

**THE BIOLOGICAL ENGINE OF THE EARTH:
THE FUNCTIONAL ROLE OF
SOIL BIODIVERSITY**

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*Soil, Climate Change and Biodiversity – Where do we stand?
Brussels, September 2010*

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SOIL BIOTA

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Life in earth...



Life on Earth...



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ROLES OF SOIL BIOTA

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- Intimately linked to the delivery of ecosystem goods and services
- Drives many of the critical processes that occur in soils
- “Biological engine of the earth”

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FUNCTIONS DELIVERED BY SOIL BIOTA

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GOODS - provision of:

- food, fibre, fuel
- biotechnological resources

SERVICES - regulation of:

- nutrient cycling
- water flow and storage
- soil structural dynamics
- biotic regulation
- detoxification
- atmospheric composition
-

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SOIL BIODIVERSITY

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SOIL BIOMASS	BACTERIA FUNGI ALGAE	TENS OF THOUSANDS spp.
	PROTOZOA NEMATODES	HUNDREDS
	INSECTS ARACHNIDS MOLLUSCS WORMS	HUNDREDS
	MAMMALS	FEW
	PLANT ROOTS	TENS

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STUDY and DESCRIPTION OF THE SOIL BIOTA

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- GENOTYPIC**
 - fundamental information – the blueprint
- PHENOTYPIC**
 - expressed information – the parts
- STRUCTURAL**
 - the physical organisation – the engine
- FUNCTIONAL**
 - processes – the working engine

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DEFINING BIODIVERSITY

- “number of different (organisms)”
 - genetic
 - phenotypic
 - functional
 - (structural)
- absolute differences (richness)
- more pertinent is ‘community structure’

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THE WORKING ENGINE: FOOD WEBS

CARBON
THE FUEL OF THE SOIL ENGINE

PLANTS → SOIL ORGANIC MATTER → BACTERIA FUNGI → PROTOZOA NEMATODES → INSECTS ARACHNIDS MOLLUSCS WORMS → MAMMALS

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FOOD WEBS

Plants → Harvest → Mineral pool → Active organic pool → Slow-passive organic pool

Management → Fertiliser → Plant residue → Fungi → Bacteria → Protozoa → Bacterivorous nematodes

Climate → Resource quality → Soil conditions

Fungi → Fungivorous microarthropods → Earthworms

Bacteria → Bacterivorous nematodes → Enchytraeids

Protozoa → Microarthropods

Bacterivorous nematodes → Macroarthropods

Hendrix et al. (1986) Bioscience 36: 374-380

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THE WORKING ENGINE: STRUCTURE MATTERS

5 mm

10 µm

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WHY IS BIODIVERSITY IMPORTANT ?

