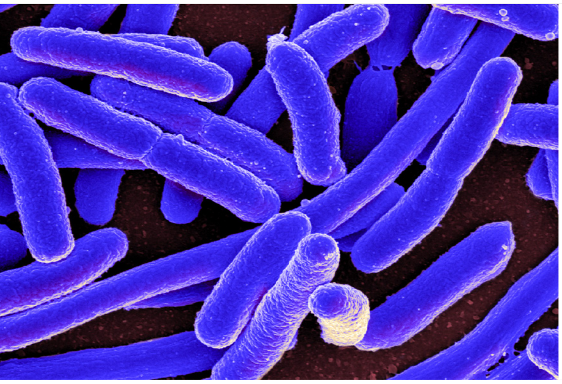
BUL 1041

Soil Insects and Other Arthropods in Palouse Agroecosystems



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Soil Insects and Other Arthropods in Palouse Agroecosystems

Contents

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Introduction

SOILS ARE LIVING, dynamic ecosystems. They support the growth of crops and terrestrial plants and are home to a wide variety of organisms. Most soil organisms are beneficial, but a few can cause plant damage directly or contribute to disease (as pathogens or vectors). Most farmers and members of the agricultural community are familiar with the importance of earthworms and microbes for soil processes. However, because of their abundance and biodiversity and the variety of ecosystem services they provide, soil insects and other arthropods are also important players in the soil ecosystem.

Despite the significant role soil arthropods play in the soil ecosystem, farmers tend not to be very familiar with them. As a result, soil arthropods are rarely considered when producers make agricultural management decisions or investigators conduct agronomic research studies. To begin to address this knowledge gap and to characterize and quantify soil arthropod communities in the region, in 2018–22 we sampled multiple agricultural fields across the Palouse region of the Inland Pacific Northwest (Figure 1). This bulletin summarizes some of our findings and introduces farmers and members of the agricultural community to the region's soil insects and other arthropods.

