SOIL MESOFAUNA

WHO ARE THEY?

Soil fauna are commonly grouped together by taxonomy, trophic level, functional groups, and body size. These groupings, depicted in Figure 1, help describe who these fauna are and what they are doing in soils.

Soil mesofauna are tiny animals that range in size from 100µm to 2mm, which is comparable to a grain of sand. Prominent fauna in this group includes:

- Collembola (Springtails)
- Acari (Mites)
- Protura
- Diplura
- Enchytraidae (potworms)
- Pseudoscorpionida
- Myriapods

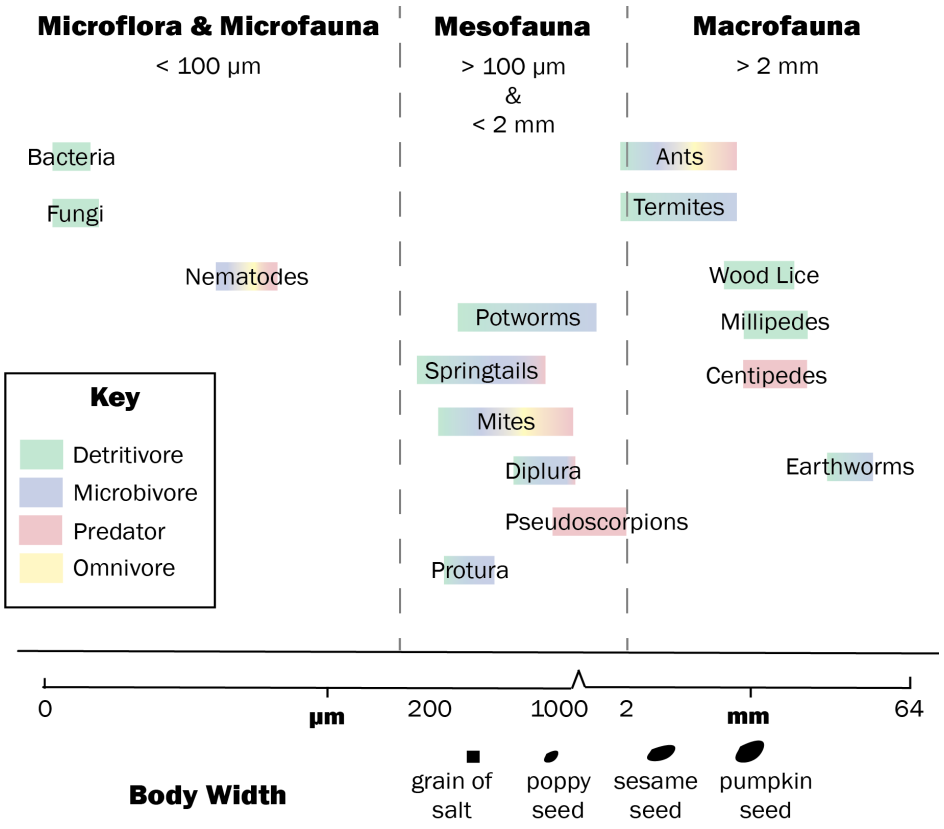

FIGURE 1. Soil fauna groups defined by taxonomy, body width, and trophic group. The color of the shapes indicates the trophic groups; location of color is not related to size of fauna. The trophic groups are generalized for each taxonomic group.

Mites and springtails are the most abundant mesofauna, examples of which are pictured in Figure 2. Soil mesofauna fill many diverse roles in soils due to their wide array of behaviors and habitat preferences. Trophic groupings describe what fauna are consuming. Functional groupings describe how fauna interact with their environment, and are influenced by how the fauna move through the soil which is determined by their body size.

FIGURE 2. (A) Collembola courtship display [family: Sminthuridae]. (B) Oribatid mite feeding on fungi [family: Euphthiracaridae]. (C) Collembola laying eggs [family: Isotomidae] (D) Mesostigmatid mite consuming a Collembola [family: Laelapidae]. Photography by Andy Murray: www.chaosofdelight.com

Trophic Groups

Detritivores - consume plant litter and organic matter
Microbivores - consume microbes
Predators - consume other fauna
Omnivores - consume a variety of flora and fauna

Functional Groups

Nutrient Mineralizers - transform nutrients into plant available forms
Litter Transformers - produce organic biogenic structures (fecal pellets)
Ecosystem Engineers - transform soil into other structured materials

Soil mesofauna can fill a variety of different trophic groups and functional roles in soil ecosystems. These different groupings help us understand how soil fauna impact crop production.

