Is Strip-Till Worth It – Part II

A quick look at Microarthropods Influences on Nutrient-enrichment

We know from many scientists observing soil fauna across the world that in a very diverse habitat of deciduous trees, coniferous and shrub-grassland zones we will have the largest variety of minute-sized insects that chew, mulch, and digest litter, leaves, stems, bark, cones that lie on the soil surface. In cultivated cropped fields the diversity has a smaller population of these organic matter digesters but oh so important to organic matter digesting and return to the surface soils.

These soil microarthropods are all free-living mites and collembolans (springtails), living in the soil. They are organic litter/matter digesting and chewing insects that initiate the carbon sequestration process and return of organic nutrients to the soil for root uptake and other microorganisms' life cycles. To provide you with a brief synopsis of what happens on and in the soil surface, Table 1 informs us what functions come from these miniature creatures (highlighted in red).

Table 1. Essential functions performed by the different members of the soil fauna community.

from Torsvik,V. et.al. , 1994. Functional roles of biodiversity: A global perspective. John Wiley and Sons

Functions	Organisms involved
Maintenance of soil structure	Bioturbating invertebrates and plant roots, mycorrhizae, earthworms, and some other microorganisms
Regulation of soil hydrological processes	Most bioturbating invertebrates-earthworms and plant roots
Gas exchanges and carbon sequestration	Mostly microorganisms and plant roots, some C protected in large compact biogenic invertebrate aggregates
Soil detoxification	Mostly microorganisms
Nutrient cycling	**Mostly microorganisms and plant roots, some soil and litter feeding invertebrates**
Decomposition of organic matter	**Various saprophytic and litter feeding invertebrates (detritivores), fungi, bacteria, actinomycetes and other microorganisms**
Suppression of pests, parasites and diseases	**Plants, mycorrhizae and other fungi, nematodes, bacteria and various other microorganisms, collembola, earthworms, various predators**
Sources of food and medicines	Plant roots, various insects (crickets, beetle larvae, ants, termites), earthworms, vertebrates, microorganisms and their by-products
Symbiotic and asymbiotic relationships with plants and their roots	Rhizobia, mycorrhizae, actinomycetes, diazotrophic bacteria and various other rhizosphere microorganisms, ants
Plant growth control (positive and negative)	Direct effects: plant roots, rhizobia, mycorrhizae, actinomycetes, pathogens, phytoparasitic nematodes, rhizophagous insects, plant growth promoting rhizosphere microorganisms, biocontrol agents Indirect effects: most soil biota

Soil microarthropods are all free-living mites and collembolans, living in the soil. Dutch scientist (Vreeken-Buijs) in the late 90's, carried out research to understand some of the roles of the microarthropods in the soil food web that control litter decomposition and mineralization of nutrients, mainly nitrogen.

In the miniature kingdom of surface litter, left from crop residues, leaves from trees, grasses, manures we find microarthropods separated into functional groups: predatory mites, predatory Collembola, nematophagous mites (mites that eat nematodes), omnivorous collembolan (springtails that eat anything that sits or moves), cryptostigmatid mites (mites that chew and ingest dead plant matter), non-cryptostigmatid mites and bacterivorous mites (mites that ingest bacteria that digest leaf litter). Food web interactions and the effect of microarthropods on decomposition and mineralization were studied at different resolution levels. Bacteria are estimated to mineralize the most N (4.5 g N/m^2 per year), followed by the fauna (2.9g N/m^2/yr), and fungi (0.3g N/m^2/yr). Bacterial-feeding amoebae and nematodes together account for over 83% of N mineralization by the fauna.

Fig. 1 Cryptostigmatid mite

Fig. 2. Collembola - Soil dwelling springtails

In a German study, (Schneider et.al.) observed specific signatures of residual ^{15}N, that of Orbitatid mites to have specific niches in the soil biota. First level eat of lichens and algae, second level eat litter sources, third level eat of the fungi within the litter decayed or fresh, and last level living and dead collembolans, nematodes, and fungi. It is noted that there are more than 10,000 different species world wide.

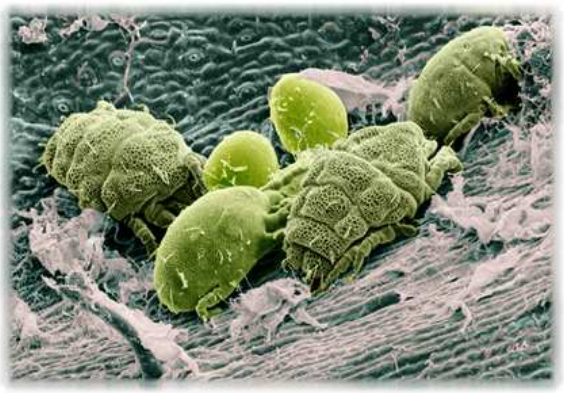

Fig. 3 Yellow mites on leaf tissues (adult & young)

Nematodes are non-segmented worms typically 1/500 of an inch (50 µm) in diameter and 1/20 of an inch (1 mm) in length. Those few species (Hunt, et al.) responsible for plant and root diseases have received a lot of attention, but far less is known about the majority of the nematode community that plays beneficial roles in soil.

An incredible variety of nematodes function at several levels of the soil food web/chain. Some feed on the plants and algae (first level); others are grazers that feed on bacteria and fungi (second level); and some feed on other nematodes (higher levels).

Fig. 4 Soil Nematodes

As one considers what is processed in the life cycles of these creatures, it is not very much nitrogen that gets released but these creatures that inhabit the soil-litter floor are a significant part of the digestion cycle. They keep residue from stacking up to depths of four and five feet high. The chewing into smaller bits and partial digestion of leaf and stem matter allows the smaller amoeba, nematodes, and bacteria to finish off the job releasing a nutrient stream so the root can utilize the organic by-products. All these creatures are part of the bio-cycling and recycling of the left over crop residue that does not get buried with proper strip-till and no-till systems. A large number of microarthropods function in the clean up of toxic materials too. Some of these miniature 'bugs' never move any further than one inch of ground surface for their entire existence – but still they are important.

Short Summary:

With the vertical tillage of strip-till in a zone of 10 inches wide or less, growers are encouraging the afore-mentioned bio-digesters; microarthropods and nematodes to flourish especially in the spring months when they are the most active in the near surface zone. Breaking down high cellulose, lignin fiber plant remains, these creatures are friends of the farmer doing their part for row crops to flourish. It is our observation that residues are broken down and disappear when the soil ecology is rich, diverse and active during the growing season.

With strip-till systems as well as no-till, leaving old root balls, stalks, leaves, stems, cobs, weeds from different crops in a cropping rotation encourages these creatures smaller than 2mm to co-exist and flourish. Without them residues would be unmanageable. Allowed to break down with the help of the creatures written in this brief article, the conservation tillage system allows a very natural cycle to function and benefit the grower of crops.

References:

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