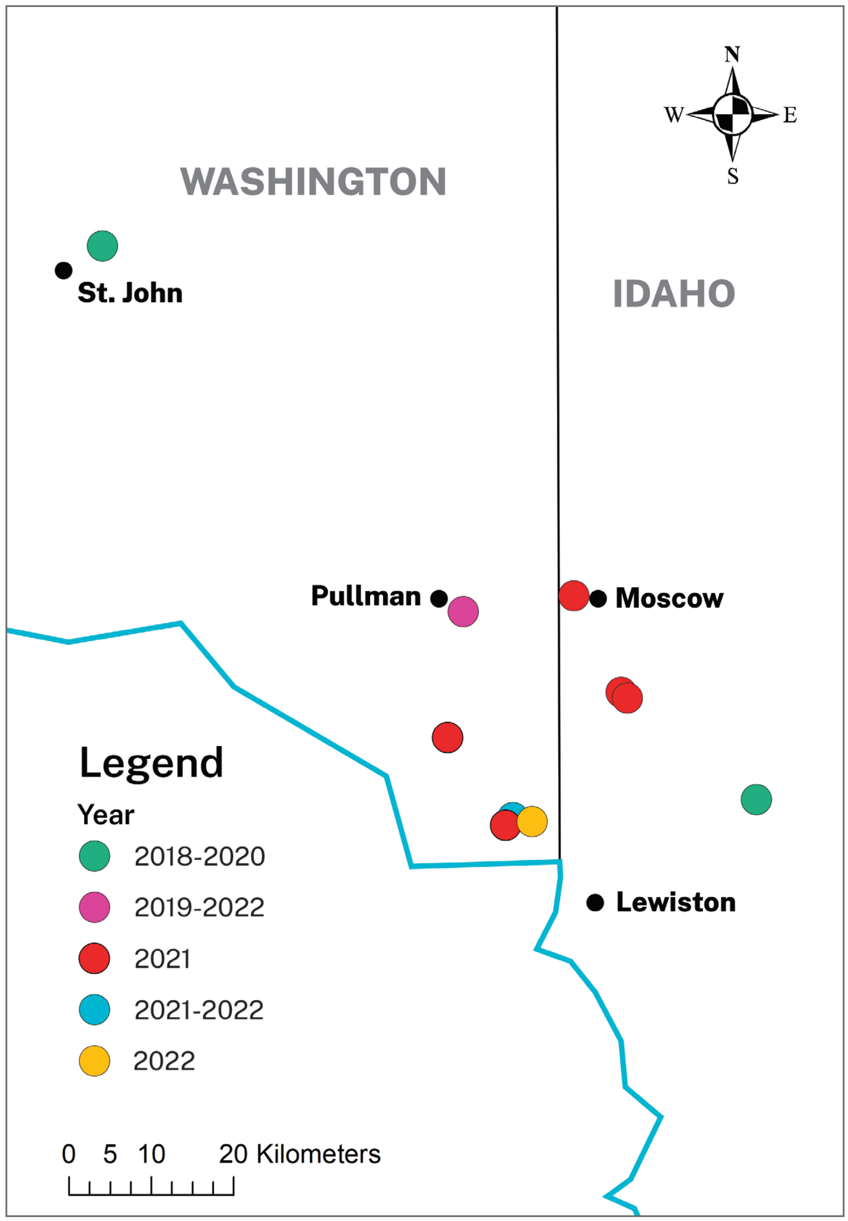

Figure 1. Sampling sites across the Palouse region (2018–22). Courtesy of Subodh Adhikari.

Soil Arthropods

Arthropods are invertebrate organisms that have jointed legs and bodies with a hard exoskeleton. They are the most diverse group of animals on the planet, both above- and belowground. Approximately 23% of all described organisms live in the soil and of those 85% are arthropods that live all or part of their lives there (Decaëns et al. 2006). The most abundant soil arthropods are mites (Acari) and springtails (Collembola). Other soil arthropods include centipedes and their relatives (myriapods), ants, spiders, sow bugs and pill bugs (isopods), beetles, two-pronged bristletails (diplurans), coneheads (proturans), and pseudoscorpions.

Soil arthropods are often categorized, based on size, as either mesofauna (> 0.1–< 2.0 mm body width) or macrofauna (>2.0 mm body width) (Figure 2). Another way to categorize them is as broad functional groups, based on what they eat (e.g., decomposers and microbe-eaters, predators, herbivores). Both categorizations provide insight into the potential functional roles of soil arthropods and the ecosystem services they provide. These services include litter breakdown, carbon and nitrogen nutrient cycling, pest and disease suppression, microbe dispersal, and primary productivity. In the following subsections, we describe three important functional groups of soil arthropods with examples collected from Palouse agricultural soils (Figures 3–5).