R

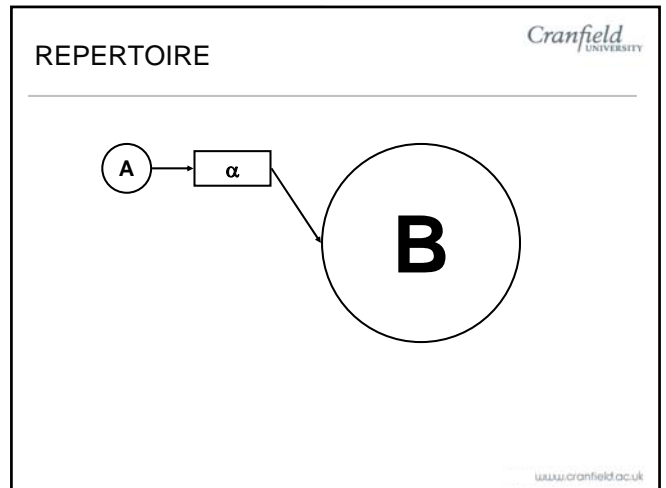
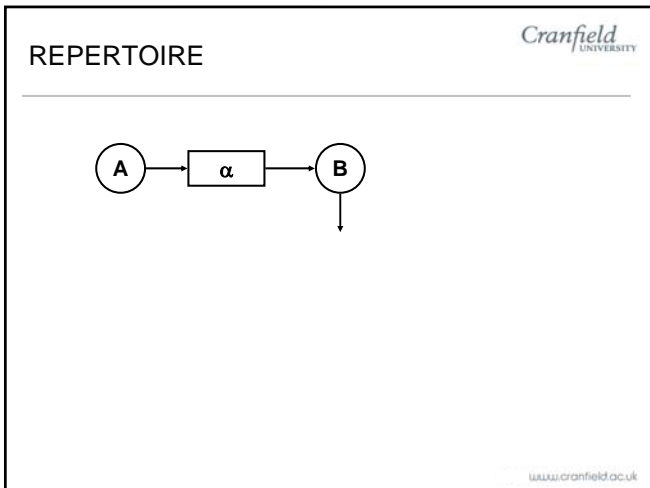
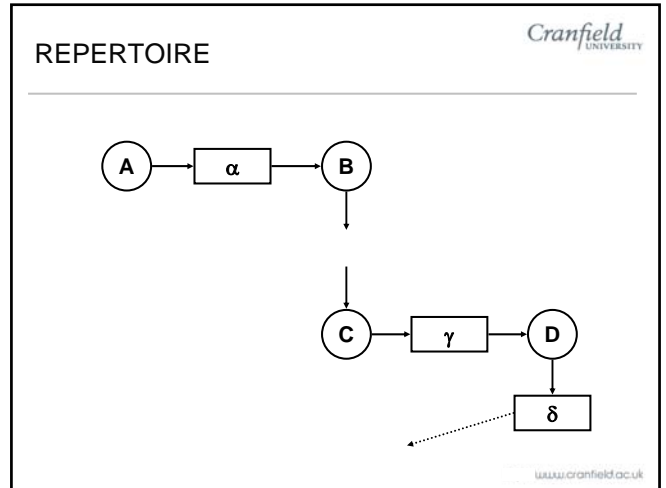
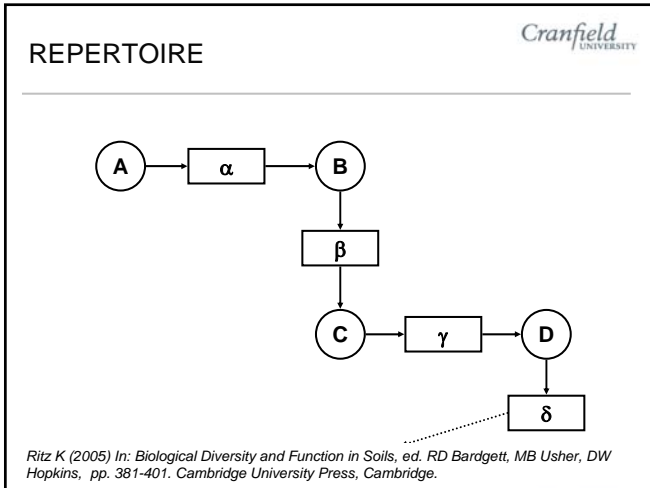
- Repertoire
- Redundancy
- Relationships

