



Healthy Soil Healthy You

Bring your soil
'back to life'
and grow
Nutritious Food

Soil Health

A Close-up Look



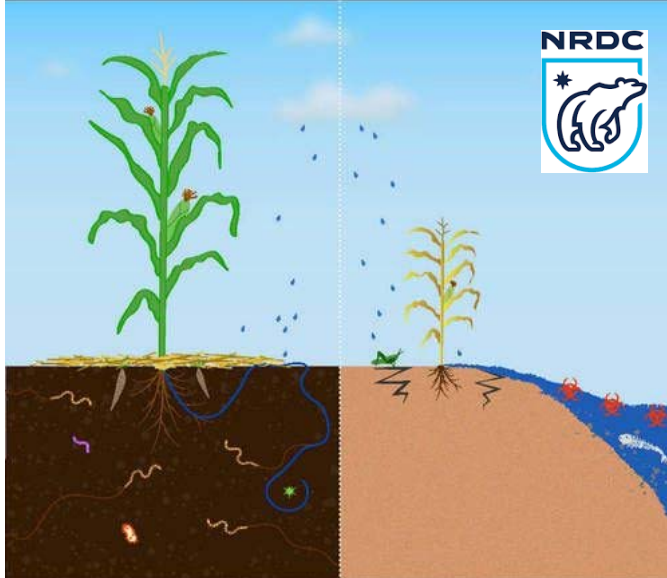
What is Soil Health?

The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans

LIVING SOIL VS. DEAD SOIL

WHY SOIL MATTERS TO FARMERS AND THE ENVIRONMENT

An entire world that feeds us lives beneath our feet. Healthy soil holds a wealth of organic matter made up of worms, good bacteria, fungi and other microorganisms that work together to help crops thrive. When soil life is disturbed or unprotected, it becomes difficult for these natural soil builders to be productive and for farmers to grow their crops. Building rich, diverse, and healthy soil ecosystems is a critical life-giving farming practice. Luckily, caring for soil is one of the most effective time-tested ways farmers can increase crop yields while protecting our natural resources.



LIVING SOIL

EARTHWORMS - create vital water channels as they burrow through the soil. These channels allow rain to soak into the soil, where it can help crops grow. Earthworms also add important nutrients to the soil.

RESIDUE - or stubble from previous crops, acts like a garden mulch. It helps soil retain moisture, suppresses weeds, and prevents erosion and contaminated runoff and reduces flooding.

MICROORGANISMS - such as bacteria and fungi, help to filter contaminants and stabilize the soil to prevent erosion. They help form the glue that keeps soil intact.

COVER CROPS - are grown for the purpose of improving soil health. Cover crops deliver natural fertilizer to the soil, prevent erosion, and increase biodiversity. Their roots also create pores in the soil for better water infiltration.

DEAD SOIL

BARE SOIL - without any residue or cover is unprotected from the elements. As a result, it cracks and turns hard and dusty, more like concrete than soil. Water cannot reach the crops' roots to grow effectively. Instead, the chalky dirt becomes runoff that flows right off the field.

EROSION - is more likely to occur from unhealthy and unprotected soils. When soil from fields runs off into nearby streams, it can cause health problems and harm fish and other wildlife.

INCREASED CHEMICALS - like dangerous fertilizers and pesticides are notorious inputs that crops from unhealthy soils now rely on to grow. These chemicals can cause serious health and environmental problems if they contaminate water.

PESTS - such as insects or weeds, are more likely to invade fields when the soil ecosystem is too weak to defend itself.

Credit: David Beatty, National Resources Defense Council
See www.nrdc.org/soil/soil-health

Soil Health A Close-up Look

Dead Soil

BARE SOIL: unprotected, turns soil hard, non porous

EROSION: nothing holding soil in place

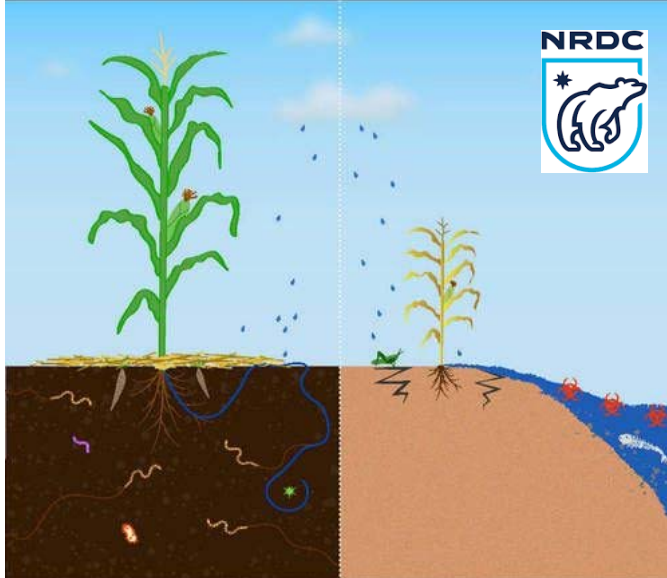
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PESTS: insects and weeds more likely to invade

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Check! Soil Health: Making Farming's Difference Count! See more info and get up to date here.

Soil Health A Close-up Look

Living Soil

EARTHWORMS: add nutrients, create water channels

RESIDUE: from previous crops, acts as mulch, organic matter

MICROORGANISMS: stabilize the soil, feeds plants

COVER CROPS: improve soil health, adds nutrients



The Carbon Sequestering Garden

Gardening for the Planet While Growing Some of the Best Food Possible

By Allison Houghton



Northeast Organic Farming Association/
Massachusetts Chapter, Inc.

www.nofamass.org

Soil Health

A Close-up Look

The Carbon Sequestering Garden

Gardening for the Planet
While Growing Some of
the Best Food Possible

Build up soil and sequester carbon by:

1. Minimize or avoid chemical, physical and biological stressors

Chemical: artificial pesticides and fertilizers

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- Actively destroy soil life
- Destabilize and degrades soil structure
- Halt soil carbon building processes

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Chemical: artificial pesticides and fertilizers

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- Destabilize and degrades soil structure
- Halt soil carbon building processes

Physical: manual tilling

Soil Health

“Rototilling is equally damaging to the soil as spraying chemicals.”



Build up soil and sequester carbon by:
2. Use plant diversity to increase soil diversity

MONOCULTURE vs POLYCULTURE

- Definition: growing only one species in a crops in the same space



Definition: using multiple crops in the same space, in imitation of the diversity of natural ecosystems



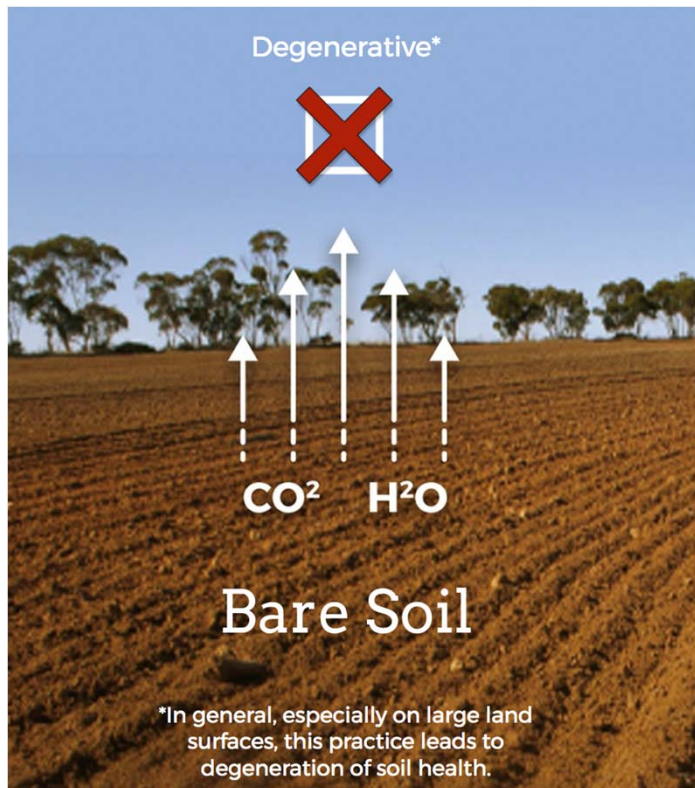
Build up soil and sequester carbon by:

3. Keep living roots in the soil year round to feed your soil



- Perennial plants
- Groundcovers
- Cover Crops
- Intercropping

Build up soil and sequester carbon by:
4. Keep the soil covered as much as possible

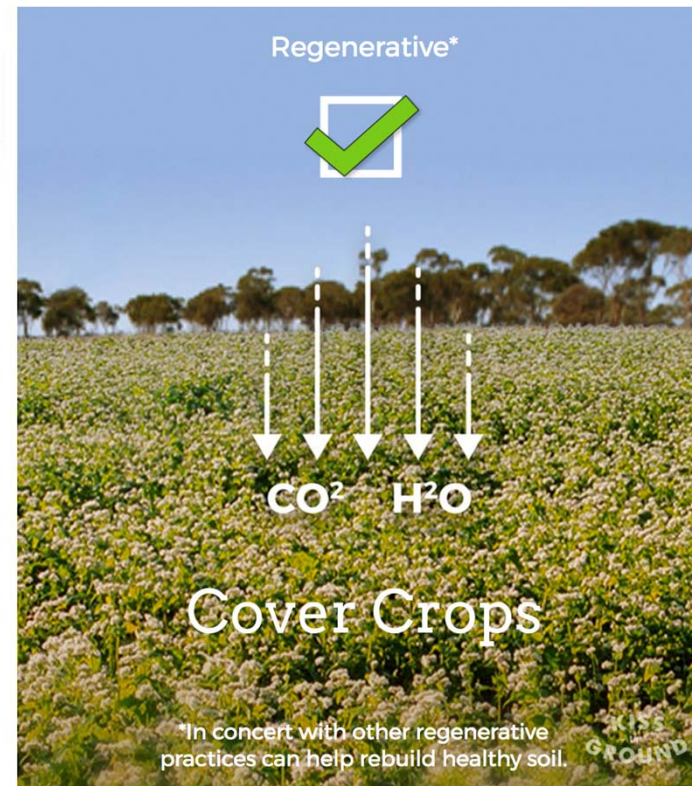


If you can see the soil it is losing carbon, vitality, life.

Soil Health

Build up soil and sequester carbon by:
4. Keep the soil covered as much as possible

The most effective way regenerate soil is to maintain living cover of diverse plants as much of the year as possible.





Natural Resources Conservation Service

United States Department of Agriculture



**Healthy, fully
functioning soil is
balanced to provide
an environment
that sustains and
nourishes plants,
soil microbes and
beneficial insects.**

USDA Checklist for Healthy Soil



Natural Resources Conservation Service

United States Department of Agriculture



**healthy, productive soils
checklist for growers**

USDA Checklist for Healthy Soil

Conservation Crop Rotation

Growing a diverse number of crops in a planned sequence in order to increase soil organic matter and biodiversity in the soil.



- Increases nutrient cycling
- Manages plant pest (weeds, insects, and diseases)
- Reduces sheet, rill, and wind erosion
- Holds soil moisture
- Adds diversity so soil microbes can thrive

USDA Checklist for Healthy Soil

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Cover Crop

An un-harvested crop grown as part of planned rotation to provide conservation benefits to the soil.



- Increases soil organic matter
- Prevents soil erosion
- Conserves soil moisture
- Increases nutrient cycling
- Provides nitrogen for plant use
- Suppresses weeds
- Reduces compaction

USDA Checklist for Healthy Soil

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No Till

A way of growing crops without disturbing the soil through tillage.



- Improves water holding capacity of soils
- Increases organic matter
- Reduces soil erosion
- Reduces energy use
- Decreases compaction

USDA Checklist for Healthy Soil

Mulching

Applying plant residues or other suitable materials to the soil surface to compensate for loss of residue due to excessive tillage.



- Reduces erosion from wind and rain
- Moderates soil temperatures
- Increases soil organic matter
- Controls weeds
- Conserves soil moisture
- Reduces dust

USDA Checklist for Healthy Soil

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Pest Management

Managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms.



- Reduces pesticide risks to water quality
- Reduces threat of chemicals entering the air
- Decreases pesticide risk to pollinators and other beneficial organisms
- Increases soil organic matter

USDA Checklist for Healthy Soil

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Nutrient Management

Managing soil nutrients to meet crop needs while minimizing the impact on the environment and the soil.



- Increases plant nutrient uptake
- Improves the physical, chemical, and biological properties of the soil
- Budgets, supplies, and conserves nutrients for plant production
- Reduces odors and nitrogen emissions

Soil Health

"The more we are in harmony with Nature the more successful we can be in growing food."



BIONUTRIENT
Food Association

www.bionutrient.org

BIONUTRIENT RICH FOOD

GROWERS

REAL FOOD CAMPAIGN

EVENTS

CHAPTERS

LIBRARY

GET INVOLVED

Our Crops

Soil is a biological system, and addressing limiting factors in air, water, carbon, minerals and biology systemically empowers crops.

[Learn more](#)

OUR CROPS

Yield, Vigor and Flavor are determined by soil vitality.

OUR HEALTH

Is affected by the quality of the food we put in our bodies.

QUALITY OF FOOD

Can be understood and identified.

Soil Health

Microbiologists estimate that there may be as many as 1,500,000 species of soil fungi, and 3,000,000 species of soil bacteria.

