Soil Biodiversity at Russell Ranch

RR field day—May 31, 2012

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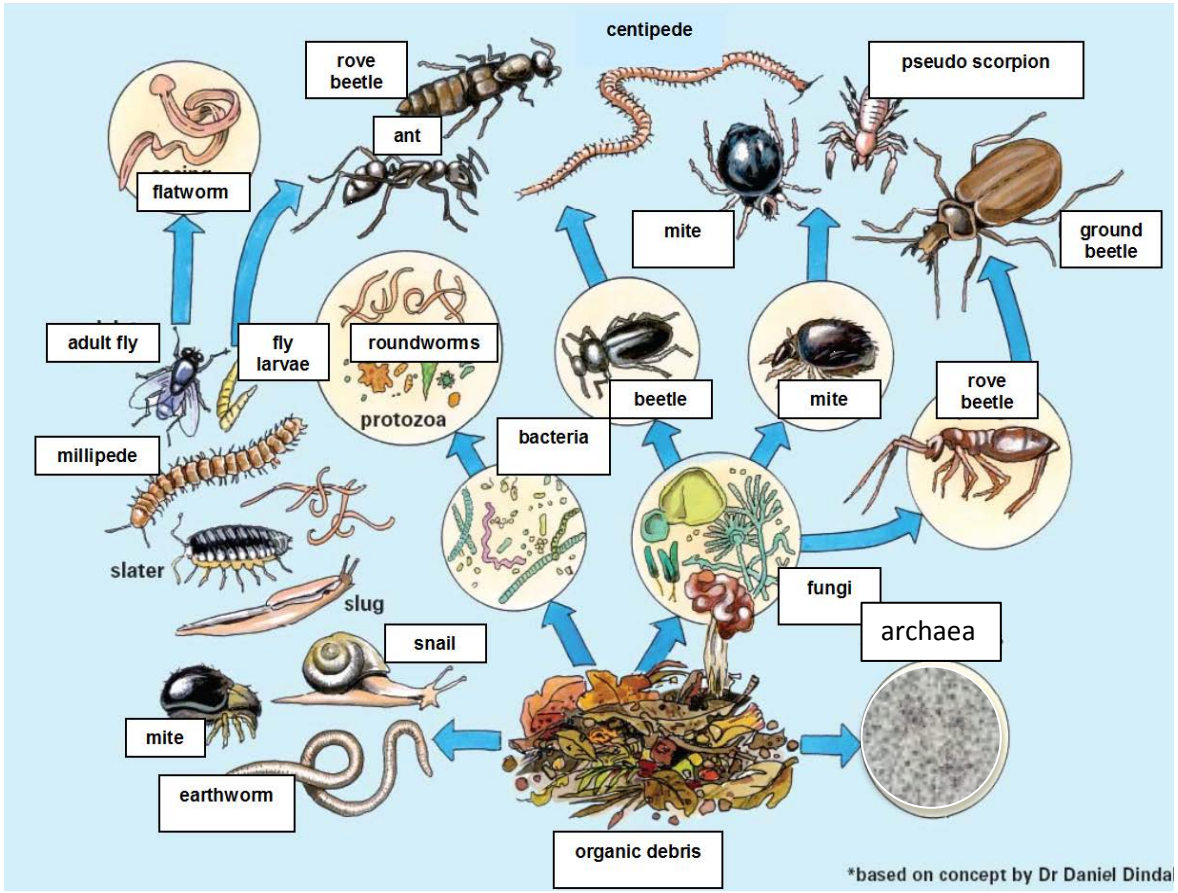
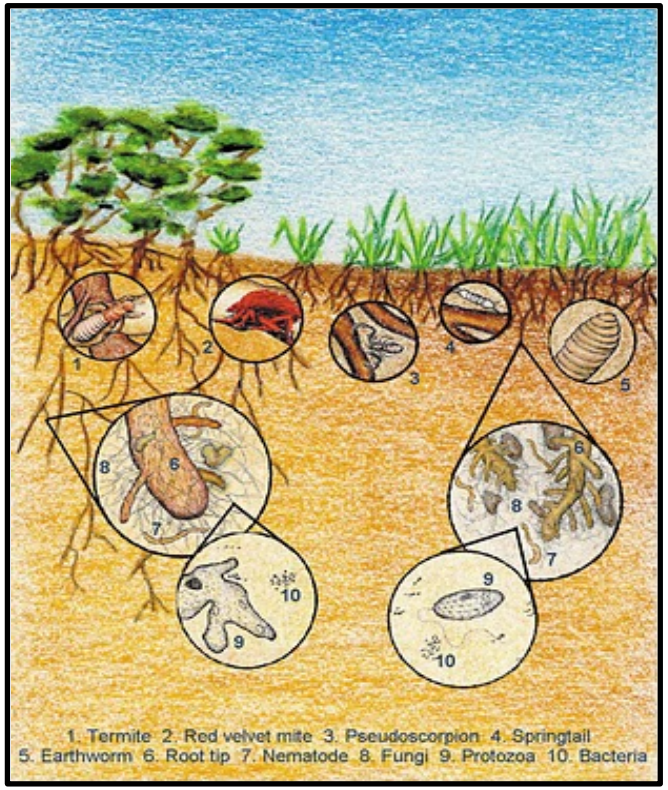
Soil is one of most diverse microbial habitats: Thousands of "species" in gram of soil. Most not yet identified nor their function(s) known.