WHY DO WE CARE?

Soil mesofauna are important because they impact many soil processes that affect crop production (Figure 3). Most notably, mesofauna stimulate soil organic matter decomposition and nutrient cycling. Mesofauna predominantly affect soil processes through their feeding habits, including:

- shredding plant litter and organic matter
- grazing on soil microbes (primarily fungi and bacteria)
- feeding on fungal seed coats and plant roots

In addition to having big impacts on nutrient dynamics in soils, through their behavior mesofauna can also influence:

- plant pathogen suppression and transmission
- seed germination
- root exudates
- plant nutrient allocation and growth

Though mesofauna primarily affect crop production through their interactions with other factors in the soil environment, these indirect effects can add up to big impacts on crops!

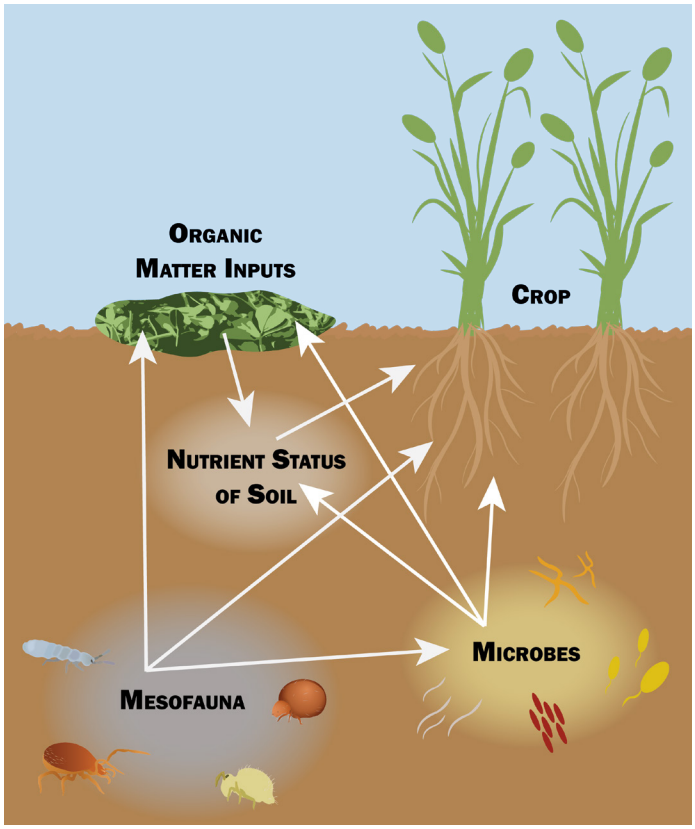

Figure 3. Visual overview of how soil mesofauna affect crop growth. Arrows depict drivers of soil processes.

Further Readings and References

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Soil Mesofauna
Fact Sheet Series
(1 of 3)

Created by Ashley Jernigan, Graduate Student, Department of Entomology, Cornell University
Funded by Cornell Entomology Department Extension & Outreach Assistantship

Cornell AgriTech
New York State Agricultural Experiment Station

SOIL MESOFAUNA

WHERE ARE THEY?

Soil mesofauna can be found on every continent in the world in a variety of habitats. Soil mesofauna includes the fauna that live on the soil surface and in litter (epigeic) and those that reside lower within the soil profile (euedaphic). In agricultural soils, most biological activity occurs in the top 4 to 8 inches of soil.

Soil mesofauna populations vary greatly over time and space. Factors that affect the distribution and abundance of these fauna include: soil type, soil compaction, temperature, precipitation and moisture, and food resource availability. Soil mesofauna aggregate in favorable habitat conditions where they have the resources they need to survive, which causes very patchy distributions across land areas. In the Northeastern United States mesofauna abundances are greatest in the spring and fall due to milder temperatures and favorable soil moisture conditions.

There are a variety of different methods for collecting soil fauna that are typically based on their body size and mobility. Soil mesofauna can be collected using heat extraction methods that utilize Berlese-Tullgren funnels. This method relies of the mesofauna's natural behavior of moving deeper into the soil profile whenever conditions get too hot and dry.