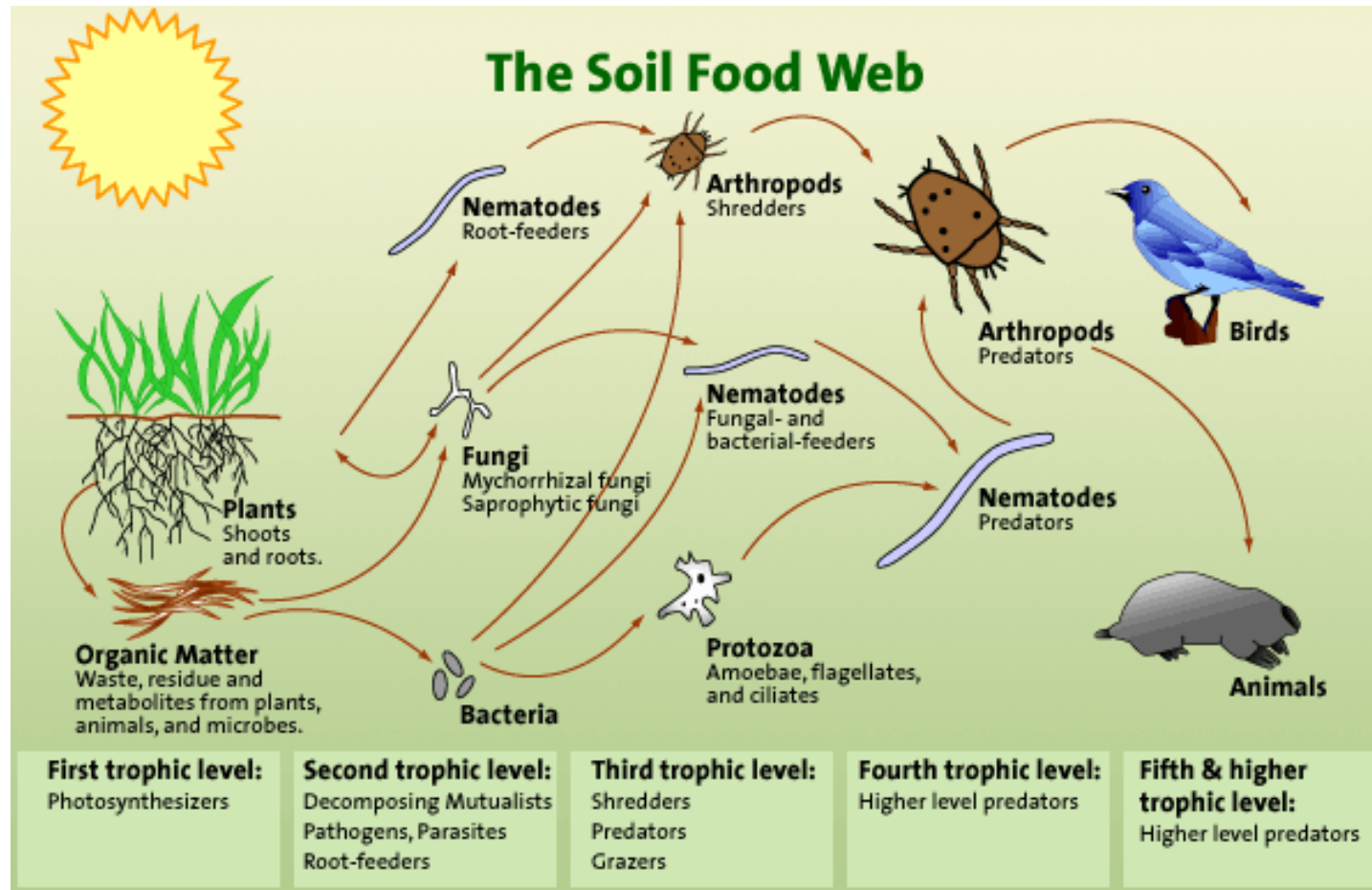
... most agricultural soils have no more than 5,000 species present



The Soil Food Web

Gabe Brown

"The soil beneath us is alive! There are more organisms in a teaspoonful of healthy soil than there are people on earth."

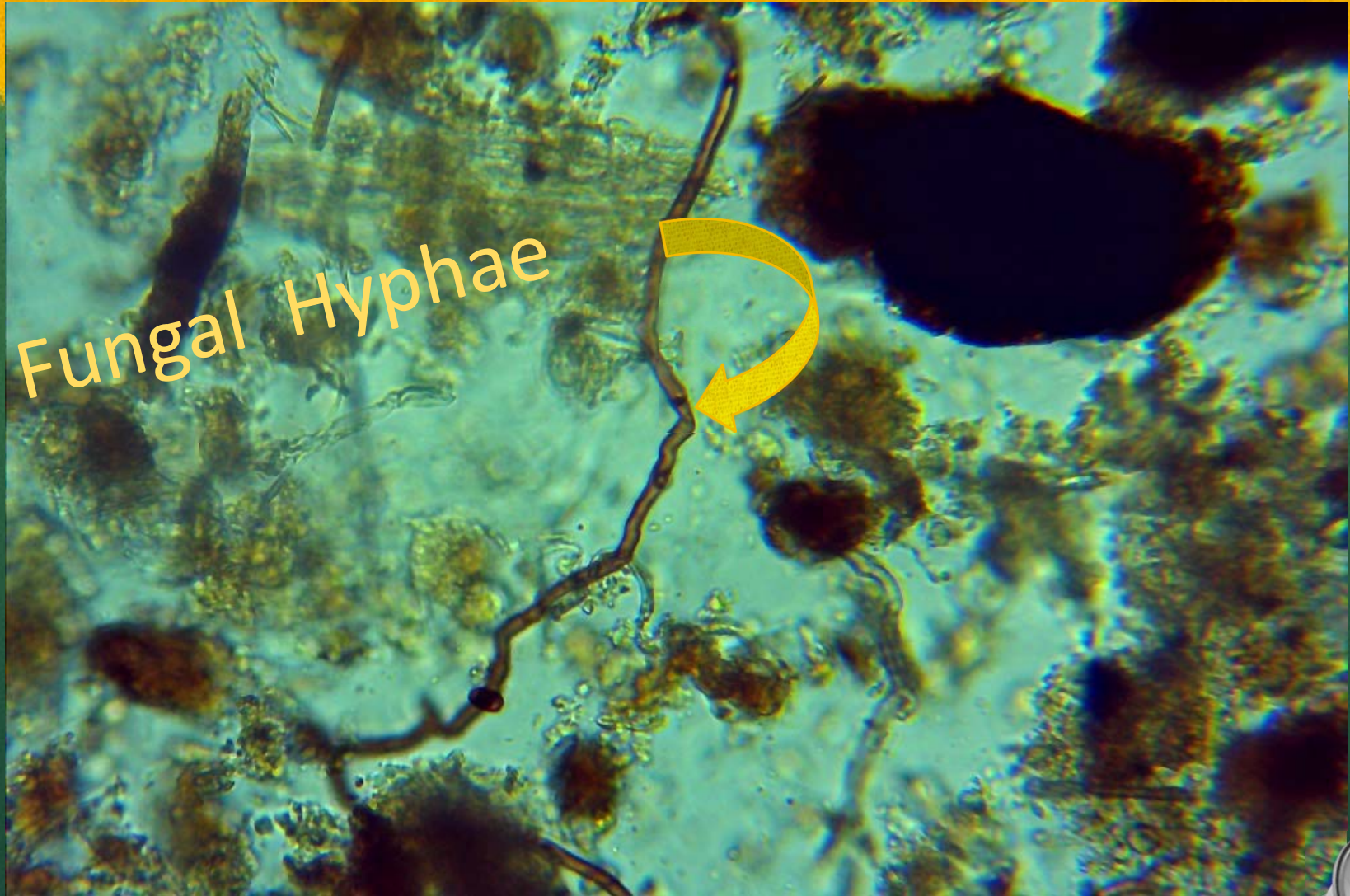


USDA's Natural Resources Conservation Services 'Soil Biology Primer'

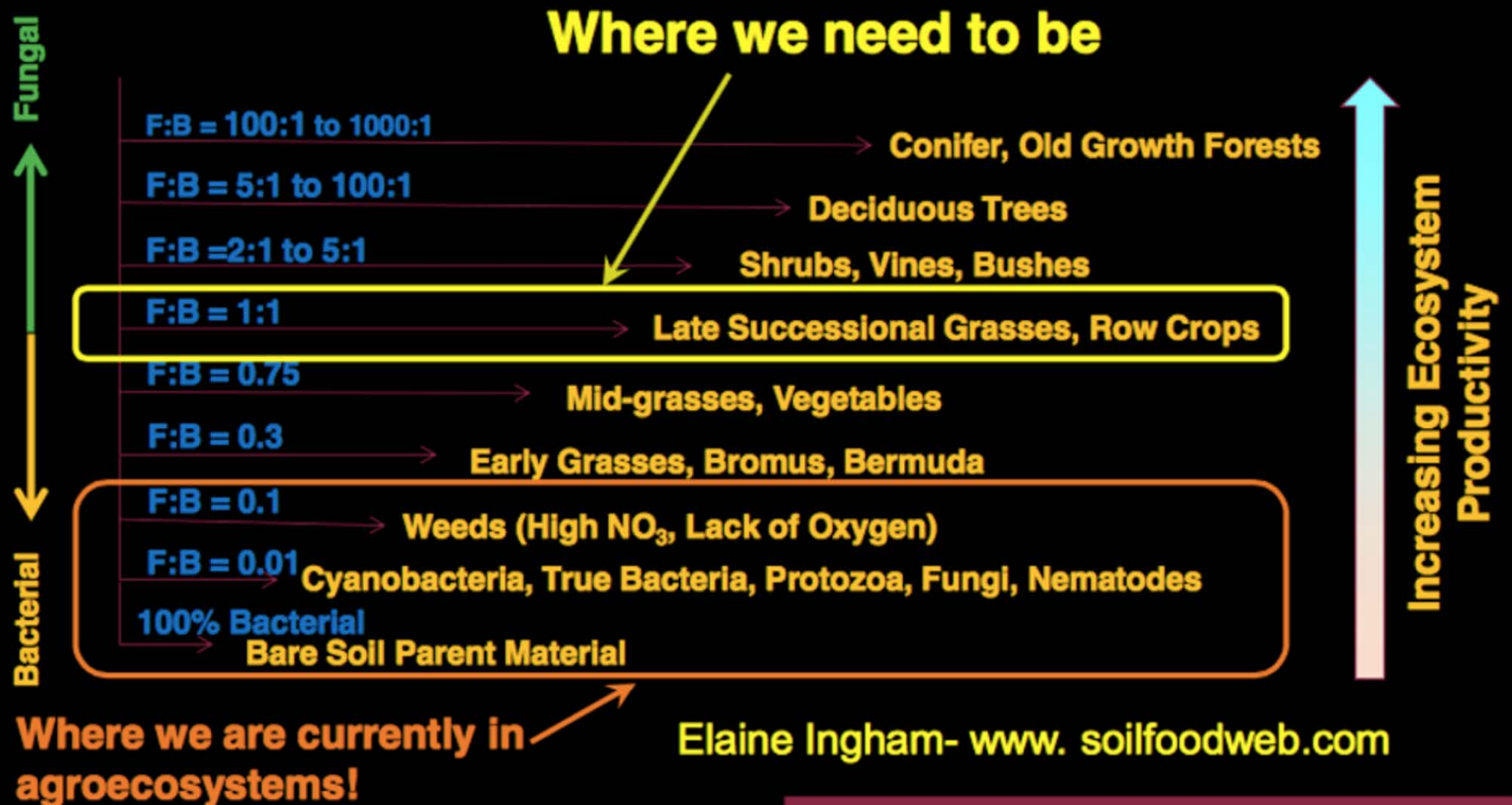
Life in the soil...