- Who: are they? Bacteria, archaea, and fungi. Of procaryotes, ~1500 different taxa detected at RR: 94-96% bacteria, 2-4 % archaea, remainder unknown. Fungi 15-20% of total microbial biomass.

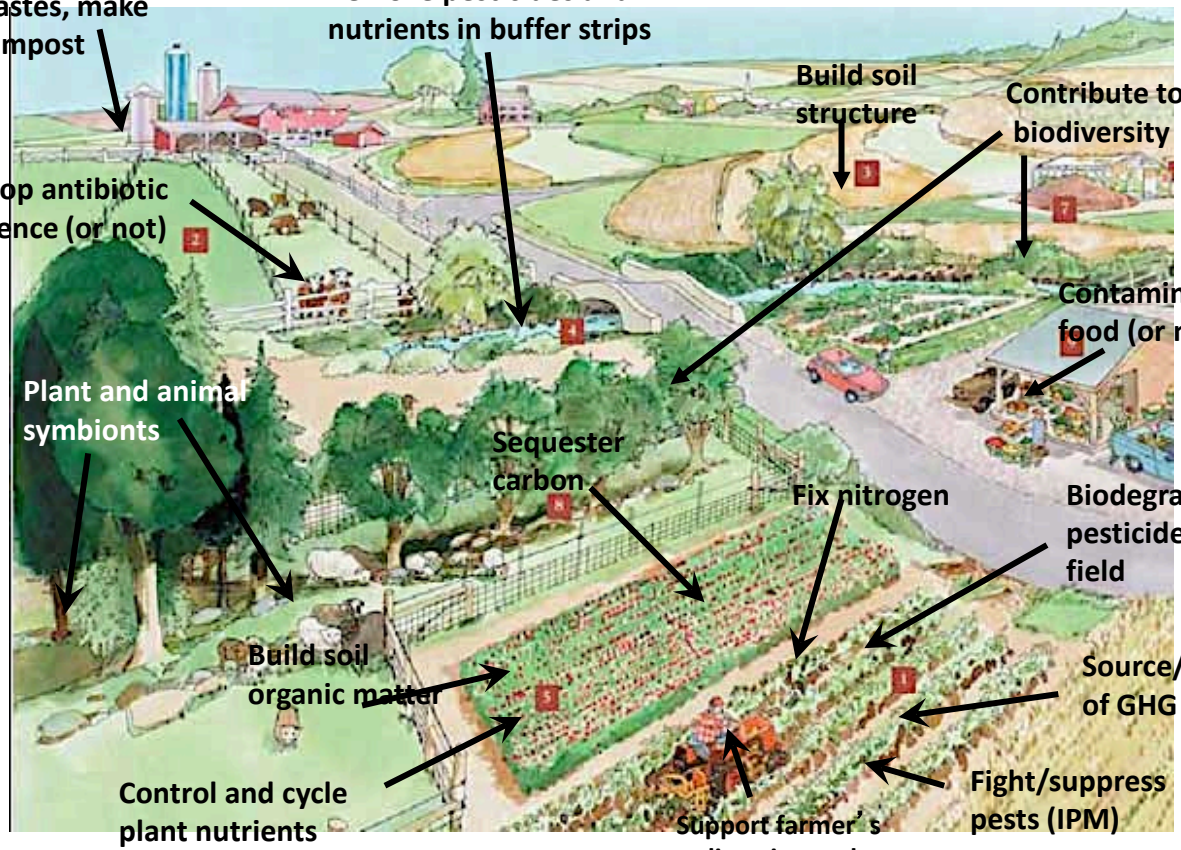




- Kinds: Number of taxa ("richness") is same in organic, conventional and uncropped plots. Composition (relative abundance and presence of some taxa) is different among farming systems.

- How many: Organic has almost 2X total microbial biomass as conventional and uncropped plots, which are not different. Fungi make up greater portion of biomass in organic than conventional.

- What: do they do? Many (desirable, undesirable and neutral) "services" provided (see figure below)
- Where: most abundant in top layer of soil (15 cm), surrounding roots and in very small stable soil aggregates rather than in other soil fractions (usually associated with higher carbon availability).
- When: larger numbers in winter and during growing season. Numbers drop in autumn before rains begin. Fluctuations in numbers appear lower in organic than other systems.