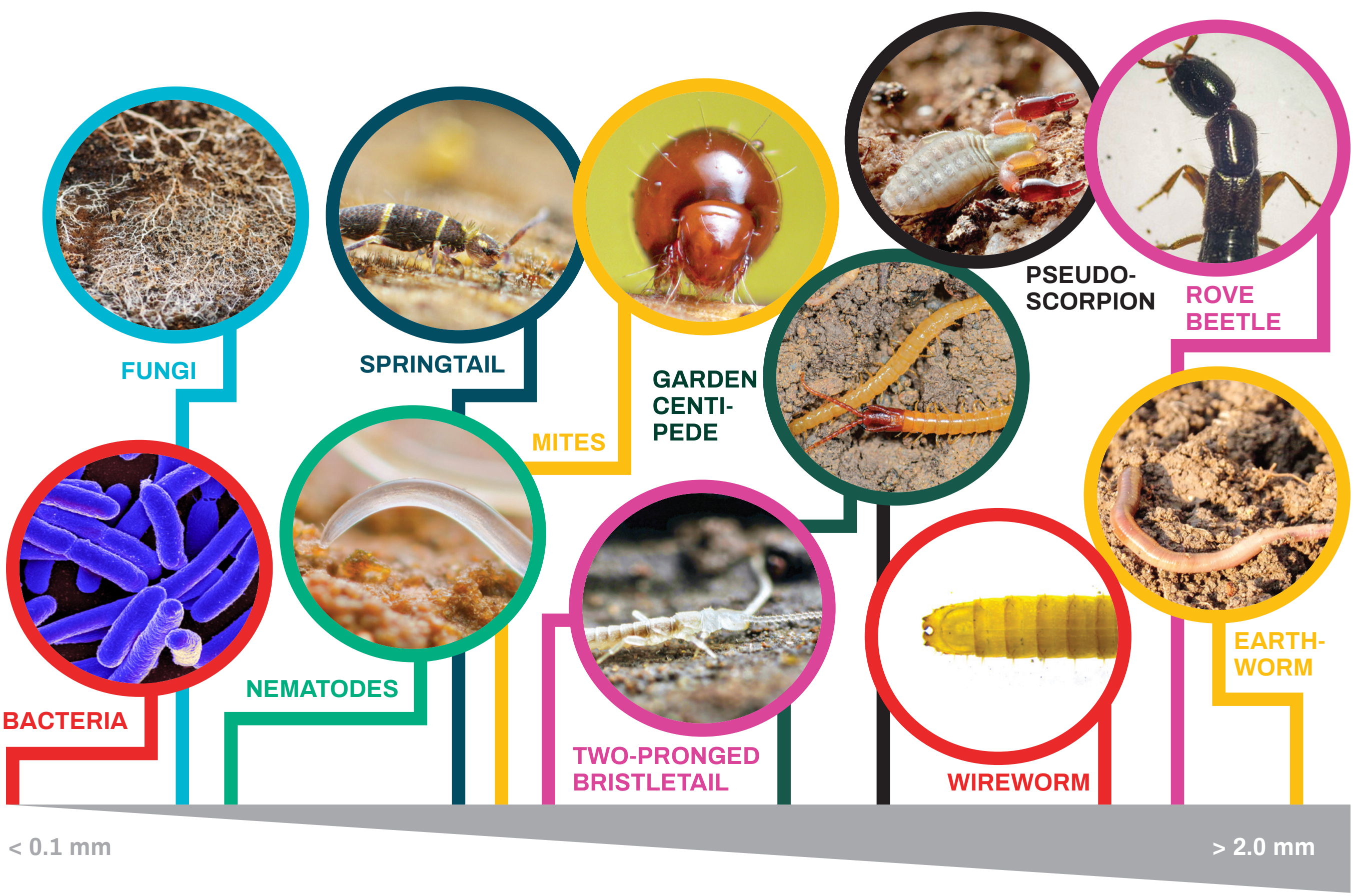

Figure 2. Soil organisms categorized by body width.

Decomposers and Microbe-Eaters

Many soil arthropods that live in Palouse agricultural soils are decomposers and microbe-eaters (Figure 3). Decomposition is the physical and chemical transformation of plant litter into simpler molecules and nutrients. Decomposers fragment and shred plant litter, increasing its surface area and improving litter quality for microbes to continue its transformation. Litter breakdown is especially important in reduced-till systems that leave plant debris on the soil surface. Decomposers alter nutrient availability in the soil and influence crop productivity. For example, the feces of springtails may contain more than forty times the concentration of nitrate-nitrogen than the food material they feed upon (Teuben and Verhoef 1992).

Arthropod effects on nutrient cycling also manifest through their interactions with microbes. Springtails and some mites eat soil fungi and bacteria. Their feeding results in increased mobilization of plant-available nutrients. Microbe feeding by soil arthropods helps to regulate the rate of microbial decomposition in a controlled and continuous manner, thus reducing the risk of nutrient loss from agricultural soils (Culliney 2013). Soil arthropods also influence the makeup of microbial communities and affect their functions. Active decomposers, like two-pronged bristletails, act as "microbe shuttles," moving bacteria and fungi within the soil.