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REPertoire

- The toolbox....
 - tools for the job
 - absence = lack of function

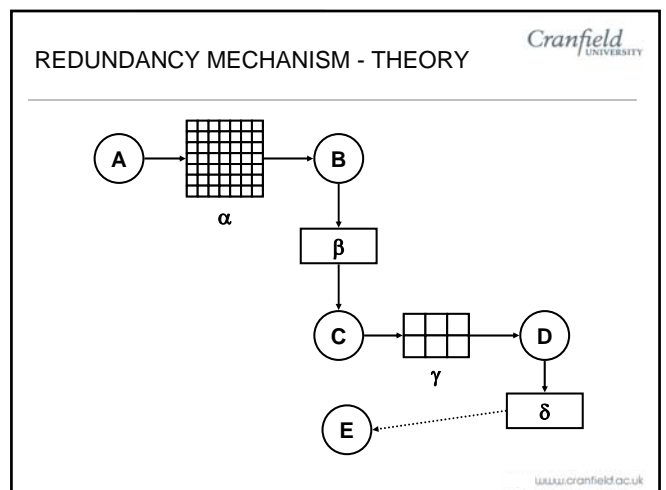
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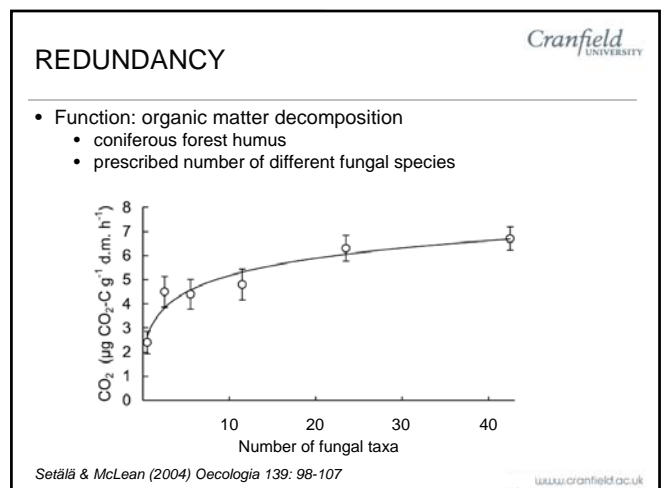
