Pesticides & Soil Biology, Part 2:

Protozoa to Earthworms

by Jill Clapperton

SCIENCE

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Editors' Note: Jill Clapperton, PhD (Plant Ecophysiology), is one of only a handful of soil ecology scientists in the world specializing in agroecosystems: plant, soil, and soil organism interactions. Formerly with Agriculture and Agri-Food Canada, Lethbridge Research Centre, in Lethbridge, AB, Canada, she is now a freelance scientist in her "new life" in Montana. Her business is called Earthspirit Consulting, earthspiritconsulting@gmail.com.

This is the second in a series of articles that examines how pesticides (herbicides, fungicides, and insecticides) affect the organisms that live in the soil. For those of you that are just 'tuning in,' the first article (*Leading Edge*, Jan. '09) summarized what scientists know about the direct and indirect effects of pesticides on microorganisms (specifically: bacteria and fungi). It continues to be important to understand that the bacteria and fungi are the *primary producers* in the soil ecosystem, and serve as an important food source for the soil animals (fauna) we are going to learn about in this article.

Soil protozoa and nematodes devour bacteria and fungi: A huge benefit to plants since bacteria and fungi are more competitive than plant roots for nutrients.

One of the questions that I get asked most often in workshops and lectures is: How do ag chemicals affect soil health? This article summarizes much of the science information regarding the effects of pesticides on soil fauna ('animals'). In terms of the soil food web, these are the organisms that live in the middle of the web (Figure 1). So, if you think of a spider's web, then a hole in the middle of the web will often cause the web to collapse, or the web becomes useless for catching and holding prey. The soil ecosystem food web is much the same: when the web is damaged, services are lost, decomposition can slow down, and nutrients are less available and/or may be lost from the system.

Now that we know where soil fauna sit in the food web, it is a good idea to know where they are classified in the tree of life (Fig. 2, p 563). I know, you thought that after university you were done with the biology lessons. However, in order to better understand how the indirect effects of pesticides impact soil fauna, we need to know how our non-target organisms are related to the target organisms. For example, will insecticides kill mites although they are not classified as insects?

Photo by Gupta Vadakattu, CSIRO, Australia.

Protozoa are single-celled organisms, but are large enough to prey on soil bacteria. Photo: light microscope, 10,000x magnification.

Soil fauna are broken down into the micro-, meso-, and macrofauna (Fig. 3, p 566) based on their size. So, we start with the 'animals' (fauna) that you likely need at least a dissecting microscope (50 – 100x magnification) to look at, which are the microfauna; then if you look at the soil closely with a magnifying glass, the animals visible are mesofauna; and, finally, the macro- or megafauna that we have no problem seeing.

Microfauna (protozoa and nematodes)

In the water films surrounding soil aggregates of a healthy rooting zone, protozoa and nematodes devour bacteria and fungi, thus keeping their populations in check. This is a huge benefit to the plants since the bacteria and fungi are more competitive than plant roots for nutrients in the rhizosphere (soil near roots; the most biologically active portion of the soil). The grazing activities of protozoa and nematodes also release nutrients to the plant. It has been demonstrated that rice plants grown with 'naked amoebae' (a group of protozoans) had more highly branched root systems, and a 45% increase in N uptake compared with rice plants grown with no amoebae.[1]

[1] K. Kreuzer, J. Adamczyk, M. Iijima, M. Wagner, S. Scheu & M. Bonkowski, 2006, Grazing of a common species of soil protozoa (*Acanthamoeba castellanii*) affects rhizosphere bacterial community composition and root architecture of rice (*Oryza sativa* L.), *Soil Biol. & Biochem.* 38: 1665-1672.