

Pocket ID Guide to Invertebrates of Urban Soils



XERCES SOCIETY
for Invertebrate Conservation

INTRODUCTION

About 25% of all known organisms on the planet are animals that live in the soil through all or a portion of their lives. The overwhelming majority of soil animals are those without backbones, i.e., invertebrates. These soil-dwelling invertebrates interact with microbes, plants, and each other, forming the life of healthy soils.

ECOLOGICAL & AGRICULTURAL ROLES / IMPORTANCE

Soil invertebrates play a number of important roles:

- » **DECOMPOSERS** feed on dead plant and animal materials, breaking them down into smaller fragments that are available for bacteria and fungi for further decomposition, releasing nutrients into the soil, now accessible for plants to use.
- » **SOIL ENGINEERS** burrow or tunnel through the soil, influencing soil structure and helping to move water and air to deeper soil layers. Soil engineers influence soil fertility by mixing nutrients and minerals between soil layers and influence microbial communities by dispersing microorganisms throughout soil layers.
- » **PREDATORS** hunt and consume other animals. They help to regulate population sizes of crop pests and can contribute significantly to controlling them.
- » **HERBIVORES** consume living plant material, feeding on roots or aboveground vegetation. Some herbivores specialize in eating a particular part of a plant, a particular plant species, or closely related groups of plants, while others feed on a wide range of plants.
- » **POLLINATORS** transfer pollen between flowers, contributing to plant reproduction. The seeds and fruits that are the product of pollination are important food sources for a variety of wildlife, as well as for people.

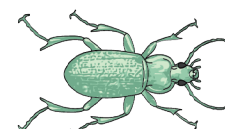


FIG. 1: Ground beetle adult; size: 18 mm (0.71")



FIG. 2: Wireworm; size: 28 mm (1.1")

A NOTE ABOUT SIZE

Size refers to the range of body length for the group. It does not include appendages, such as legs or antennae. Shown: ground beetle adult [FIG. 1], wireworm [FIG. 2].

- » Hunting techniques may be to lie in wait, or to actively follow prey
- » Move with targeted, controlled jumps to get around and to attack prey
- » Jumping spiders reposition themselves to get a better look at what they are interested in—which could be you!

WOLF SPIDERS (FAMILY LYCOSIDAE)

A few species make burrows, but most wolf spiders are wanderers without a fixed home or nest site. They do not build webs and hunt as they roam. Wolf spiders are regularly seen in human structures like sheds, garages, or homes, and can be relatively large for temperate North American spiders.

KEY FEATURES [FIG. 5]:

- » Brown and black; velvety appearance
- » 1 pair of larger eyes; 2 pairs of smaller eyes on the "face"; 1 pair of smaller eyes on sides
- » Females carry and protect egg sacs and young spiderlings



FIG. 5: Wolf spider, 3–35 mm (0.12–1.4")

WEB-BUILDING SPIDERS (FAMILIES HAHNIIDAE, AGELENIDAE, ATYPIDAE, CLUBIONIDAE)

Several groups of ground-dwelling spiders build webs near the soil surface to trap the animals they eat. These spiders often hide out of sight near their web, which makes them difficult to observe. However, the type of web is an indication of the type of spider, as their name implies.

These include dwarf sheet spiders (Hahnidae), sac spiders (Clubionidae), and funnel weavers (Agelenidae). Purseweb spiders (Atypidae) construct vertical tubes of silk, usually at the base of rocks or trees, within which they wait and ambush prey, pulling them into the tube [FIG. 6].



FIG. 6: LEFT—Funnel weaver spider web; RIGHT—Purseweb spider web

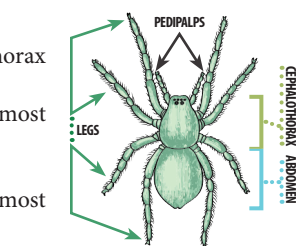


FIG. 3: Spider body plan example

SPIDERS

ROLE: Predators

Spiders are diverse, widespread, and effective predators of insects and other invertebrates, including other spiders. All can make silk, but many do not use webs to catch food. Relatives include scorpions, mites, and harvesters ("daddy longlegs").

KEY FEATURES [FIG. 3]:

- » 2 body regions: combined head/thorax ("cephalothorax") and abdomen
- » 2 jaws with fangs (not shown) that, in most species, can inject venom
- » Straw-like mouth; eat liquid food only
- » Eyes: Usually 8, but sometimes 6 or fewer; most hunt by vibration or touch, not sight
- » 10 limbs (8 walking legs, 2 "arms" called pedipalps), all attached to the cephalothorax
- » Spinnerets (not shown), attached to abdomen, produce silk; number and size vary

JUMPING SPIDERS (FAMILY SALTICIDAE)

About 13% of all known spiders are jumping spiders. They have powerful vision for sensing movement, detail, and distance, related to their distinctive eye pattern. They do not build webs, instead using silk to anchor and steer their jumps, return to a spot, and extend their reach to prey. They live and hunt on the soil surface, and on plants and other structures, and actively hunt almost always by day to take advantage of their excellent eyesight.