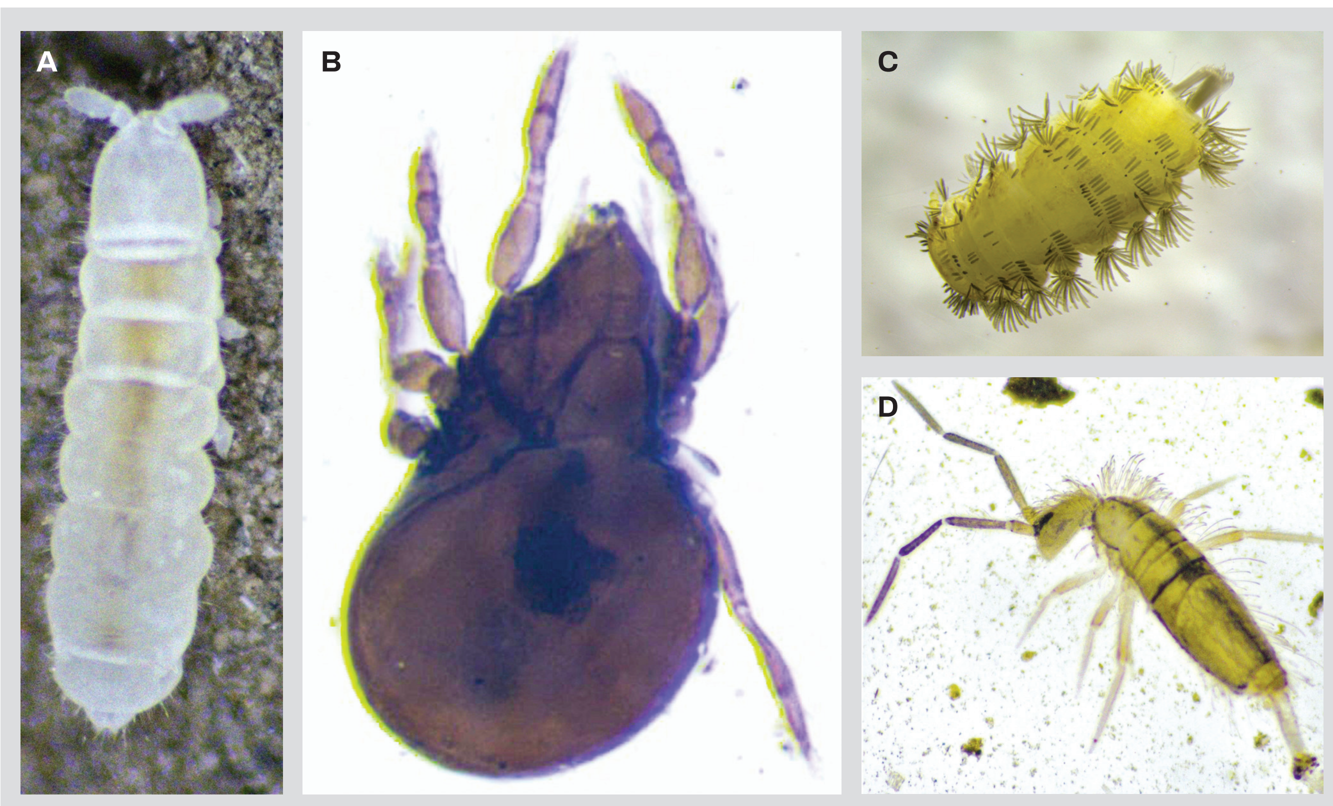

Figure 3. Decomposers and microbe-eaters collected from Palouse agroecosystems. **A**, Collembola: Onychiuridae (springtail); **B**, Acari: Oribatida (oribatid mite); **C**, Polyxenida: Polyxenidae (duff millipede); **D**, Collembola: Entomobryidae (springtail). Photos B and C courtesy of Kaya Labanon, University of Idaho.

Predators

Predators, also known as natural enemies, kill and eat other organisms for food (Figure 4). Conserving and promoting predators in agricultural soils can boost the potential for the biological control of pests, a key ecosystem service. Several soil arthropods are generalist predators, meaning they are not picky about what they eat. Many mites are voracious predators with fascinating hunting and feeding styles. They pierce their prey and inject enzymes to liquify their tissues before sucking them dry. Some snout mites shoot sticky silk strands from their snouts to capture prey. Predatory beetles are also important as generalist natural enemies of pests in soil. Immature and adult rove beetles (Staphylinidae) and immature soft-winged flower beetles (Melyridae) are abundant predators in Palouse agricultural soils.