A

Diagram of Basic Mesofauna Extraction Setup

Funnel
Purpose: to direct fauna from soil into preservation liquid

Examples:
- oil funnel
- top half of 2 liter bottle

Incandescent Light Bulb
Purpose: heat source to dry out soil

Example Bulb Holders:
- clip on utility lamp
- desk lamp

Mesh Screen
Purpose: to hold soil in funnel

Examples:
- window screen
- hardware cloth
- cheesecloth

Small Container
Purpose: to catch and store fauna, preferably with a lid

Examples:
- small dish
- specimen cup
- bottom of 2 liter bottle

Preservation Liquid
Purpose: to kill and preserve fauna

Examples:
- liquids with high alcohol content, such as rubbing alcohol

B

FIGURE 1. (A) Diagram of basic components necessary to conduct a soil mesofauna extraction, with examples items for components. (B) Pictures of example modified funnel setups.

Evaluating the soil mesofauna present in a field requires three main steps: soil sample collection, mesofauna extraction, and sample processing. Each of these steps can be tailored based on an individual's goals, resources, and constraints. For example, you may want to see how a new crop management practice impacts the soil mesofauna or compare the soil mesofauna between different fields. The main thing to keep in mind is that uniformity in sample collection, extraction, and processing is necessary to be able to compare findings between samples.

After completing your first extraction it is important to practice sorting through samples to be able to find the small mesofauna. Tips for observing and counting the extracted mesofauna include:

- make sure you have good lighting
- try placing the sample on different color backgrounds (black or white)
- put the sample in a flat, shallow dish or container to improve clarity

It is easiest to begin with total mesofauna counts while you get comfortable with this process. Informative comparisions can be made with just measurements of total mesofauna abundance, though as you become more familiar with mesofauna identification you may choose to identify your fauna to broad taxonomic groups (total mites, total collembola, and other taxa) to get a better understanding of the communities.

Steps to determine the mesofauna in your soils:

1. Create a sampling plan and collect soil samples
   - Choose a time when conditions are favorable for soil mesofauna
   - Determine how many soil samples are necessary to capture the spatial variabity in your field
   - Using a shovel, collect uniform soil samples to a depth of at least 4 inches
2. Extract mesofauna from soil samples
   - Set up modified Berlese-Tullgren funnel(s) following example diagram
   - Place soil samples on funnels and leave for uniform amount of time until extraction is complete, usually about three days
3. Processing the extracted soil mesofauna
   - Using a good magnifying glass or other magification tool, aim for at least 30x magification, observe the mesofauna extracted in each soil sample
   - Determine level of mesofauna identification you are comfortable with
   - Record observations of the number of mesofauna in each sample

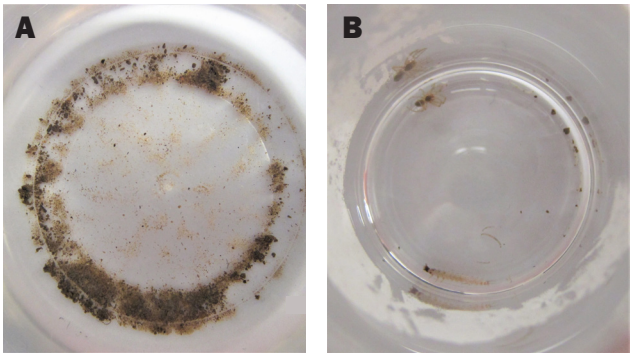

Figure 2. (A) Image of extracted mesofauna sample. (B) Image of processed sample with soil removed.

Further Readings and References

Helmberger, M., Wickings, K. 2017. The Soil Animal Handbook, Version 2.1.1, Cornell University, Geneva, NY.

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Soil Mesofauna Fact Sheet Series (2 of 3)

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HOW DO WE KNOW?

SOIL MESOFAUNA

WHAT AFFECTS THEM?

Soil mesofauna are affected by environmental factors including soil type, structure, temperature, moisture, and food resource availability. Crop management decisions impact many of these factors in manners that either benefit or harm the mesofauna. Soil mesofauna communities can be highly diverse, and therefore contain many different species that respond differently to environmental conditions. However, generalization can be made about how environmental conditions and crop management practices impact the overall activity and functioning of soil mesofauna communities (Table 1).

Table 1. Generalized overview of how environmental conditions are impacted by crop management practices and how those changes affect the overall activity and functioning of soil mesofauna communities.

Crop Management Practice	Environmental Condition	Effect on Mesofauna Activity
Crop Rotation	Food Resources	Positive
Cover Cropping	Soil Structure Soil Temperature Soil Moisture Food Resources	Positive
Intercropping	Food Resources Soil Structure	Positive
Organic Matter Inputs	Food Resources	Positive
Tillage	Soil Structure	Negative
Irrigation	Soil Moisture Soil Temperature Food Resources	Positive
Pesticides	Food Resources	Variable

When trying to manage your fields to enhance soil biological activity it is important to focus on creating a habitat that can support a diverse and active soil mesofauna community. The responsiveness of different species within the mesofauna community to changing environmental conditions leads to the high spatial variability we observe with mesofauna.

