Soil Food Web

Cheryl Kemp From News Leaf #51`.

"Using Nitrogen Fertilisers is the best way to get weeds" weeds", says Dr. Elaine Ingham, "and then you need to use the herbicides, which kill off more beneficial micro-organisms, and then you get fungal diseases, so you need to use the fungicides, and then you get insect attack, so you need to buy the pesticides – the chemical companies have you all sown up and dependant" – and the crash of dropping jaws was palpable as Dr. Elaine Ingham started her lecture recently to over 100 farmers in Coffs Harbour.
I was cheering – at last someone has seen what happens and has the courage to say it to the farming community – thank you Elaine!

For years we have noticed that if you balance your soils using Biodynamics, then the weed problems will go, and the fungal diseases and pests only show if something is out of balance. We have had much proof from observant farmers that this happens, but never 'scientific proof'. It was good to hear Dr. Elaine Ingham, Soil Microbiologist from Oregon State University, USA come out with the story of what actually takes place in the soil.
It also helped me to perceive and understand what is happening when we work with the Biodynamic Preparations.
Dr. Ingham has been researching the Soil Food Web – the soil bio life that works in the root zone. Her work has totally changed the way many see the soil, and challenged those who preferred not to admit its relevance to agriculture. Now we are able to recognise a whole symbiotic system working below the surface as there is one working above.

Studies have found that the best soils have a specific fungi/bacterial ratio. At the top of the range are the old growth forests, with a fungal ratio of 1000 fungi to every 100 bacteria (with a huge variety of types of bacteria and fungi and other soil micro organisms)—

Plant Succession Soil Succession from best to lowest

- Old growth forest 1000 fungi to 100 bacteria(fungal dominated)
- Deciduous trees 100 5 (fungal dominated)
- Shrubs, vines and bushes 5 2 (fungal dominated)
- Late succession grasses
- and row crops 1 1
- Vegetables, mid succession
- grasses 0 .75 (bacteria dominated)
- Early grasses, Bromes,
- Bermuda 0 .3 (bacteria dominated)
- Weeds 0 .1 (bacteria dominated)
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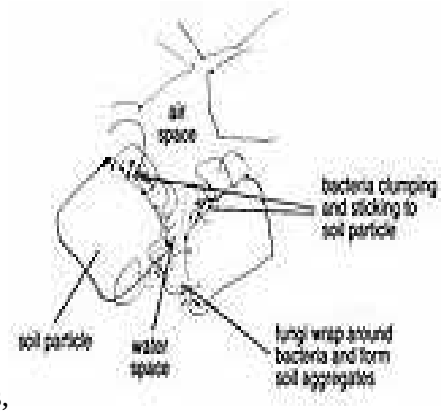
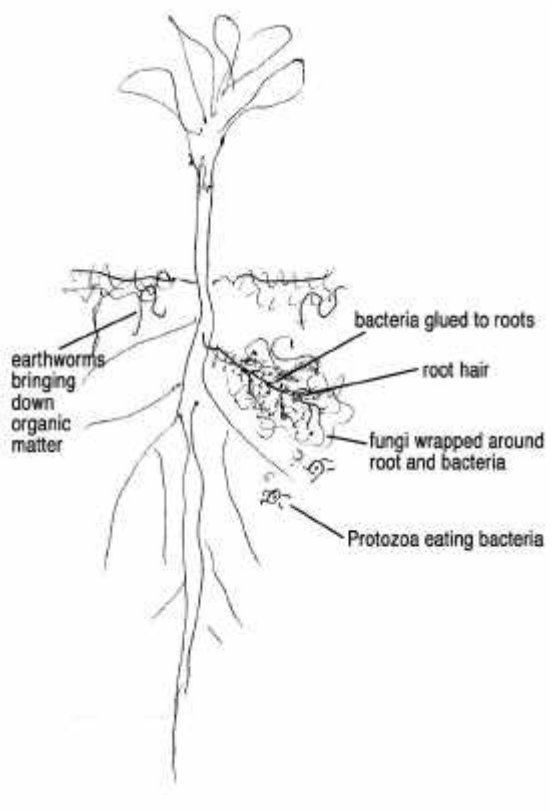
If you think of the picture of an old forest, remember the fungi that do the entire breakdown and can be seen on the fallen timber, also think of the moisture held in the soil, smelling so damp and earthy. Good soil food web activity. As we clear the forest to make way for the pastures and crops, the fungi are broken up. The inrush of O_2 through ploughing, increases bacterial activity for a short time which is then lost. Pasture

lands exist where the fungal level has dropped which is an important point; when we think trees and vines, we need to think fungi, as they prefer a more acid soil. Grass likes a more bacterial and alkaline soil. Weeds survive where nothing else will – very low bacterial activity, no fungal activity and survival species to try and cover the earth.
Note: the fungal and bacterial activity we are talking about here is a good and balanced activity. If the numbers of beneficial fungi and bacteria are low, then the harmful lot come in – boom and bust, this is where you get the imbalance.