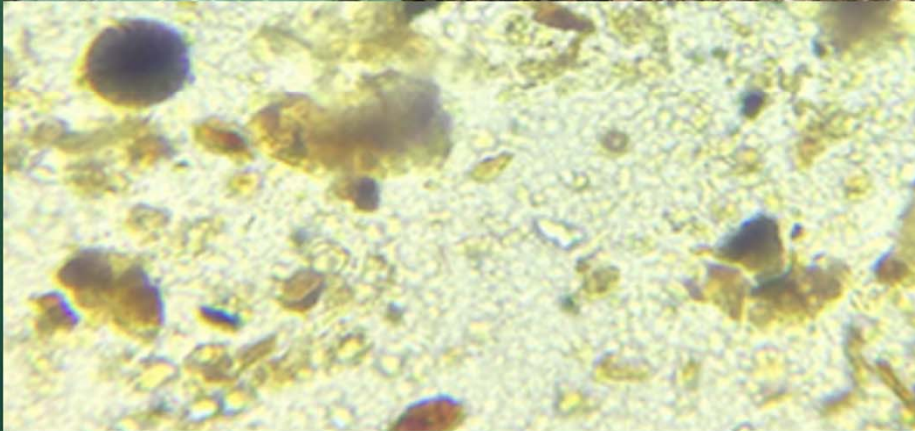
Fungal Hyphae



Different plants need different soil microbe communities

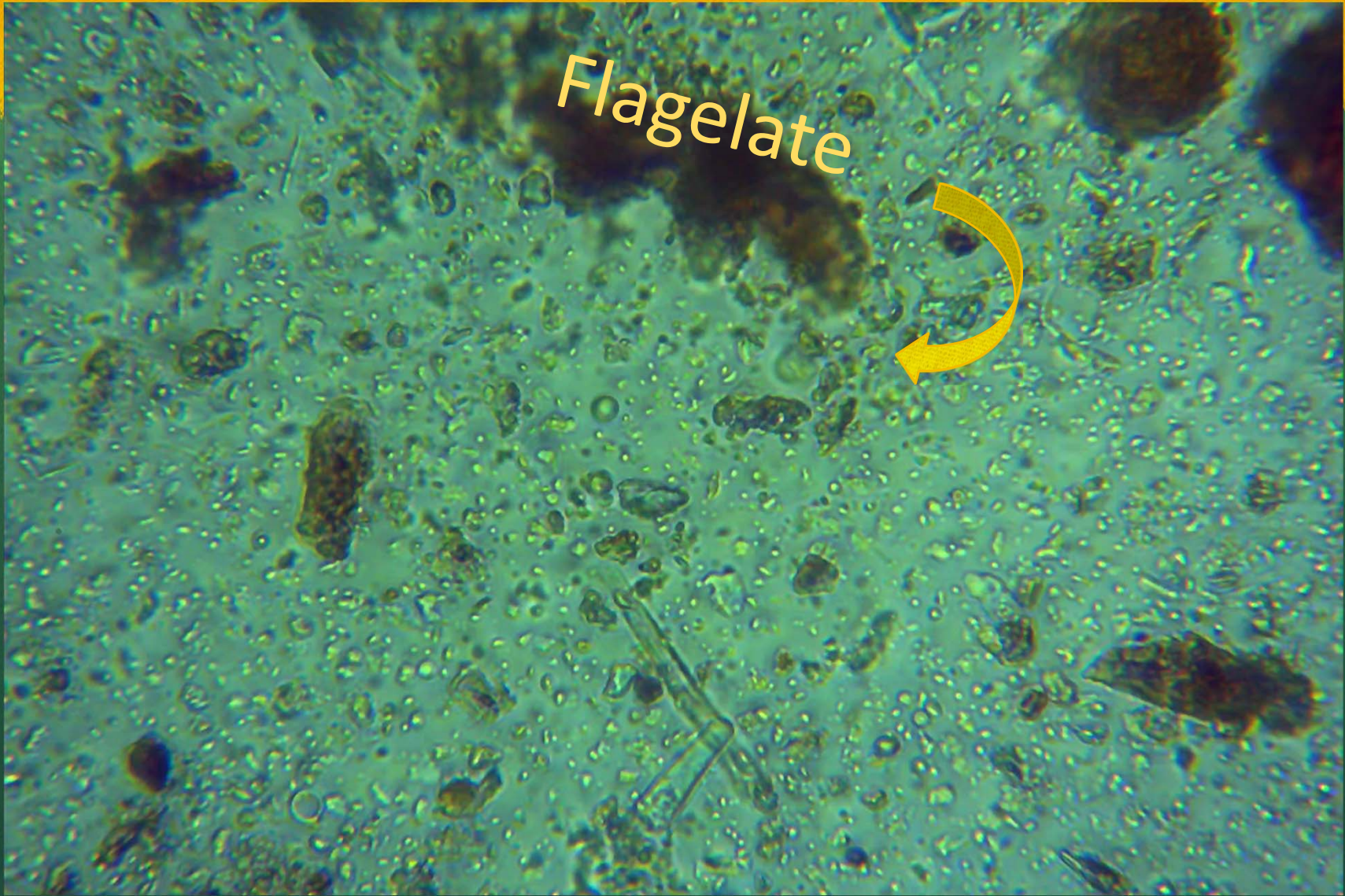


Different plants need different soil microbes



Beneficial Micro-organisms

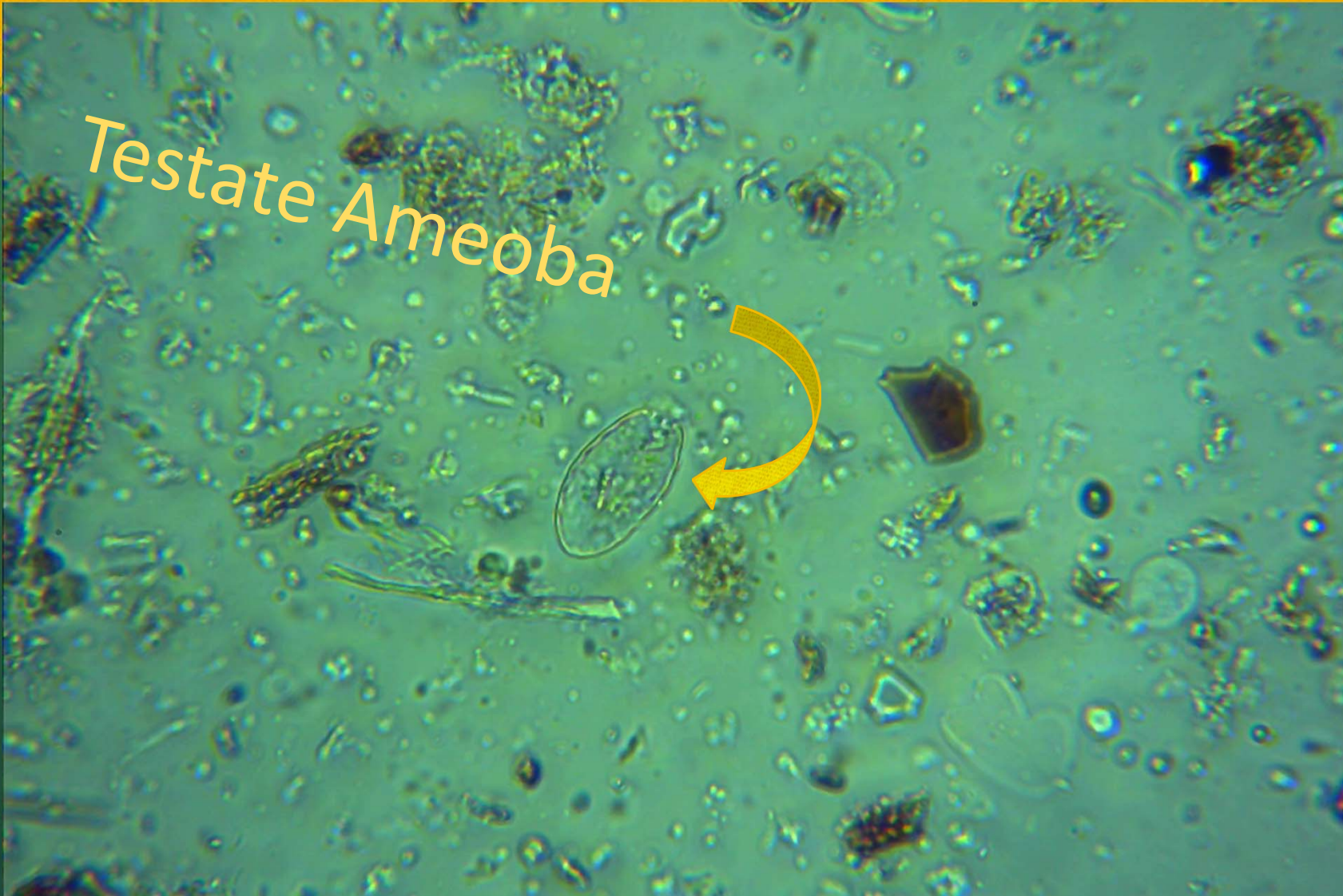
100X Magnification



Beneficial Micro-organisms

100X Magnification

Testate Ameoba



Beneficial Micro-organisms

Bacterial Feeding Nematode 100X



Beneficial Micro-organisms

Bacterial Feeding Nematode 200X



