Notes by David Oldacre on talk by Dr Kari Dunfield to Halton MG meeting of March 5th 2014

Kari Dunfield Assistant Professor, Applied Soil Ecology http://www.uoguelph.ca/~dunfield/

Topic: What about Soil Health? How can soil microorganisms affect plants?
In her talk she provided a brief overview of her research program, which examines microorganisms in agro-ecosystems. In addition, she shed some light on the enormous diversity of microorganisms that exist in the soil and their role in soil and plant health.

Dr. Kari E. Dunfield is a Tier 2 Canada Research Chair in Environmental Microbiology of Agro-Ecosystems, and an Associate Professor in Applied Soil Ecology in the School of Environmental Sciences at the University of Guelph. She holds a BSc in Microbiology from the University of Calgary (1995), a MSc in Plant Science (1999) and a PhD in Soil Science (2002) from the University of Saskatchewan. Her research program focuses on the impact of agricultural practices on the diversity of soil microbial communities, and on source water quality

The objective of her studies is to assess the anthropogenic impacts on the earth's critical zone focussing on micro organisms. , specifically on Agro-ecosystems as discussed in the following website:
www.feedingninebillion.com
There will be less land available with more requirements for agricultural products (i.e. to get maximum yields) – with more pathogens in the water, greenhouse gassing, and soil degradation. Management systems that improve soil health often result in greater inputs and water nutrients.

A healthy soil means less inputs , less cost, less greenhouse gasses, less chemicals, and less environmental impact.

Indicators of soil health include:

- Productivity and crop yield
- Water regulation and partitioning
- Waterlogging and soil compaction
- Soil nutrient cycles and greenhouse gas emissions
- Soil organic matter and aerobic cycling
- Soil structure
- Number and diversity of soil organism which respond very quickly to soil health (a major research focus)

Biological diversity – it has been estimated that there are 10^{11} to 10^{12} stars in a galaxy, and there are 10^{9} bacterial cells in one teaspoon of soil!

Methods involve examining microbial RNA and DNA of samples taken from the soil itself. The activity and diversity of soil micro-organisms can determine the health of the soil itself.

What the micro-organisms are actually doing:

- Soil structure – how soils aggregate
- Carbon cycling - if there were no micro-organisms we would be covered in plant detritus!
- NPS cycling – is driven by soil bacteria
- Plant growth promotion

Root system has different micro-organsims. The rhizo sphere is soil directly in contact with the roots:

- Root and soil stability
- Water relations
- Root exudates
- Microbial interaction

- Growth promotion
- Nutrient uptake

An important group is the symbiotic nitrogen fixing bacteria which provide:

- Nitrogen fixation – provides nitrogen for legumes
- Carbon - provided for rhizobium

Two basic types of plant nodules:

Nitrogen fixing nodules

- Determinate - vascular bundles e.g. soybeans
- Indeterminate – e.g peas and clovers

Effective nodules -

- LHS - white non-fixing nodules, lacking haemoglobin,
- RHS - pink coloration

Mycorrhiza - symbiotic associations between plants and soil

- Arbuscula – Mosses, ferns, seeds
- Ectomycorrhiza – Trees, Amanita, Laccaria,

(According to Wikipedia) is a form of symbiotic relationship that occurs between a fungal symbiont and the roots of various plant species. The mycobiont tends to be predominantly from the phyla Basidiomycota and Ascomycota, although a few are represented in the phylum Zygomycota. Ectomycorrhizas form between fungi and the roots of around 2% of plant species. These tend to be composed of woody plants, including species from the birch, dipterocarp, myrtle, beech, willow, pine and rose families.

The genus ***Amanita*** contains about 600 species of agarics including some of the most toxic known mushrooms found worldwide, as well as some well-regarded edible species. This genus is responsible for approximately 95% of the fatalities resulting from mushroom poisoning, with the death cap accounting for about 50% on its own. The most potent toxin present in these mushrooms is α-amanitin.

Laccaria is a genus around 75 species of fungus found in both temperate and tropical regions of the world.[1][2] They are mycorrhizal. The type species is (Laccaria laccata), commonly known as the deceiver. Other notable species include L. bicolor, and the amethyst deceiver (L. amethystina), sometimes incorrectly written as L. amethystea. Because some Laccaria species have the ability to grow vegetatively and/or germinate from basidiospores in culture, they are often used as experimental systems for studies of ectomycorrhizal basidiomycetes.

- Ericoid – Rhododendron, Blueberries

(According to Wikipedia) The ericoid mycorrhiza is a mutualistic symbiosis formed between members of the plant family Ericaceae and several lineages of fungi. The symbiosis represents an important adaptation to acidic and nutrient poor soils that species in the Ericaceae typically inhabit,[2] including boreal forests, bogs, and heathlands. Molecular clock estimates suggest that the symbiosis originated approximately 140 million years ago

- Orchid Mycorrhiza
    - Very small seeds
    - Require mycorrhiza for initiual nutrient

- Hyphal coils in embryos and roots of adults
- Plant is initial parasitic

External Hyphae form a better distribution surface for absorbing phosphorous which does not move in the soil

Carbon fluxes in Mycorrhizal fungi plants – up to 20% of carbon can be transferred. See the following link
http://link.springer.com/chapter/10.1007/978-3-540-38364-2_2

Soil aggregation - Dog-strangling vine (*Vincetoxicum rossicum*) is highly mycorrhizal and rapidly colonized.

And that is where I stopped taking notes!