The role of the bacteria in the soil is very important. Look at how soil aggregates are made: think of a number of clay or sand particles, then attach some bacteria, which stick onto the material by a slime coating kind of a glue, and very hard to lift off. Elaine explained that we have this bacteria sticking to our skin – even though we had a shower this morning. They stick on, and we would get rather sick if they didn't! So they are small. When a large number of these bacteria glue together in a heap, in amongst the soil particles, the fungi, which grow long threads, known as hyphae, wrap around the bacteria and clumps of soil particles, and gradually form aggregates. These soil aggregates clump together, leaving spaces between them for air, water
and movement of micro



arthropods, nematodes,
insect larvae and earthworms



(soil animals). In fact the movement of the micro arthropods actually form the shape of the aggregates. So this means there is plenty of space for water to infiltrate into the soil, for oxygen to diffuse into the root system, and to allow CO_2 to move out of the soil. Without good soil structure, soil becomes anaerobic, water puddles on the surface and erosion can become a problem.

Now we can look at the role of the soil bacteria and the root.. The bacteria also glue and clump onto the roots in the soil. They are able to absorb the carbons or sugars that the plant sends down from the photosynthesis process. The more root exudates coming down to the root, the more bacteria can be fed. The bacteria make nitrogen from these simple plant sugars and fill up with nitrogen (called nitrifying bacteria). This nitrogen is accumulated in the cells of these bacteria – and is not available to the soil at this stage (called bacterial accumulators). Then they are eaten in turn by the protozoa (amoeba, flagellates and ciliates) which cannot take up the entire N in the bacteria, and so release some to the soil. This lot are called soil mineralisers, as they release minerals and food into the soil, available for other micro-organisms and plant roots to take up.

Elaine Ingham explains that 1 x active living amoeba or protozoa eats 10,000 bacteria per day = 400kg N per hectare per month released into the soil. One hectare of corn uses 125kg N per month, so you can see

we have plenty of soil available N for plant growth if we keep the soil food web active. So it is obvious, the more root exudate coming through, the more bacterial activity, and the more protozoa activity, the more N released to the soil and then the more the plant can avail itself..

As Rudolf Steiner explains in the Agriculture lectures:
Horn Silica (Prep.501) stimulates the cosmic forces (sunlight/photosynthesis) to go into the soil, to increase the growth forces in the soil and increase plant growth. 100% of the energy comes from above the ground and 60% of the above-ground energy goes to the roots! Carbon dumping to the roots of plant saps feeds the beneficial bacteria and fungi and leaves no space for harmful ones. The soil organic matter needs to be at least above 2% to support the soil food web. When you think of the role of Horn Manure, to develop soil structure, increase humus and increase water holding capacity, you can see that there is a correlation here. Obviously the Biodynamic Preparations help the bacterial and fungal activity in some way to do their work.
The fungi decompose the complex carbon compounds, improve the accumulation of organic matter, and retain nutrients in the fungal biomass, reducing leaching of nutrients out of the root zone. Not only do they physically bind soil particles into aggregates, but they are an important food source for other organisms in the food web. Mycorrhizal fungi can improve plant growth when they become associated with the roots of some plants. Fungi also compete with plant pathogens and decompose certain types of pollutants.
Healthy agricultural soils (one teaspoonful) should have around 100 million to one billion bacteria, several metres of fungi, several thousand protozoa (flagellates and amoebae, 100 to several hundred ciliates) and 20-30 nematode bacterial feeders, a few fungal feeders and a few predatory nematodes. In one square foot of soil there should be up to 100 arthropods and 5-30 earthworms. These numbers increase with forest soils.
Some interesting points —
· In compacted soils, water collects in areas and causes anaerobic zones. Anaerobic organisms overgrow and make alcohol, which kills the plant roots. If water can't infiltrate, then neither can O_2. Interestingly, riparian zone plants can deal with the alcohol in the roots.
· Soil biology opens up the soil, rebuilds structure and lets in O_2, allowing aerobic bacteria in.
· Low pH, 4.5? Soils anaerobic (acid sulphate soils are anaerobic) lift the organisms in the soils and it lifts the pH.
· Lime can rush the rise in pH, but it doesn't lift the soil life up, so it is wasted unless the soil life can be increased at the same time. Compost does it slowly and builds systems and soil food web better to maintain balanced pH.
· If trees and shrubs and vines are happier in the fungal dominated soil, and the grasses prefer the bacterial dominated soil, then we can increase the fungal dominated area under trees and shrubs by using fungal dominated compost – made with wood chips etc (see below). Herbs also appreciate the fungal dominated soils, so we could plant herbs, such as thyme, lavender and marjoram, for example, under the trees, and this will keep the grasses away from the tree bases. (Could add a second crop here!)
Bacterial foods ar are: simple sugars, carbons, proteins. They are green, such as grass clippings, cover crops, and legumes. Sugars such as molasses, syrup, plant