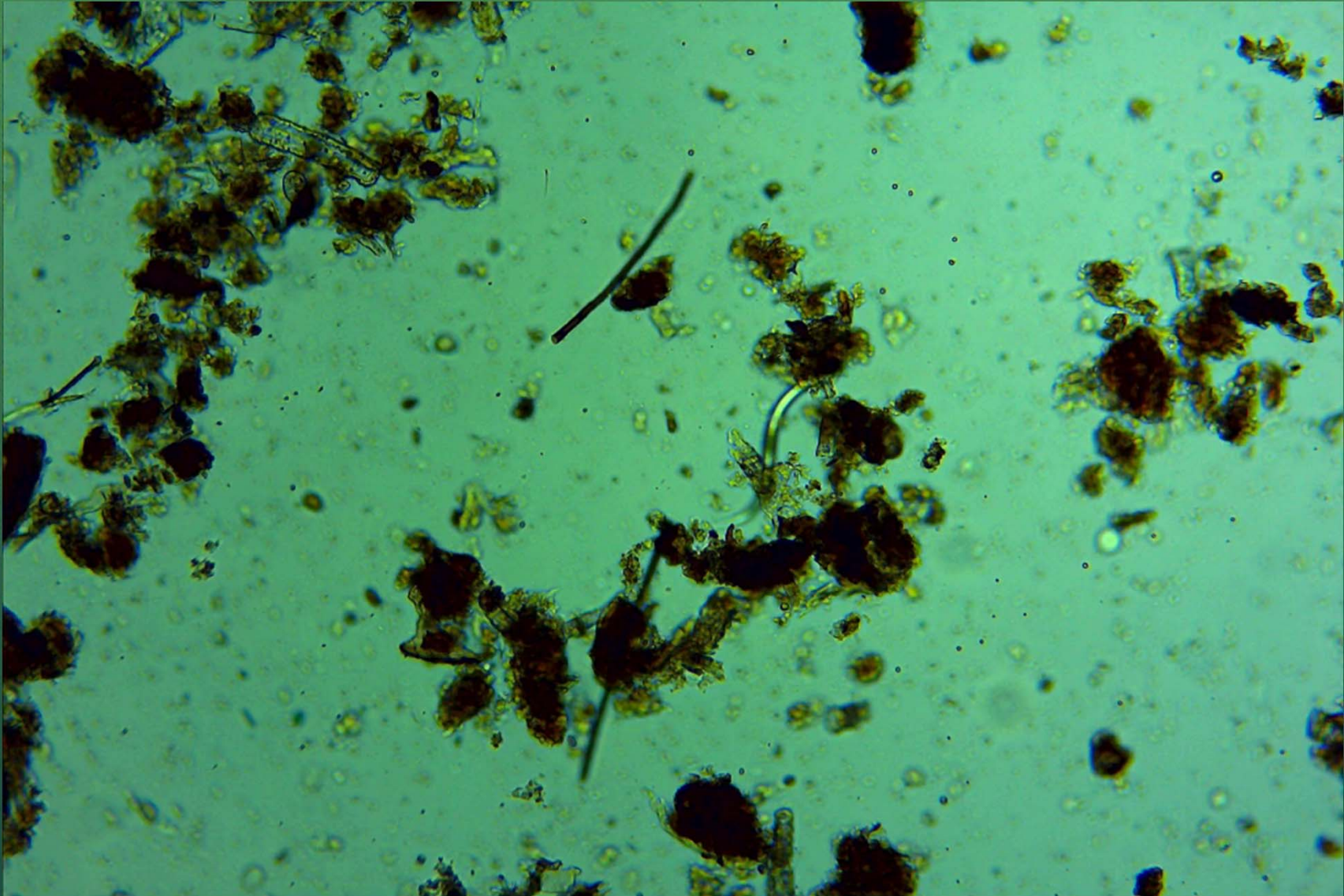
Beneficial Micro-organisms

Bacterial Feeding Nematode 400X



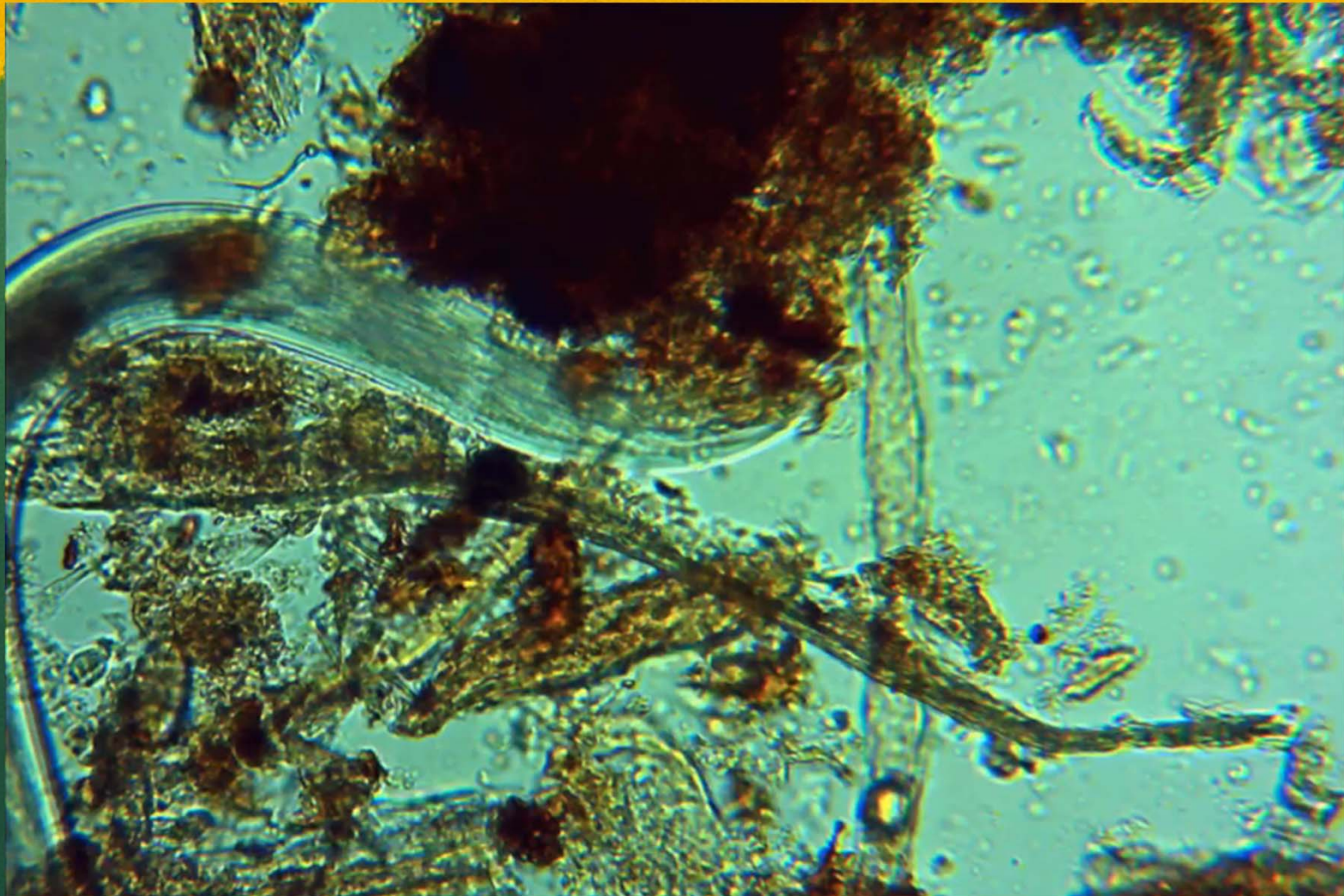
Beneficial Micro-organisms

Nematode 100X movie



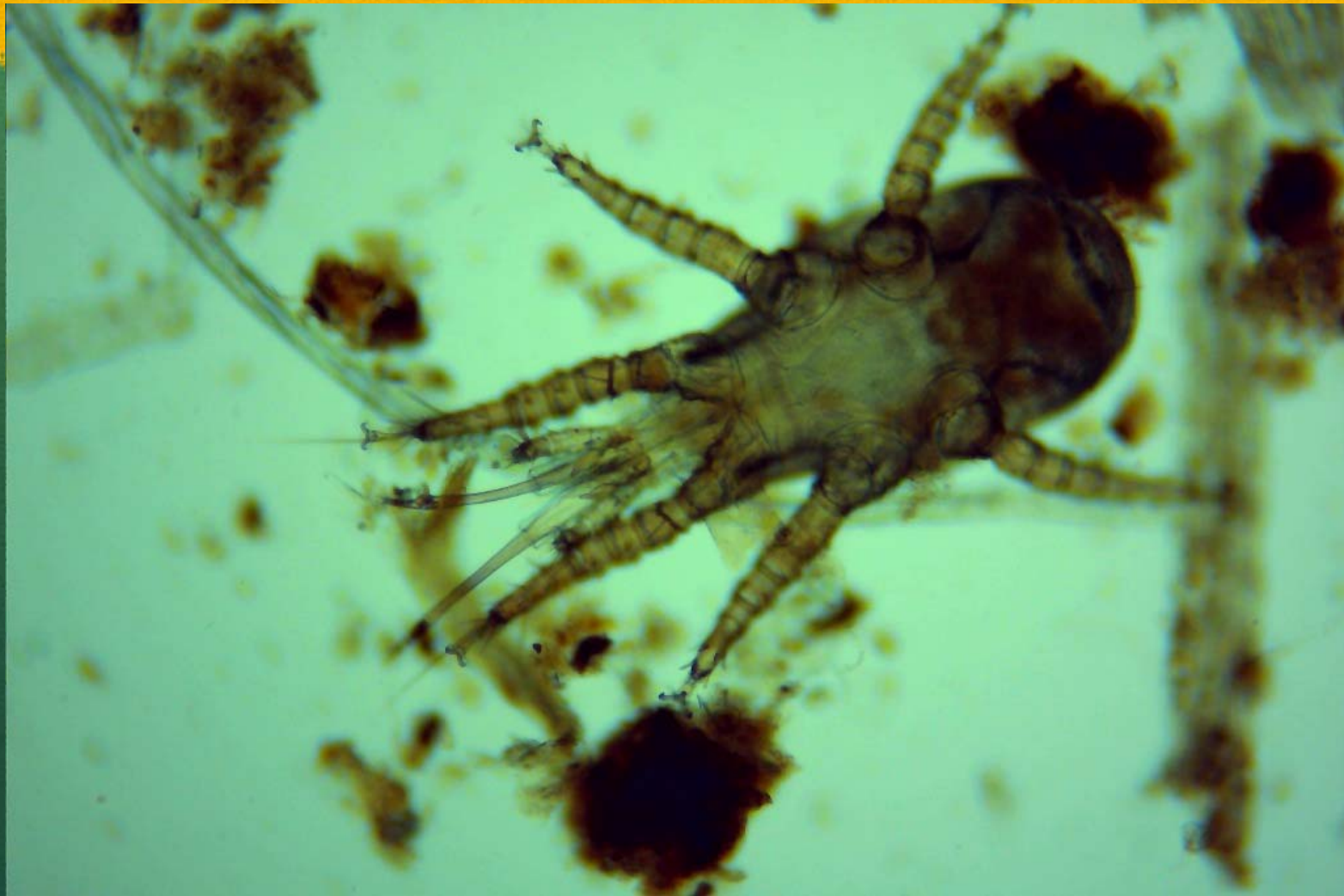
Beneficial Micro-organisms

Nematode 400X movie



Beneficial Micro-organisms

Microarthropod 100X



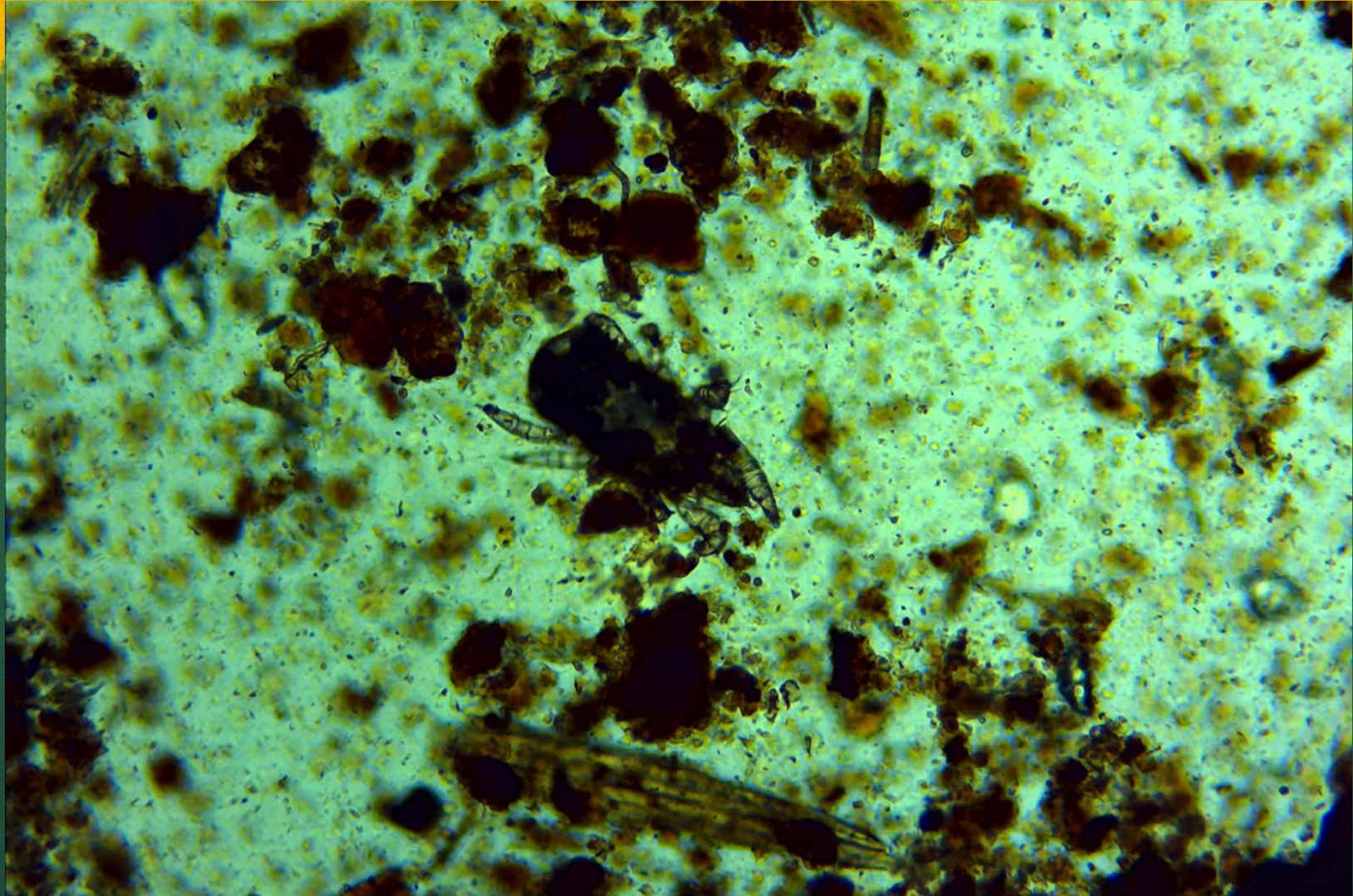
Beneficial Micro-organisms

Microarthropod 100X movie

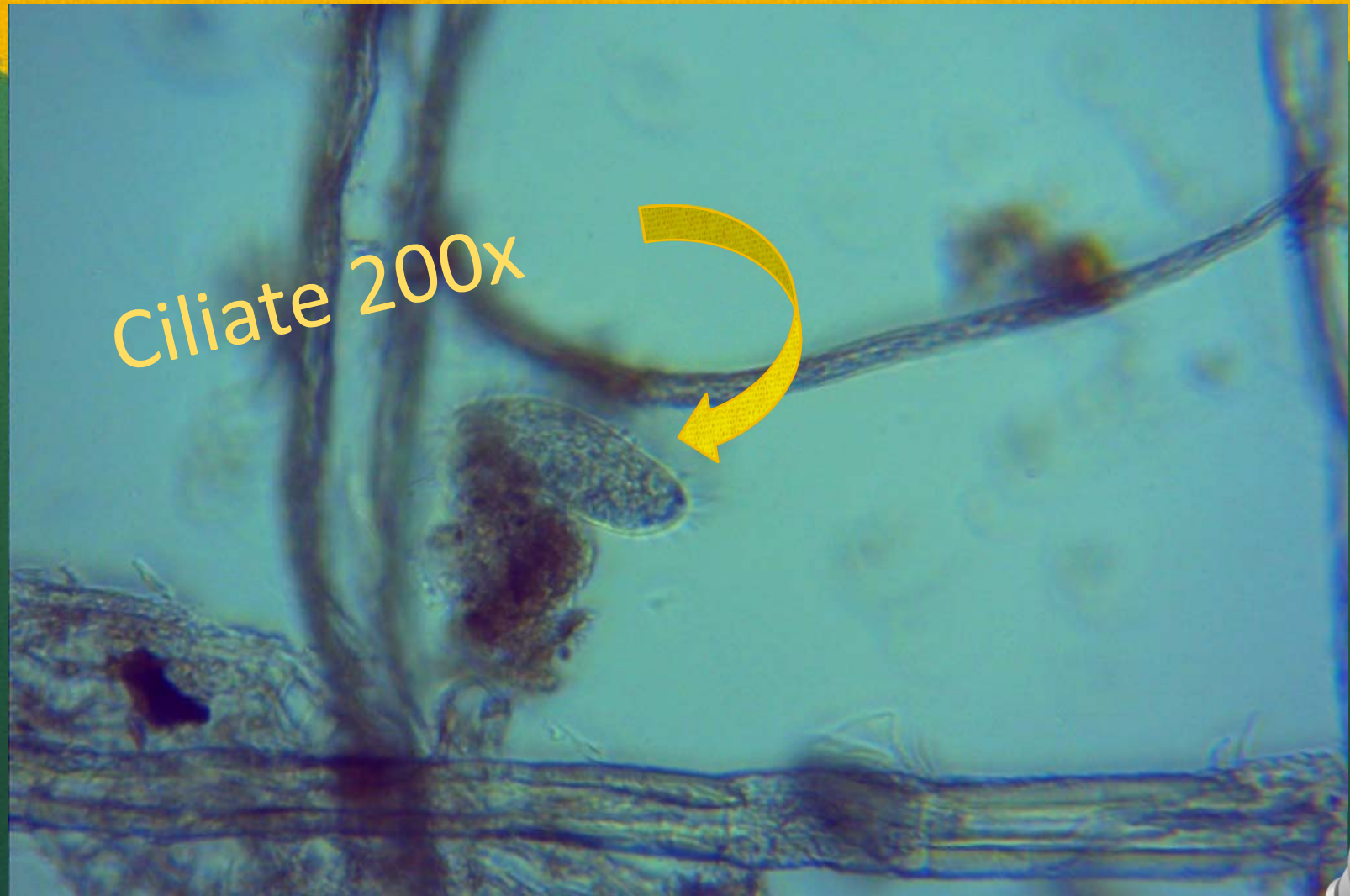