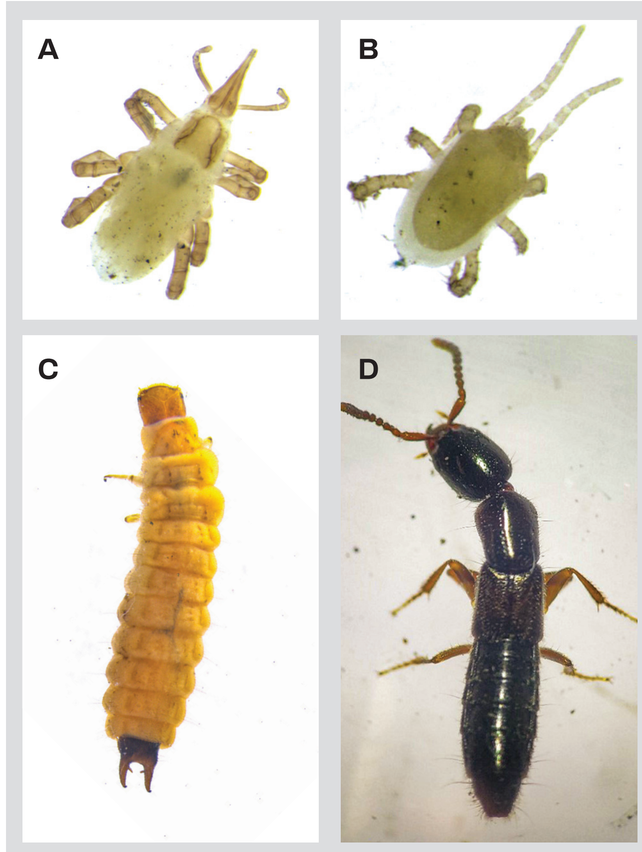

Figure 4. Predators collected from Palouse agroecosystems. **A**, Acari: Prostigmata (snout mite); **B**, Acari: Mesostigmata (predatory mite); **C**, Coleoptera: Melyridae (soft-winged flower beetle larva); **D**, Coleoptera: Staphylinidae (rove beetle adult). Photos A–C courtesy of Kaya Labanon, University of Idaho.

Herbivores

Herbivores consume plant material and can be pests in agroecosystems (Figure 5). Symphylans, commonly called garden centipedes (even though they are not true centipedes), are the most abundant myriapods in Palouse agricultural soils. They feed on roots and seeds and can become pestiferous if populations reach high densities, which can occur in managed systems when their populations are not controlled by other organisms (i.e., natural enemies). Wireworms (Elateridae), the immature stage of click beetles, are familiar belowground pests on the Palouse. Wireworms attack many different crops but are most important on the Palouse as pests of cereal grain crops. The larvae can spend several years in the soil feeding on germinating seeds and young seedlings. Please visit the Pacific Northwest Insect Management Handbook for details on the management of symphylans and wireworms.

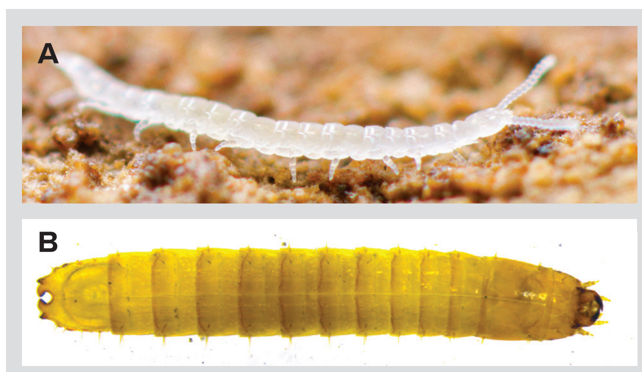

Figure 5. Herbivores collected from Palouse agroecosystems. **A**, Symphyla: Scutigerellidae (garden centipede); **B**, Coleoptera: Elateridae (wireworm larva). Photo A courtesy of Andy Murray, https://www.chaosofdelight.org/. Photo B courtesy of Kaya Labanon, University of Idaho.

Soil Arthropods in Palouse Agroecosystems

From 2018 to 2022, multiple fields across the Palouse region of the Inland Pacific Northwest were sampled to evaluate their soil arthropod communities (Figure 1). Researchers collected them from the 0.0 to 4.7–inch soil layer, where most biological activity in agricultural soils occurs. They extracted them from the soil samples with Berlese-Tullgren funnels, which rely on heat and light to dry a sample. Forced down the soil profile, the arthropods were eventually collected in a preservative (95% ethanol) within which they underwent microscopic examination. Through June 2022, researchers collected and identified 118,626 soil arthropod individuals from over 900 samples. Figure 6 shows the general community makeup of soil arthropods in Palouse agricultural soils.