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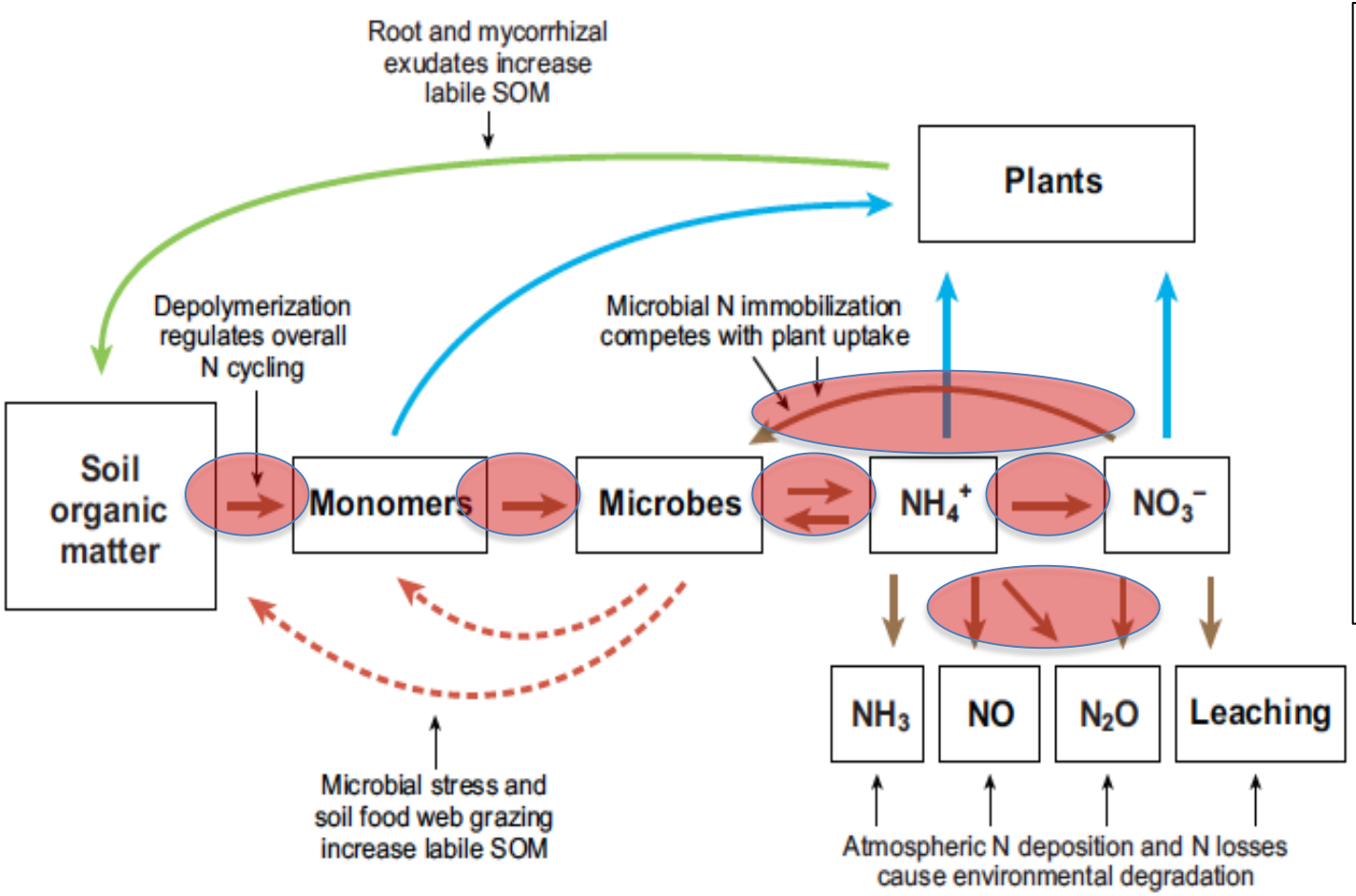
How microorganisms contribute to agriculture

Research questions

1. Do microbial communities in agricultural soils have lower resistance and resilience in response to stressors (e.g. drought, heat) than nonagricultural soils? Are there differences in response of conventional vs organic soil communities?
2. Do inoculants (introducing non-native microorganisms) provide benefits in terms of disease control and nutrient cycling? Under what conditions?
3. Can microbial communities be managed to increase nitrogen use efficiency of crops?

Microbes and Nitrogen use efficiency

- Nitrogen benefits and costs: air and water pollution, health, climate change
- Plant N use efficiency currently about 50%
- Uptake is regulated by relationships between soil microorganisms and plants. Large amount of fertilizer goes through microbes before plant gets it.
- Can we apply scientific revolution in soil ecology for biological management of synthetic N efficiency.



(diagram from Jackson et al., 2008 (Ann Rev Plant Biol 59))

Shaded circles show microbial processes or influences

Interventions

- Increase microbial biomass to compete with nitrifiers for NH4 and store more organic nitrogen
- Decrease nitrification to prevent conversion of N to leakier form of NO3
- Decrease denitrification to reduce loss of N from soil (and N2O)
- Enhance mycorrhizal fungal uptake