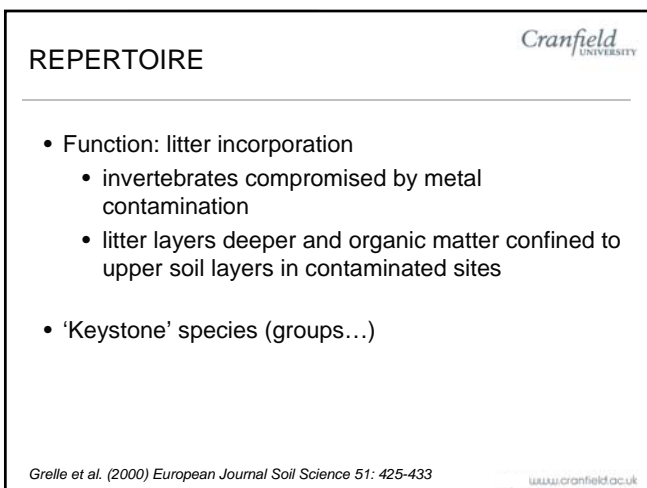
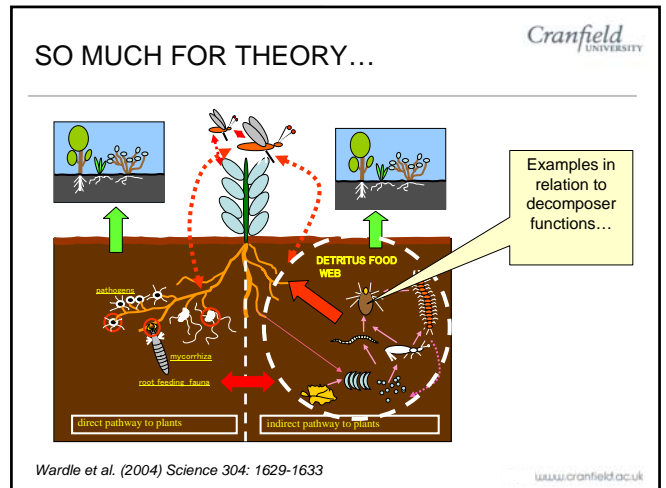
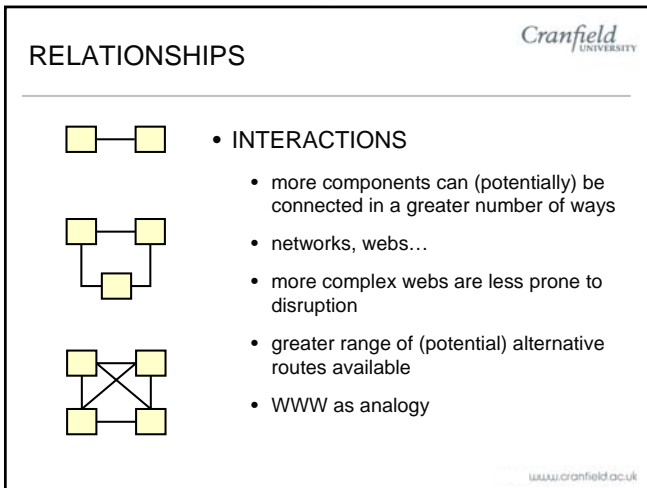
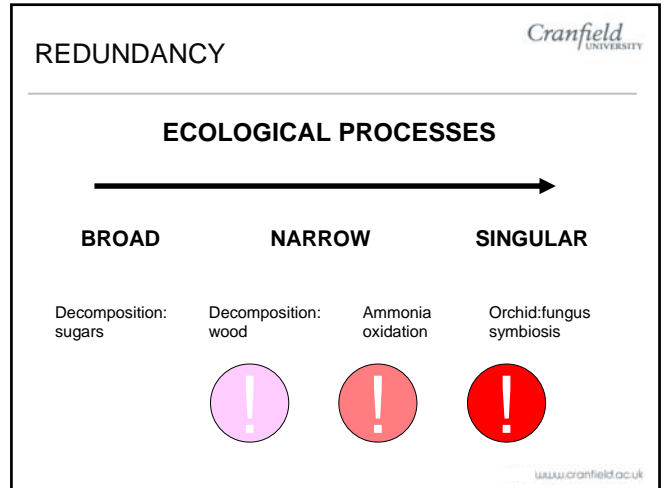
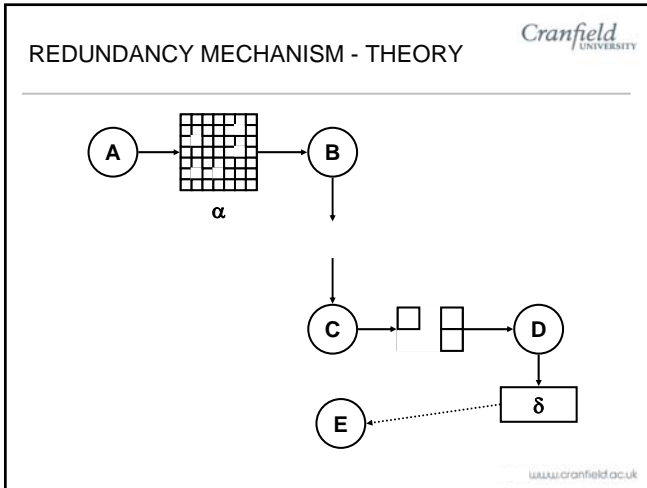