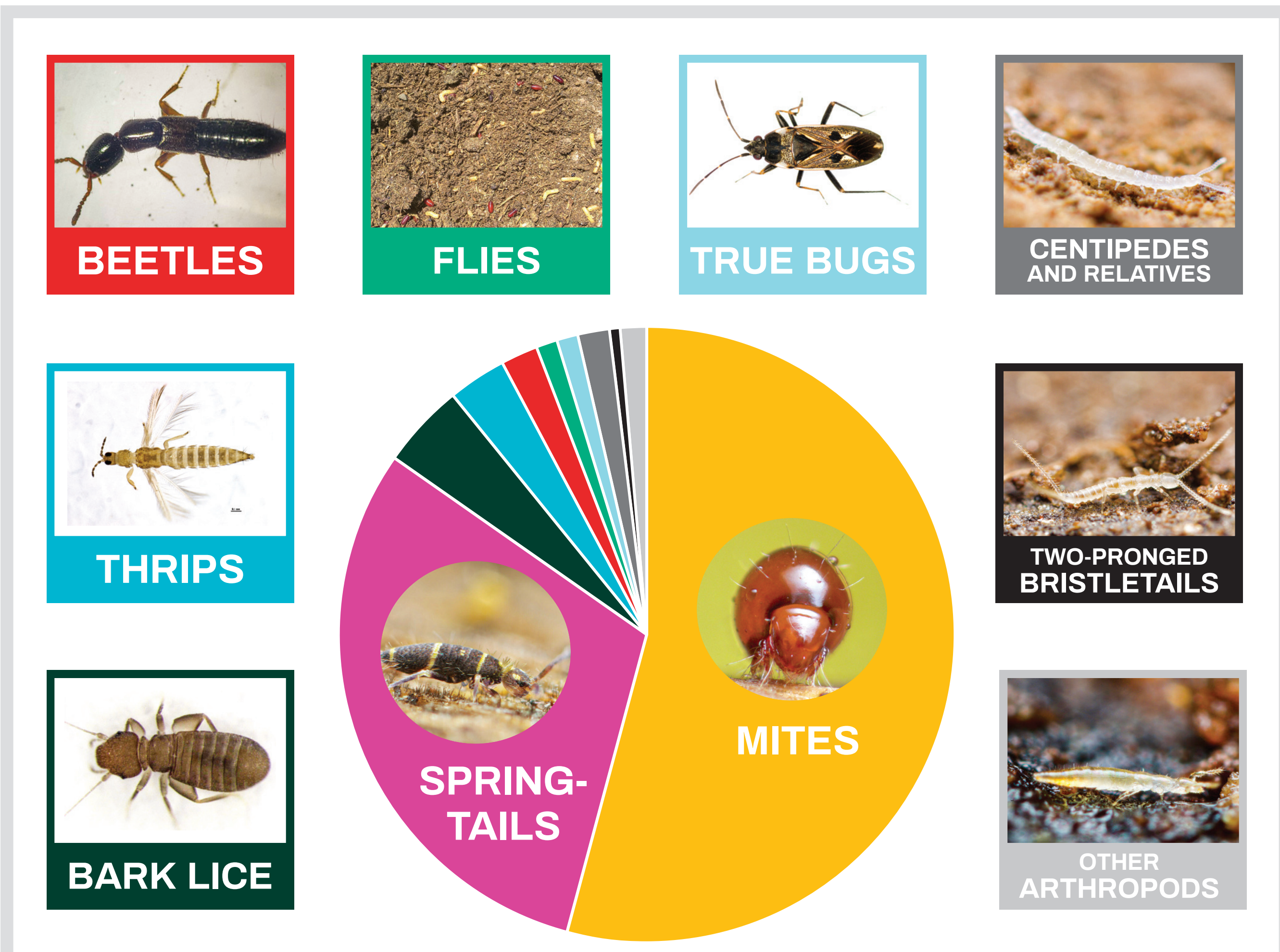

Figure 6. Community makeup of soil arthropods collected from Palouse agroecosystems (2018–22). Total number of arthropods collected, 118,626. Mites: 54%, springtails: 31%, insects: 12%, centipedes and relatives: 2%, other arthropods (conehead pictured): 1%. Approximately 5.7% of all soil arthropods collected could be considered pests.

