutants
 - human, animal, plant health factors
- Soil structure
- Biotechnological resource

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SOIL BIOMASS



- Handful of arable soil (c. 200g).....
-approximately 0.5 g of fresh biomass (mainly ‘microbial’)
- equivalent to...

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SOIL BIODIVERSITY

SOIL BIOMASS

- BACTERIA
FUNGI
- PROTOZOA
NEMATODES
- INSECTS
ARACHNIDS
MOLLUSCS
WORMS
- MAMMALS
- PLANT ROOTS

μm

mm

cm

5

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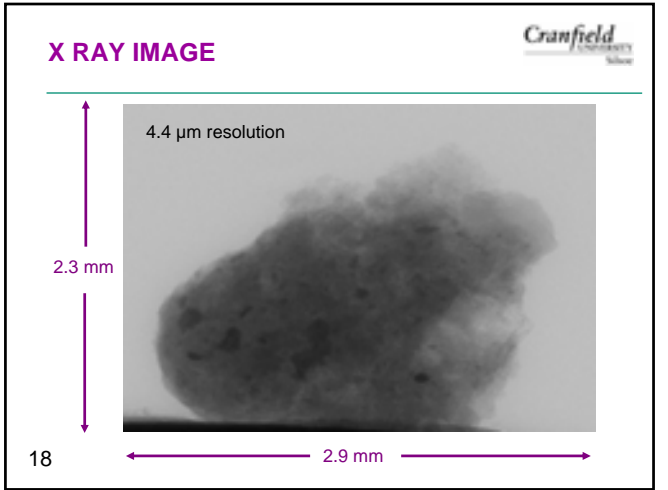
SOIL BIODIVERSITY

SOIL BIOMASS

- BACTERIA
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NEMATODES
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ARACHNIDS
MOLLUSCS
WORMS
- MAMMALS
- PLANT ROOTS

- TENS OF THOUSANDS spp.
- HUNDREDS
- HUNDREDS
- FEW
- TENS

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TOMOGRAPHIC SLICES

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A WALK THROUGH SOIL ...

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WHAT CONTROLS SOIL BIOTA ?

- **RESOURCES**
 - food (substrate), water, air
- **ENVIRONMENT**
 - living space
 - abiotic factors (e.g. temperature, pH)
 - biotic factors (who's there....)
 - ◆ soil organisms – the community context
 - ◆ importance of interactions with plants

MANAGEMENT....
...via manipulation of controlling factors

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RESOURCES

22

THE SUBTERRANEAN LARDER

CARBON
THE CURRENCY OF THE SOIL ECONOMY

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LIVING SPACE

- Why is the spatial organisation of soils so important ?
- Pore networks:
 - define the physical framework in and through which all soil processes occur
 - govern the **distribution** and regulate the **movement** of gases, liquids, particles and organisms through the soil matrix

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PHYSICAL PROTECTION OF ORGANIC MATTER Cranfield University

INTACT STRUCTURE... DISRUPTED STRUCTURE ...

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PHYSICAL PROTECTION OF ORGANISMS Cranfield University

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Elliott & Coleman 1989, Ecological Bulletin 39

HOW DO SOIL ORGANISMS AFFECT SOIL STRUCTURE ? Cranfield University

MOVING GLUING

SEWING PAINTING

EATING

27

MOVING... Cranfield University

- Faunal engineering
 - earthworm casts
 - faecal pellets
 - mammalian burrowing

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GLUING... Cranfield University

- Adhesive nature of extracellular polysaccharides
 - plant, animal and microbial origin

STERILE	plus BACTERIA

29 0.5 mm

SEWING... Cranfield University

- Enmeshment by fungi and plant roots

30 3 mm

PAINTING...

- Coating of surfaces by water-repellent compounds



Glomalin

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(Sara Wright, USDA Beltsville)

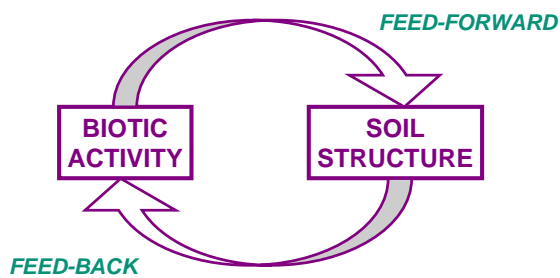
EATING...

- Decomposition of binding agents by soil biota
 - pivotal role of soil disturbance



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INTERACTION LOOPS



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SOIL ARCHITECTURE



- Soil is a living system, founded on an appropriate spatial configuration
- Appropriate community structures living within such an inner space lead to an effective functioning of the system
- Research challenges
 - quantification and diagnostics

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CONCLUSIONS



- New views of the underworld...
 - out of site...
 - ...not out of mind
- Sustainable soil management requires sympathetic management of the soil biota
 - food (organic matter)
 - living space (tillage)

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THE BIOLOGICAL ENGINE OF THE EARTH