In October 2020, multiple farms across the Finger Lakes Region of New York State which varied greatly in crop rotation and management history were sampled to assess their mesofauna communities. Across all of these samples, the total number of soil mesofauna found in a single sample ranged from 58 – 1678 individuals per kilogram (approximately 2 lbs) of dry soil, with a average of 545 individuals per kilogram of dry soil. The average mesofauna abundance observed is depicted in Figure 1.

The different farms and fields sampled varied greatly in mesofauna abundance due to the varying environmental conditions. Crop diversity, both incorporating more diverse crop species in rotations and increasing diversity through intercropping practices, had positive effects on mesofauna abundance and diversity. The rough amount of ground cover was also related to the mesofauna abundance, with more dense ground cover promoting a more abundant mesofauna community. The application of insecticides to control crop pests decreased the amount of mesofauna. Overall, increasing the number of management decisions which reduce soil disturbance and feeds the soil's biological food web leads to more abundant and diverse mesofauna communities.

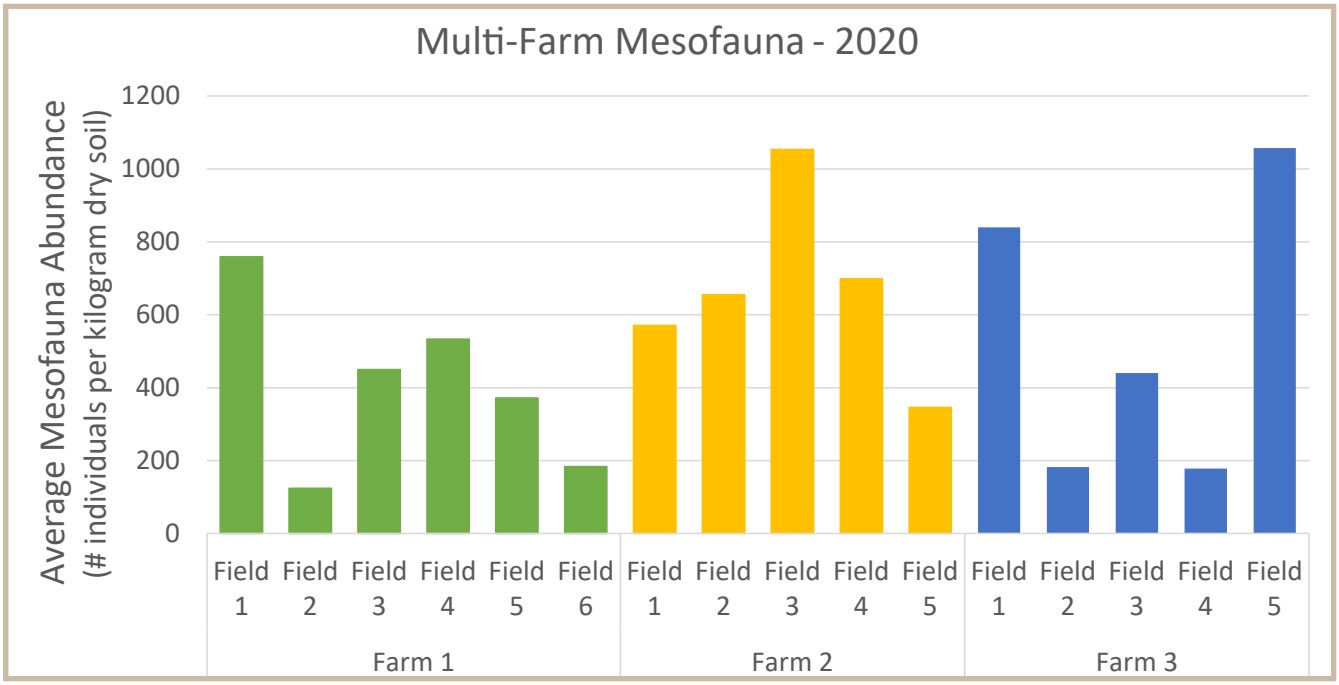

FIGURE 1. Bar graph illustrating the high variability of the average mesofauna abundances found on farms across the Finger Lakes Region of New York State.

FURTHER READINGS AND REFERENCES

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HOW CAN I MANAGE THEM?

SOIL MESOFAUNA FACT SHEET SERIES (3 OF 3)

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