Approaches to Managing Soil Arthropods

One approach to managing soil arthropods is through the use of cover crops. Producers on the Palouse are increasingly interested in incorporating cover crops into traditional rotations. They provide benefits that include nitrogen fixation, weed control, nutrient retention, water infiltration, and reduction of water- and wind-driven soil erosion. Cover crops also promote soil arthropod biodiversity. In a collaborative on-farm study with farmers on the Palouse, researchers discovered that multispecies cover crops (3–13 species) foster soil arthropod diversity and abundance more than typical spring crops, including chickpea, barley, and spring wheat (Figure 7).

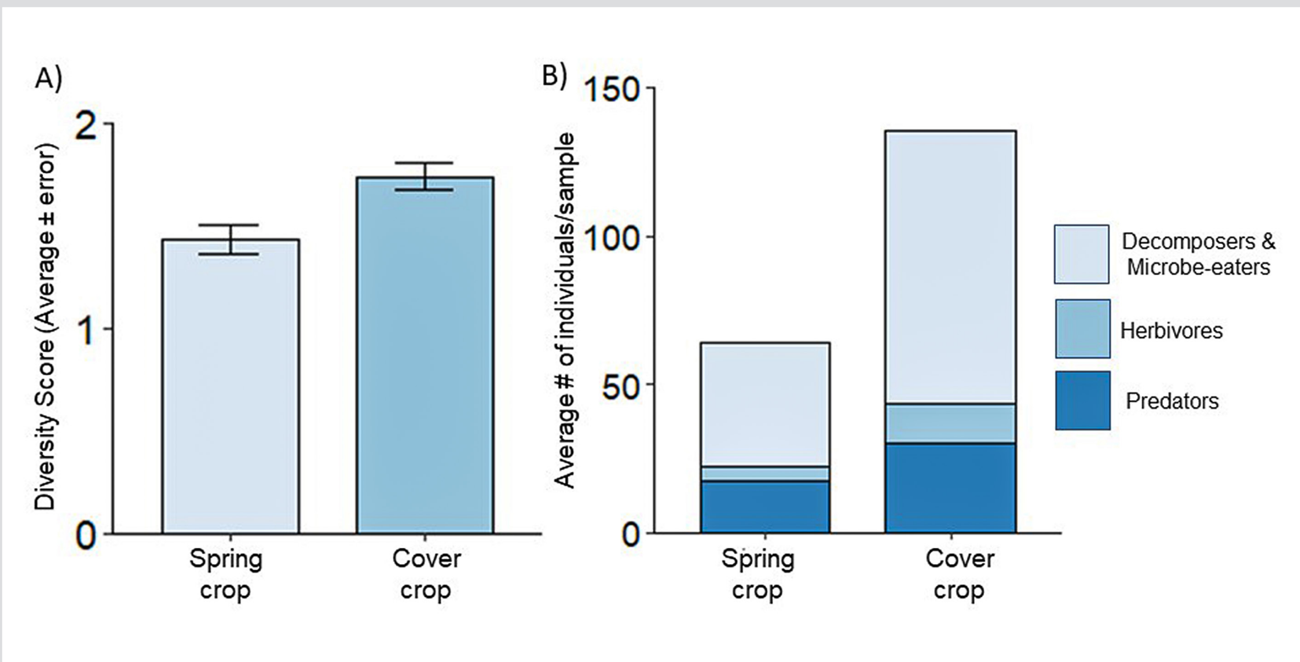

Figure 7. Effects of cover crops and spring crops on the **A**, diversity, and **B**, abundance of soil arthropods collected from six large-scale, commercial farms. The diversity score is a measurement that considers both the number of species (richness) and abundance of each species (evenness) in a community.

Summary

- Arthropods are an important but understudied group of soil organisms. They regulate processes in the soil that affect the delivery of ecosystem services tied to soil health and agricultural productivity.
- Recent and ongoing research is attempting to identify avenues to manage these communities and understand their contributions to crop production on the Palouse.
- There is potential for producers on the Palouse to manage their soil arthropod communities with cover crops. Cover crops utilized on large-scale commercial farms promote soil arthropod abundance and biodiversity more than the spring-planted crops they might replace in rotation.
- Consider soil arthropods when making agricultural management decisions. Promoting the abundance and biodiversity of soil arthropod communities contributes to the development of sustainable and resilient agroecosystems across the Palouse.

Further Reading

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Xerces Society for Invertebrate Conservation. Farming with Soil Life: Online Short Course. YouTube video series.

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