Beneficial Micro-organisms

Microarthropod 100X movie



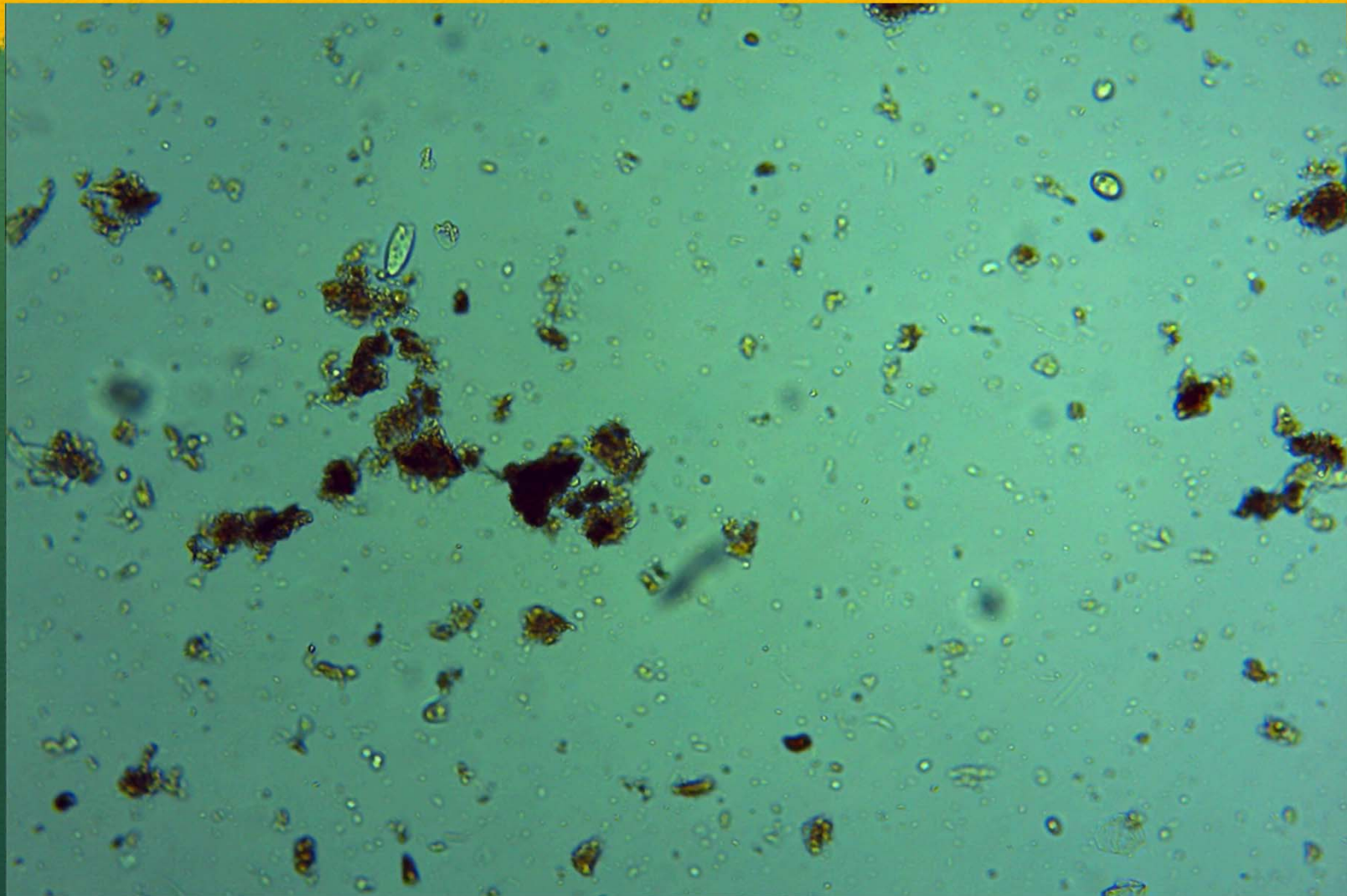
Micro-organisms indicating anaerobic conditions



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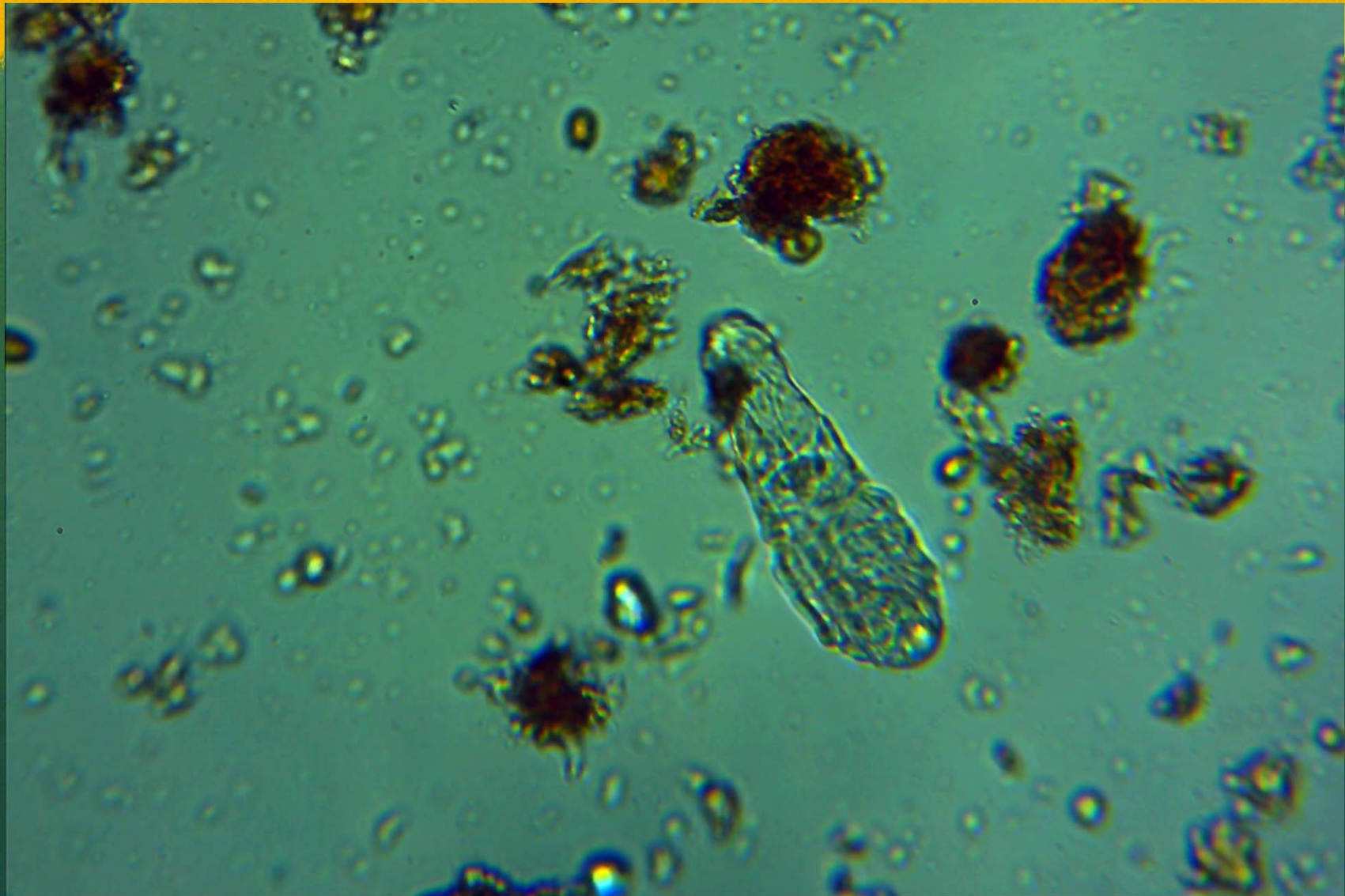
Ciliate 200X

movie



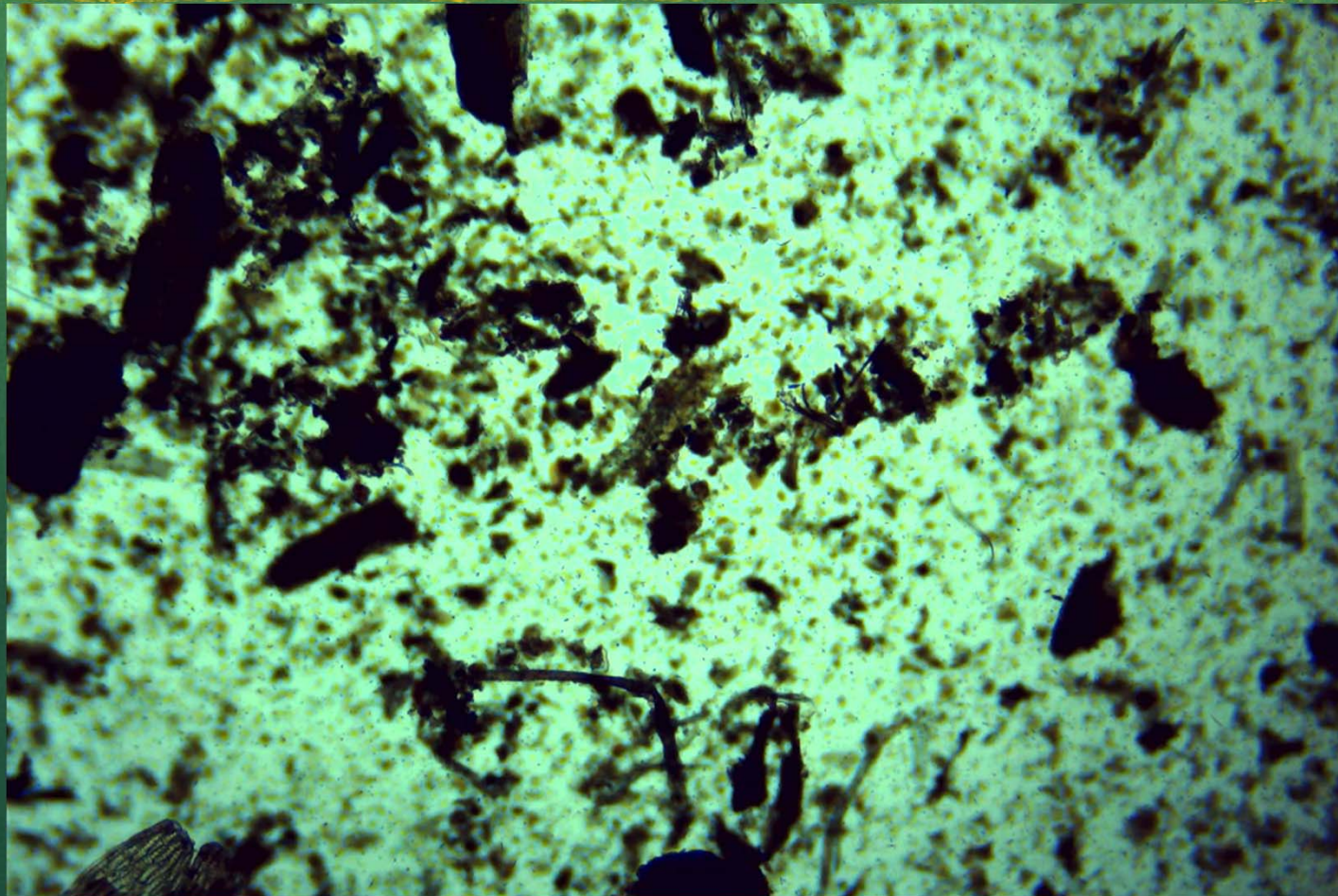
Micro-organisms indicating anaerobic conditions

Insect larvae 200X movie

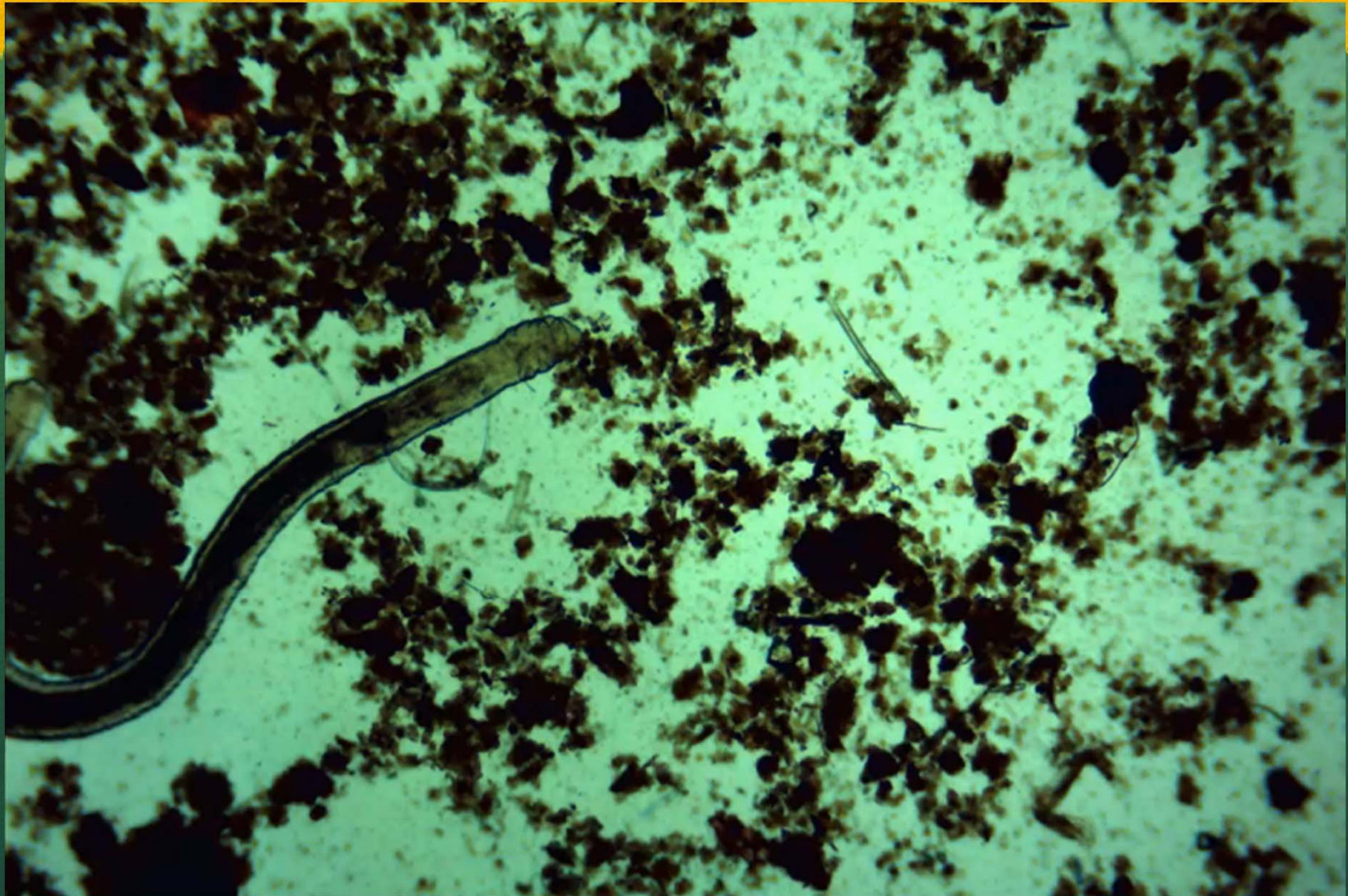


Beneficial Micro-organisms

Nematodes & Microarthropods, can you find them?