extracts, and compost made with a high green content
or with manures, and compost teas made with bacterial dominated
compost maintained aer aerobically! obically!
Fungal foods ar are: complex sugars, fats, proteins. Brown plant materials high in cellulose, lignin, tannin, chipped woody fibrous material, straw, sawdust, compost made with woody materials. Fungal foods should be placed on the surface of the soil while bacterial foods should be mixed lightly in the surface of the soil. Many soil organisms are killed when ploughing and compaction of the soil, because soil structure is destroyed. Many bacteria are released when the soil is turned, but soon lost to the atmosphere. Elaine feels that we need to work with more organic no-till methods so as not to lose soil structure and soil life.
Elaine recommends an easy way to feed the soil is to make a compost tea from compost that is placed in a tea brewer for 16-24 hours, where it is circulated like in a washing machine. The compost is placed in a basket and the whirling oxygenated water, filled with some food to feed the bacteria, lifts the bacteria and fungi off the compost and they grow rapidly. The tea is then poured onto the earth to bring in bacteria and fungi etc.
This was very interesting to me, as I saw a great connection here to what we are doing in Biodynamics. Only, in Biodynamics, we use the Horn Manure (Prep. 500), the Manure Concentrate (Cow Pat Pit or CPP) and Horn Clay stirred for just one hour, and lightly sprinkled or sprayed onto the soil, to stimulate the activity of the bacteria and fungi. The picture is a bit like: you could run around and catch a lot of flies in a jar, so you can spread them out over your land, or you could place a piece of rotting meat out, and the flies will come!
Steiner speaks of the work of the Biodynamic Preparations as not being so much bringing in the bacteria etc, but as stimulants – able to attract that activity. We already know that 507 (Valerian Compost Preparation) is able to stimulate the phosphorus activating bacteria, and each of the other Compost Preparations stimulate the activity of other types of bacteria and fungi.

The Biodynamic Farming & Gardening Association in Aust. Inc. recently had some Biodynamic Horn Manure tested for soil food web activity, at the Soil Food Web Laboratory in Lismore, NSW, and the results show high levels of bacterial activity and fungal activity with good biodiversity (solid unstirred Prep. 500). We would like to get some stirred Horn Manure (500), plus CPP and Horn Clay done next, to see what kind of activity is available as well.
These notes from Dr. Ingham's talk are only a touch on the information she gave. If you would like to know more, see her website www.soilfoodweb.com. There are also CD's available of her talks and a book, "Soil Biology Primer", Soil and Water Conservation Society of USA, also available from their Laboratory. Soil Food Web Laboratory, Lismore NSW. Phone 02 6622 5150.
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Some feedback from recent Soil Food Web testing in USA…
In the past Barrel Compost (Cow Pat Pit/CPP/Manure Concentrate) was tested as tea after stirring. It was done after three in the afternoon and sent right out express mail. It came back as the most highly rated tea of all we sent in. Most recently, the lab on Long Island is testing the materials before they get used as a tea inoculant or a bd remedy. They all test very high in the fungi, bacteria, and protozoa that they like to

see. I have been doing these combined remedies, also 500, bc, clay bc, and equisetum. Through Soil Food Web testing we have found that equisetum is the medium that promotes the most benefit for the growth of large diameter fungal hyphae, length, and quality of growth. So add equisetum to your mix, let that imprint during the stirring process, and see what happens to the soil. Over this past winter I was astounded at the growth that occurred in over-wintering crops and you could visibly see the fungal filaments in the soil along with the incredible crumb structure. After 15 years the Biodynamics is really showing its capability. Earthworm activity is likewise, amazing. It occurs to me that the BD remedies radiate through the soil making it like candy to the worms. They are so attracted to the soil and begin to just gobble it up.
...Sstorch
* * *

Hugh Lovel continues the discussion…
"Now that soil biology is surging forward and unlocking doors, scientists are finding out that organic agriculture—with its heavy emphasis on humus management, composting, compost teas, Biodynamic Preps, microbial inoculants, biocatalysts, biostimulants—is a great place to conduct research. I recall a paper by Dr. Pfeiffer that provides a microbial analysis of the Biodynamic Preps. The 3 volume series containing Ehrenfried Pfeiffer's articles, "Biodynamic Gardening and Farming" from Mercury Press, is a gold mine of insight into microbial action, Biodynamic Preps, agronomy, humus, etc.
"These are essential for the Biodynamic farmer's library," says Hugh Lovel during the recent discussion on Dr. Elaine Ingham's work. "First, those are not composts. Those are fermented microbial inoculants and biocatalysts—derived from animal manures, animal parts, plant parts, and ground crystal rock—used as preparations to treat composts.
"Secondly, variability between each batch of BD Preps is to be expected. Microbial antagonists extracted from the BD Preps may have some commonality, but they will also vary. Microbial makeup in BD Preps made in India, Australia, Europe and the US (eg Virginia, Wisconsin and California) will surely vary to a degree, or even to a great degree. Further work may elucidate the common microbial features of BD Preps, and that would be quite interesting.
What is fascinating is that the research was conducted by a prominent international agricultural research centre, such as ICRISAT, in the first place. Yet, why not! BD is a tried and proven organic agricultural system."