REDUNDANCY

- Range of particular tools available
 - extent to which can 'afford to lose some'
 - underwrites the insurance concept

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RELATIONSHIPS

- Complexity and food webs:
 - review of 7 studies (14 – 202 species)
 - link density weakly dependent upon web size
 - connectance decreases with web size
 - larger webs have more 'weak' trophic interactions, leading to greater stability

Banasek-Richter et al. (2009) Ecology 90: 1470-1477

WHY IS BIODIVERSITY IMPORTANT ?

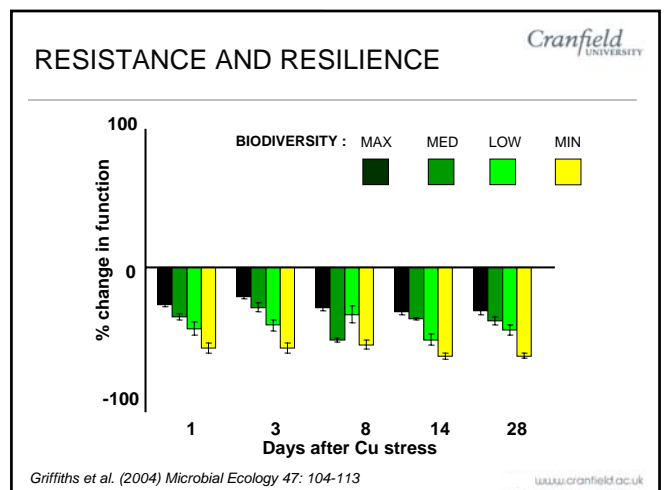
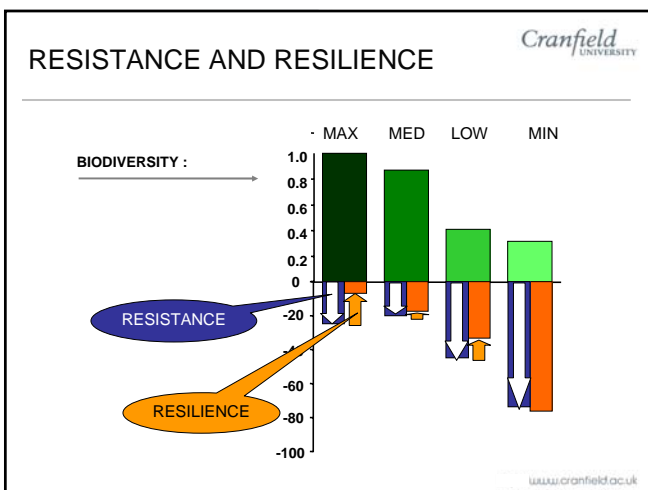
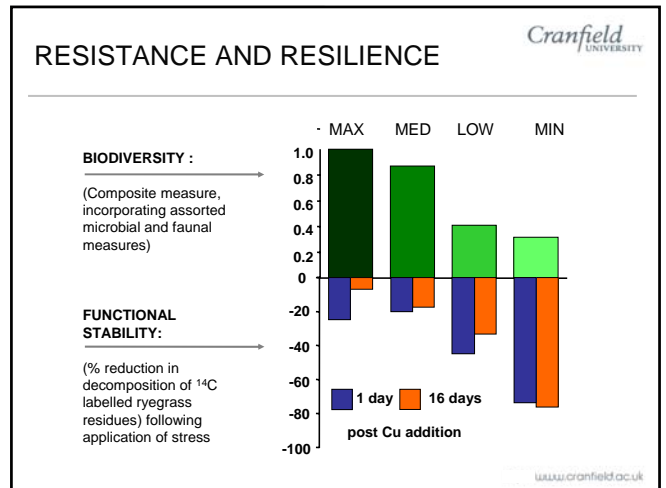
R

- Repertoire
- Redundancy
- Relationships
- Resistance
- Resilience

RESISTANCE AND RESILIENCE

- Resistance and resilience
 - more diverse systems are more resistant to perturbation and show greater resilience
- Function: organic matter decomposition
 - grassland soil
 - experimentally manipulated biodiversity gradient
 - added grass material to mineral grassland soil
 - effect of a persistent stress (Cu) upon decomposition of this material

Griffiths et al. (2000) Oikos 90: 279-294



RESISTANCE AND RESILIENCE

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- Resistance and resilience
 - more diverse systems are more resistant to perturbation and show greater resilience
 -maybe !
 - *appropriately configured systems* are more resistant to perturbation and show greater resilience

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CONCLUSIONS

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- *Organisms carry out functions*
- “Biological toolbox”
 - more diverse = more tools
- Biodiversity is vital !
 - for now...
 - functions needed at present
 - for the future...
 - potential for future adaptation
 - resilience to a changing environment

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