Baby pot worm, nematodes & fungal hyphae





Research and Trials

Life in the Soil

Soil with added
Chemical Fertilizer



Organic Soil
With Worm Castings (10%)



May 17th

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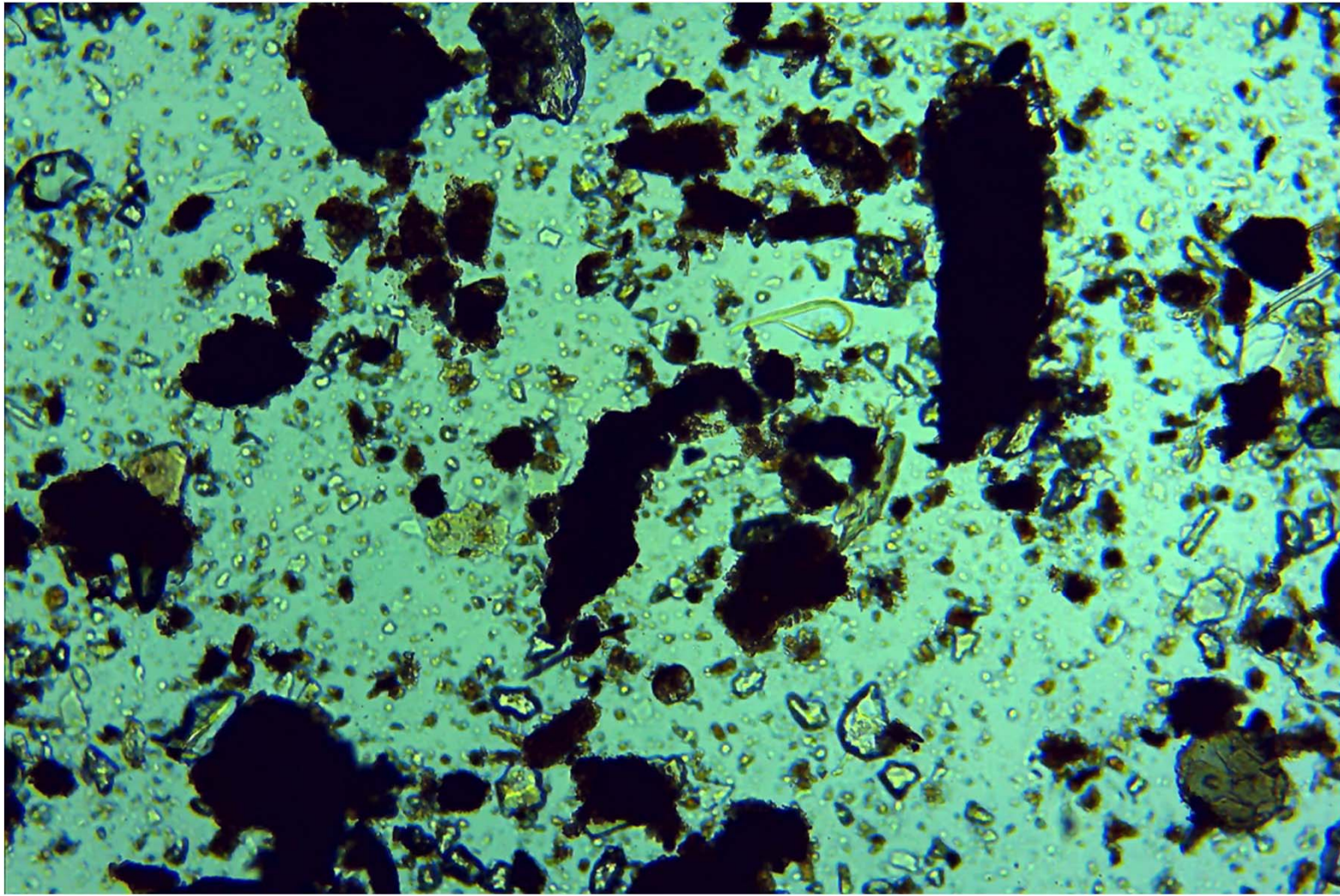
Microscopy

Bagged soil with added chemical fertilizer



Microscopy

Bagged organic soil with 10% worm castings

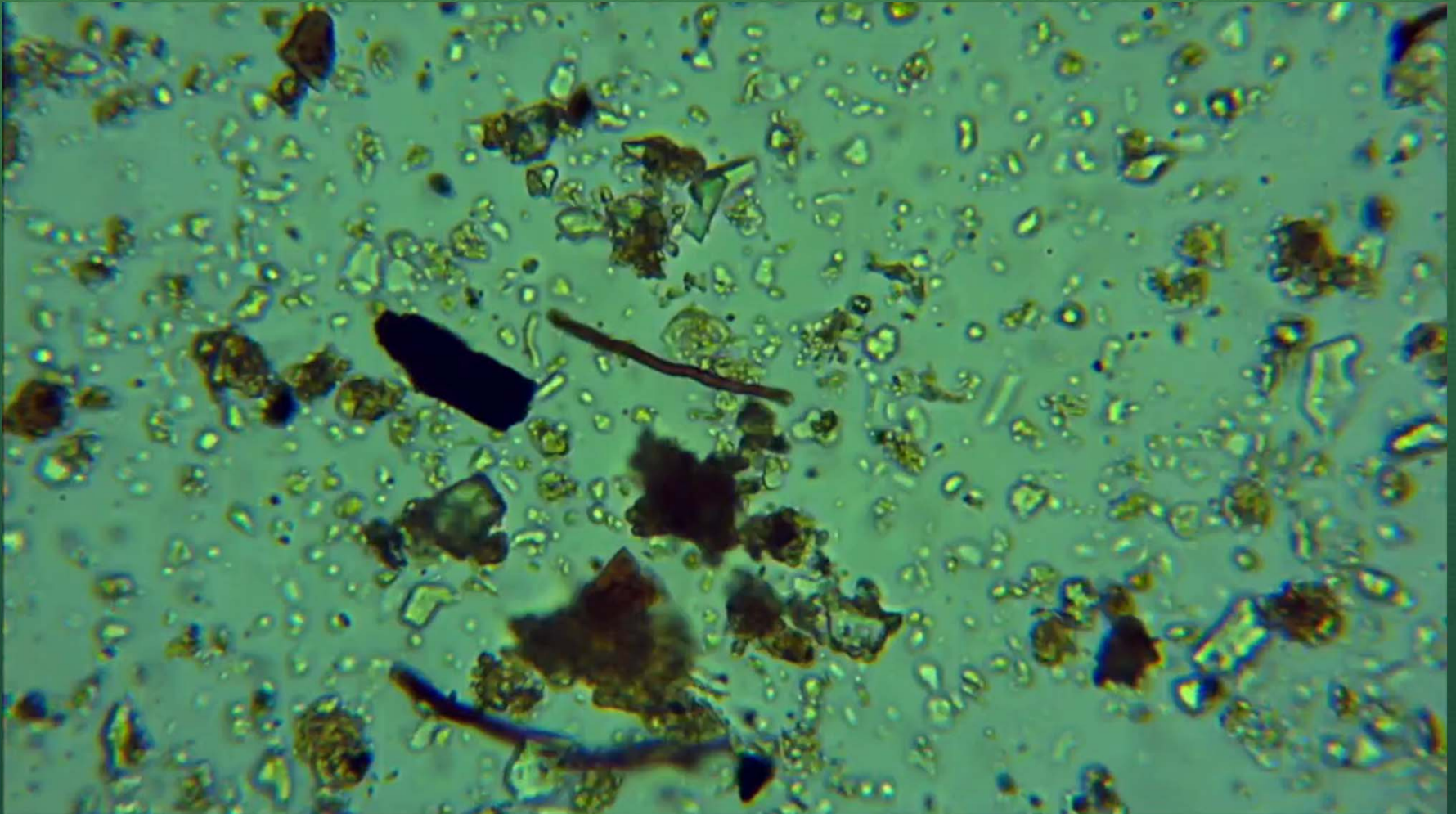


Soil Biology is key to building soil carbon and land health

- Make nutrients (phosphorus, calcium) plant available
- Capture atmospheric nitrogen and fix in soil
- Trigger/support immune response to fight of pests/disease
- Holds nutrients in the soil
- Plant roots exude carbon-rich 'glues' that build soil structure
- Improve speed/quality of composting process

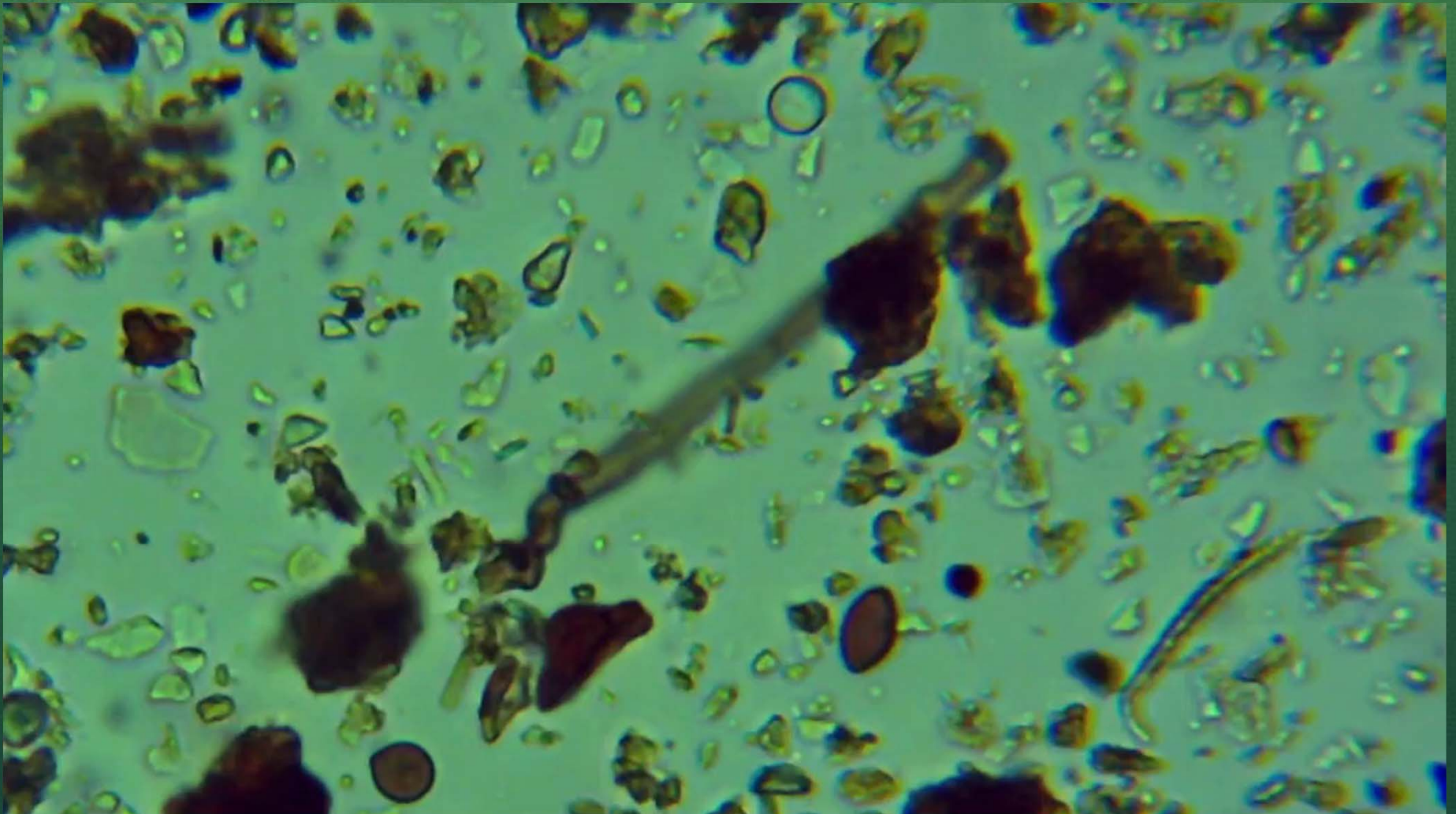
Soil Samples

Diane's Garden - 400x Magnification



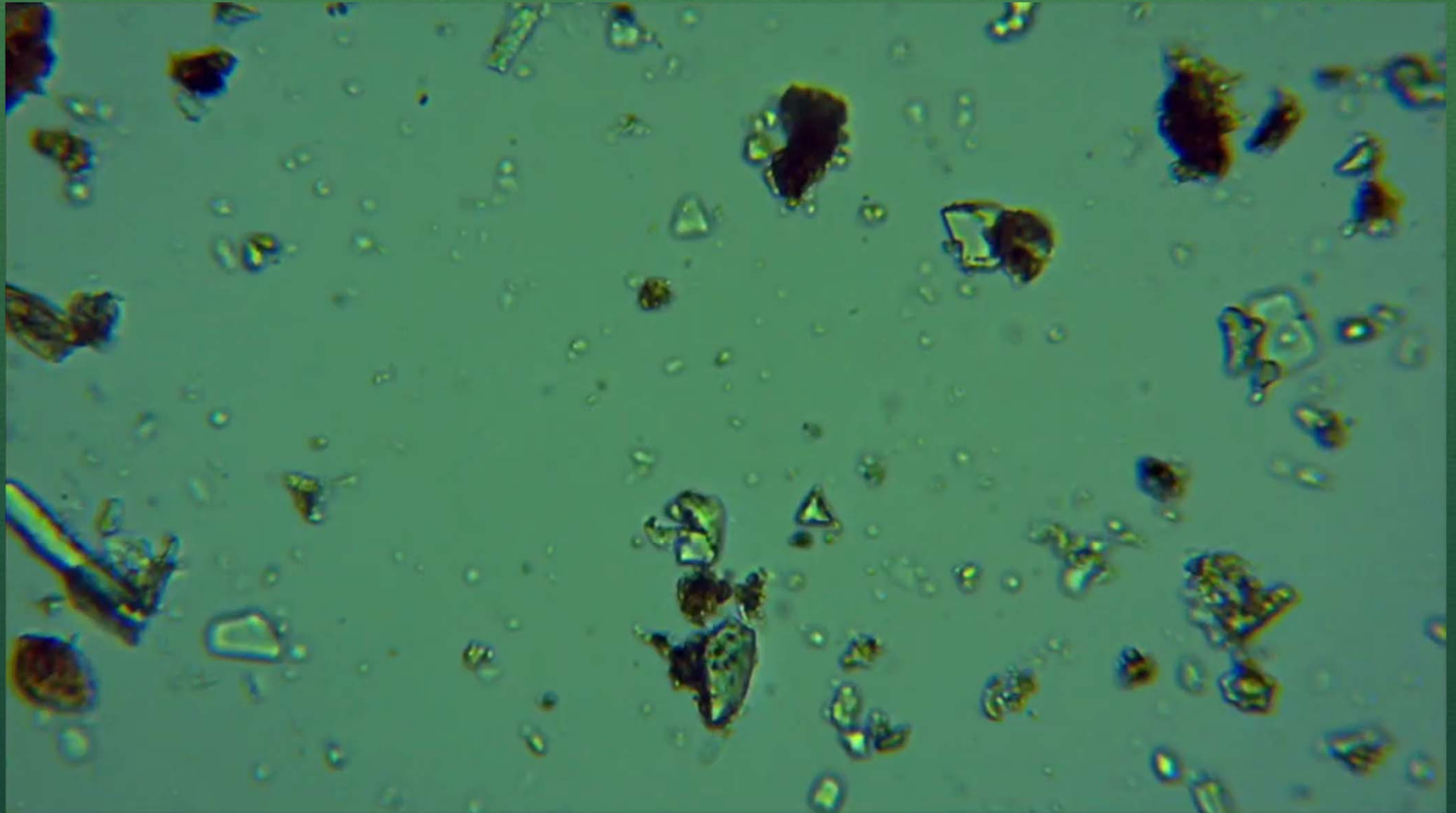
Soil Samples

Jim's Garden - 400x Magnification



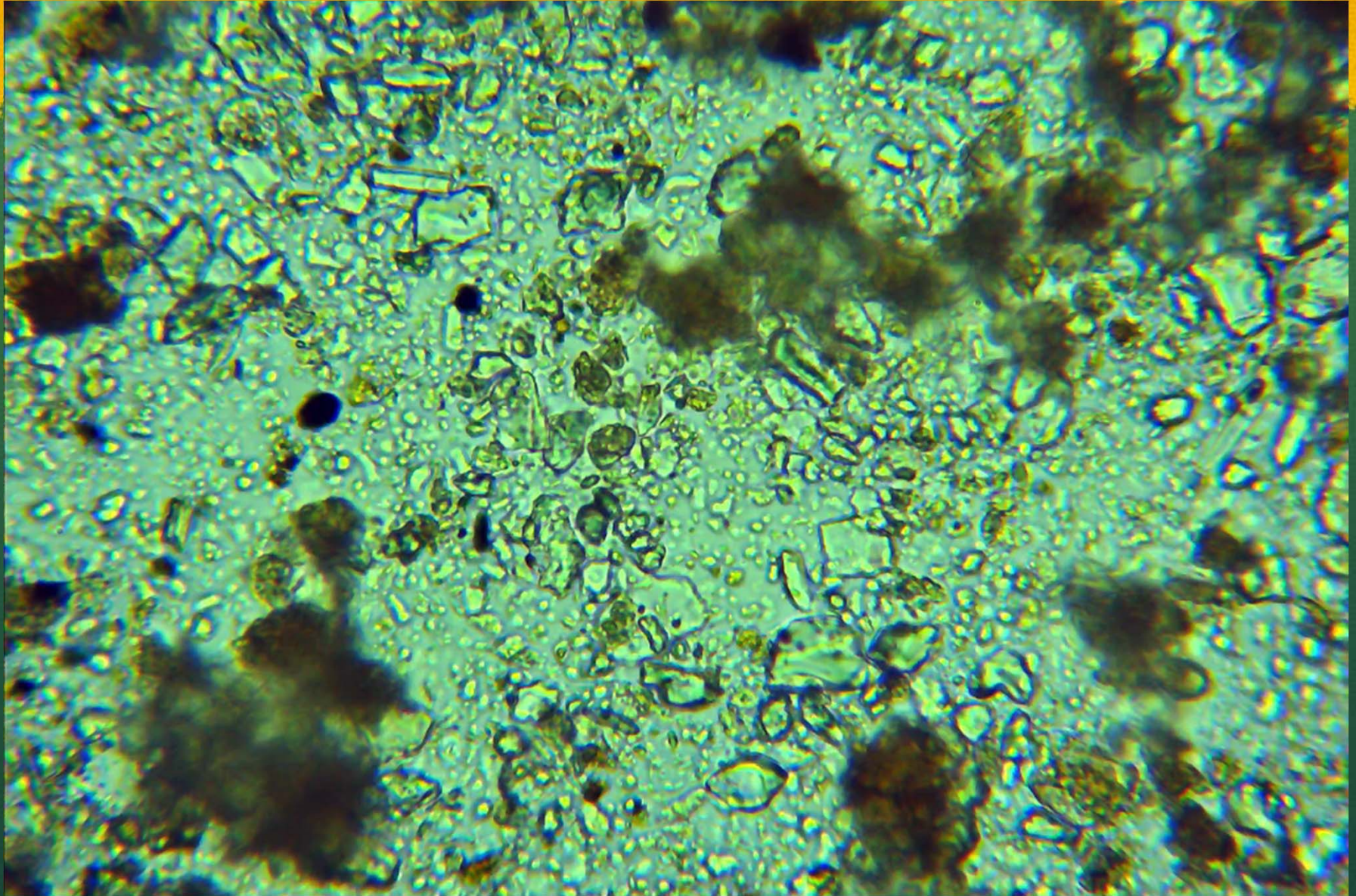
Soil Samples

Shirley's Dahlia Garden

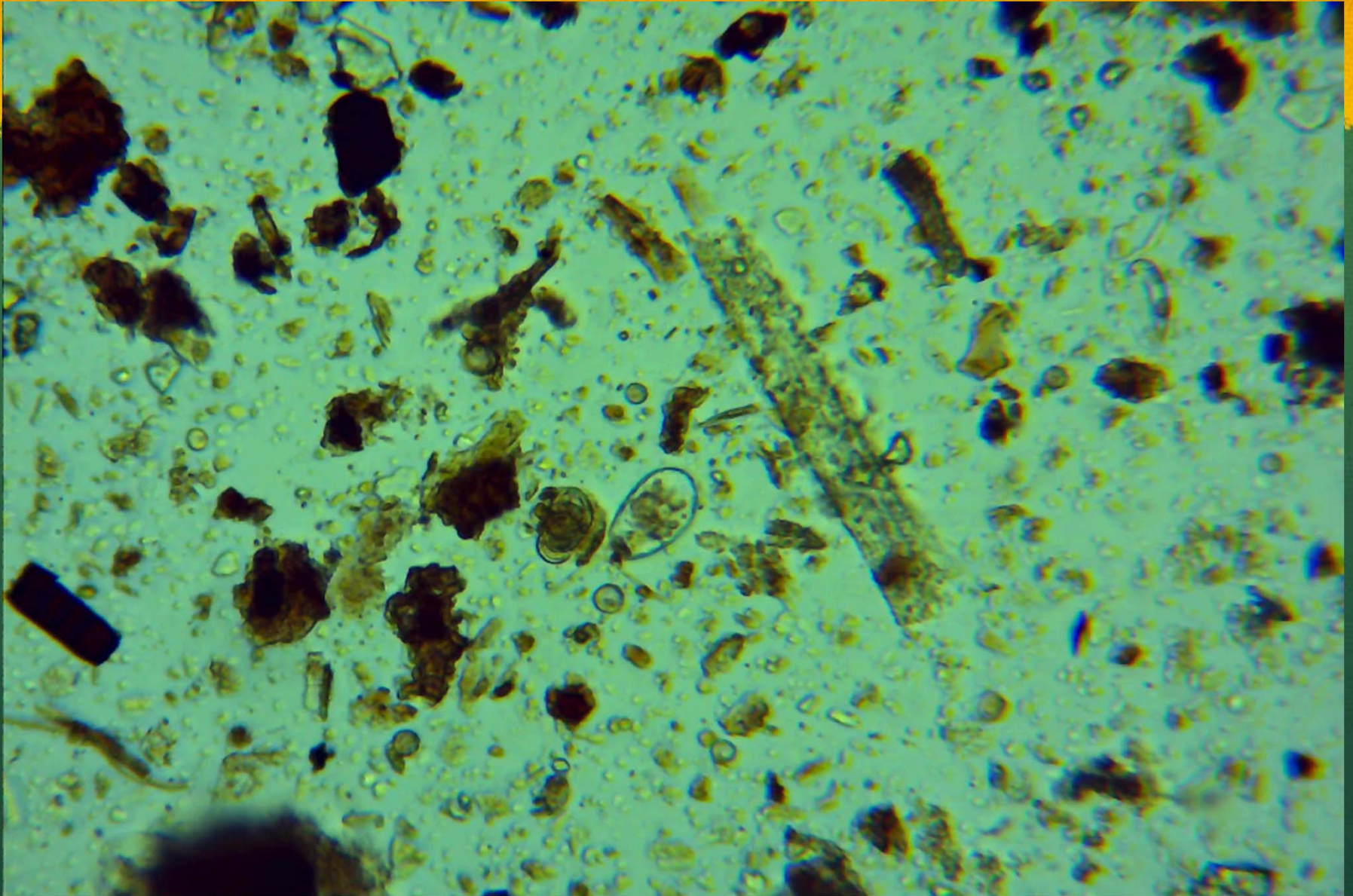


Soil at *The Hickories Farm*

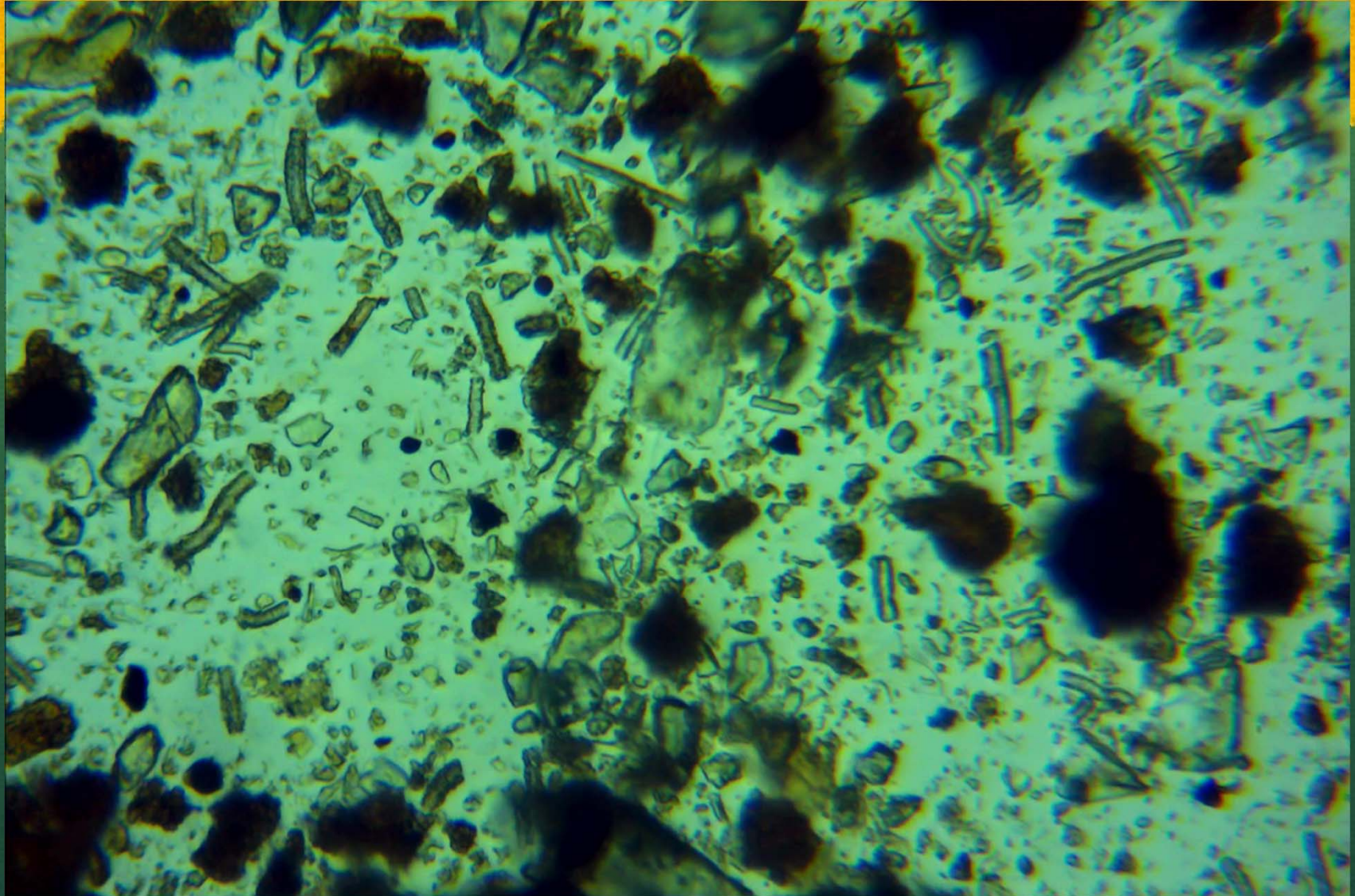
400x Magnification



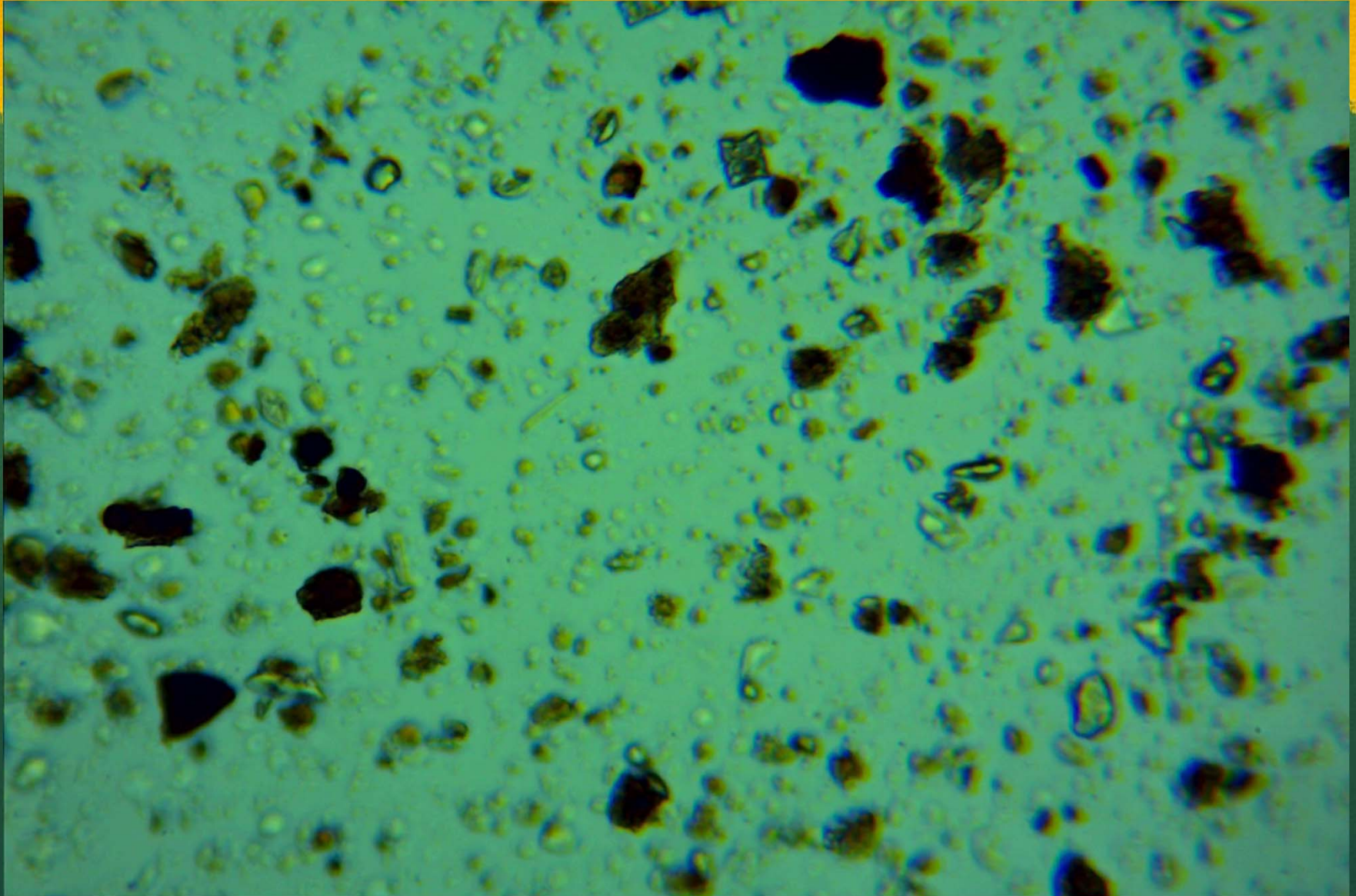
Compost at Hickories Farm



No Till Bed at Assawaga Farm



No Till – Cover Crop - Assawaga Farm



ADDING BIOLOGY

In Soil and Hydroponic Systems

For Conventional, Sustainable and Organic
Plant Growing Systems

*Outdoor Applications and Indoor Controlled Environments
In Soil and Soilless Media*

Elaine R. Ingham, Ph.D.

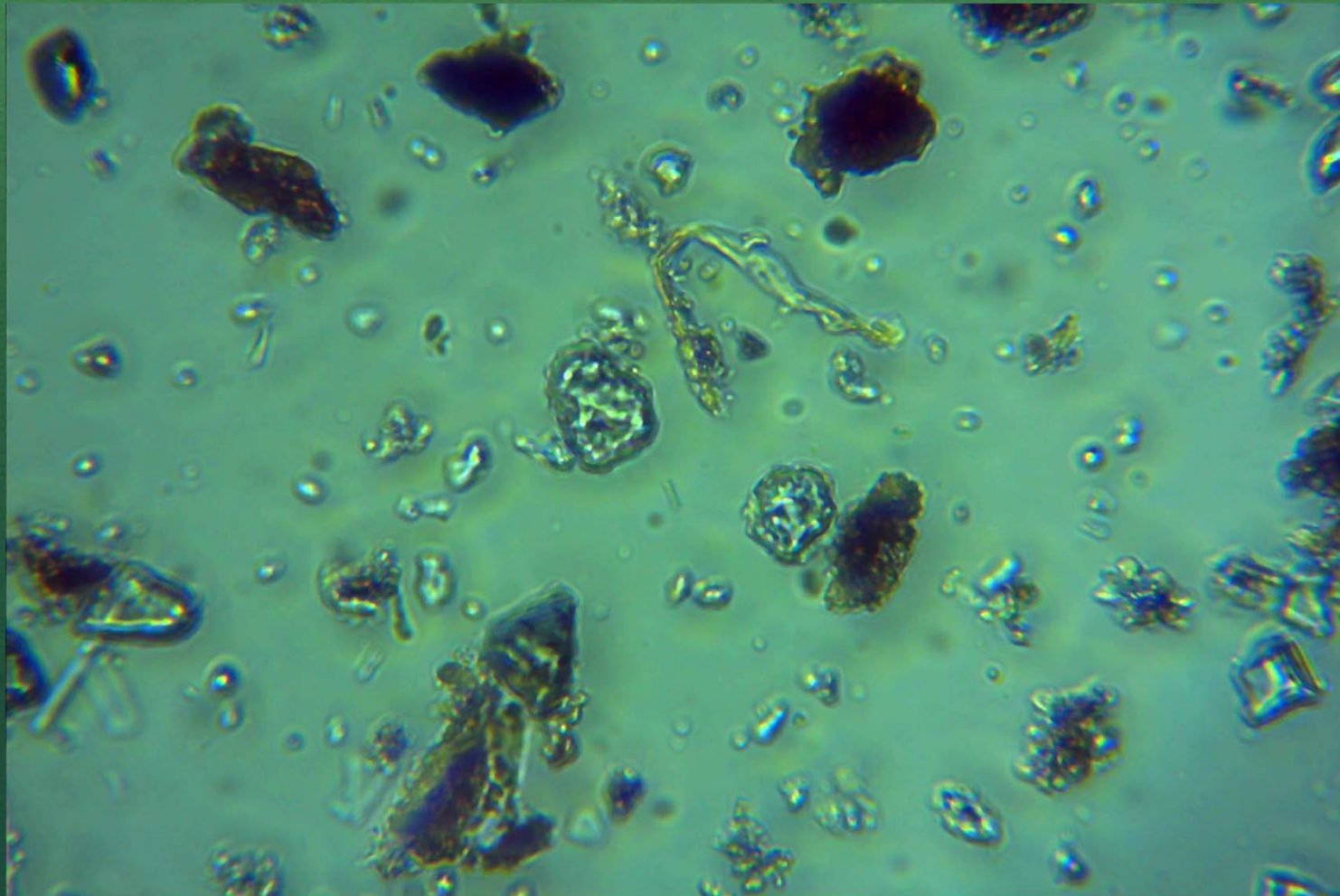
Carole Ann Rollins, Ph.D.

Benefits of Biological Organic Systems

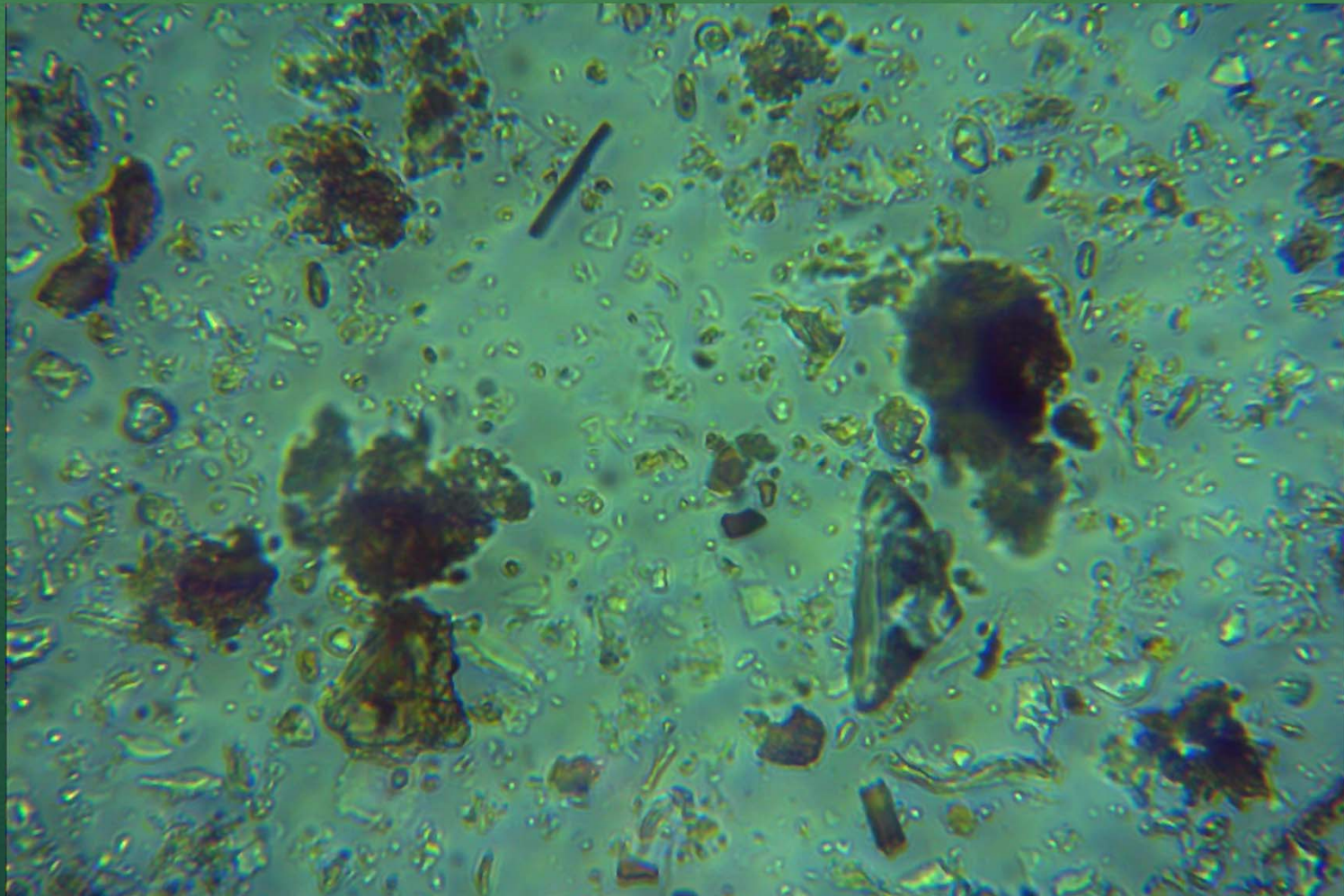
"The only way to get things back in balance is to introduce the full spectrum of beneficial biology back into our growing systems through inocula such as occur in properly made compost, worm castings and compost teas."

Dr. Elaine Ingham

Soil at RWP Botanical Center Control



Soil at RWP Botanical Center Inoculated with Compost Tea 3 weeks earlier



“Essentially all life depends on the soil. There can be no life without soil and no soil without life; they have evolved together.”

Charles E Kellogg,
*USDA Yearbook of
Agriculture*, 1938