KEY FEATURES [FIG. 4]:

- » Typically covered in short bristly hairs; some with metallic coloring under the hairs
- » Front of cephalothorax is a rectangular "face" with a central pair of larger eyes flanked by a 2nd pair of smaller eyes; 2 more pairs of eyes are behind and above these front pair



FIG. 4: Jumping spider, 3–25 mm (0.25–1"); with plant bug prey

ACKNOWLEDGMENTS

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under agreement number 2021-38640-34714 through the North Central Region SARE program under project number ENC21-205. USDA is an equal opportunity employer and service provider. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

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ABBREVIATIONS

cm	Centimeter(s)
FIG.	Figure(s)
mm	Millimeter(s)



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MYRIAPODS & ISOPODS

MILLIPEDES (CLASS DIPLOPODA)

ROLE: Soil Engineers; Decomposers

Millipedes are found within moist areas, such as upper soil layers, the leaf layer, or under bark pieces on the soil, stones, or logs, where they eat decaying vegetation and other detritus. Some species excavate deep tunnels. Immatures look like smaller versions of the adults, with fewer segments and legs.

KEY FEATURES [FIG. 7]:

- » Black, brown, or gray, sometimes with brightly colored legs or patterns
- » Elongated, segmented bodies; at least 20 segments
- » Short, elbowed antennae; 1 pair
- » Chewing mouthparts
- » 2 pairs of legs on each body segment; attached to underside of segment
- » Some species are bioluminescent; others can coil their bodies or roll into a ball



FIG. 7: Millipedes have 2 pairs of legs per body segment, 2–165 mm (0.12–6.5") [most are 50–60 mm (2.0–2.4")]

NOTE: If handling millipedes, note that they may secrete a toxin that deters predators; this toxin is not poisonous to people, but should be washed off skin to avoid possible irritation.

CENTIPEDES (CLASS CHILOPODA)

ROLE: Predators

Centipedes are found in deep or shallow soil layers, in the leaf layer, or under bark pieces on the soil, stones, or logs. Centipedes are primarily active at night, hunting other arthropods and earthworms. Immatures look like smaller versions of the adults, sometimes with fewer segments and legs.

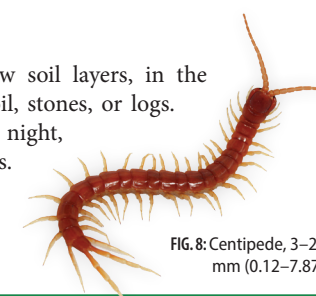


FIG. 8: Centipede, 3–200 mm (0.12–7.87")

ABOUT THIS GUIDE

This ID guide is part of Xerces' Soil Life project and resources. For more information, visit xerces.org/soil-life. The invertebrate animals featured in this guide are those that are large enough to see with the naked eye, and which are commonly found in the soils or leaf layer in urban farms, gardens, or yards in towns and cities across the contiguous United States. Each profile includes where you would likely find the animal, identification features, and the ecological and/or agricultural roles of that group. Tiny animals that would require specialized equipment to capture and view them, such as nematodes, mites, and springtails, are not included in this guide, nor are slugs or snails, which are relatively easy to recognize but quite difficult to identify to further detail.

Tips for finding and observing these soil invertebrates include:

- » Move slowly when observing the soil surface. Many soil invertebrates can detect small changes in light (such as your shadow) and may hide as a result. Others, such as predators, have exceptional eyesight and will move away quickly if you move too swiftly.
- » Move the leaf layer carefully to search for soil invertebrates.
- » Temporarily place a clear glass jar or plastic cup over nest entrances or burrows to see who may be coming or going from those holes in the ground.
- » For additional monitoring methods, see **chapter 3** of *Farming with Soil Life: A Handbook for Supporting Soil Invertebrates and Soil Health on Farms*.

HOW TO USE

This pocket guide is intended as a portable, accessible, basic guide for observing and learning about soil invertebrates. It can be printed double sided and folded to fit in a pocket (scan the QR code for folding instructions). In the PDF, clicking the  in the upper right of each profile opens the full profile in the *Farming with Soil Life Handbook* publication.



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KEY FEATURES [FIG. 8]:

- » Brown, yellowish, or gray
- » Elongated, flattened, segmented bodies; at least 15 segments
- » Pincer-like appendages on 1st segment behind the head; used to inject venom into prey
- » Antennae long, threadlike; 1 pair
- » One pair of legs on each body segment, attached to side of segment

Closeup of FIG. 8 features



WOODLICE, PILLBUGS, SOWBUGS (ORDER ISOPODA)

ROLE: Decomposers; Herbivores

These terrestrial crustaceans are found in moist areas only: upper soil layers, moist leaf layer, or underneath logs or stones. Woodlice activity depends on moisture and temperature; they are more active on cool, damp days, and may be primarily nocturnal during warm, dry summers. Woodlice primarily consume dead plant material, but some also feed on roots or fruits.

KEY FEATURES [FIGS. 9 & 10]:

- » Gray, brown in color
- » Hard shell-like segments, with the appearance of armor
- » 2 pair of antennae
- » Biting, chewing mouthparts
- » 7 pairs of legs
- » A unique characteristic of sowbugs (Porcellionidae) are 2 short, tail-like appendages, "uropods," on their hind end
- » A unique characteristic of pillbugs (Armadillidae) is that they can roll into a ball as a defensive posture

FIG. 9: Woodlouse, 5–15 mm (0.2–0.6")



FIG. 10: Pillbug curled into defensive ball.

NOTE: Species common in urban areas are likely to be introduced. All pillbugs and many sowbugs are species introduced from Europe.

INSECTS

We cover a range of taxonomic groups in this guide. Insects are the most diverse soil animals. Adult insects can be distinguished from other groups by looking for 3 body regions (head, thorax, abdomen), 6 legs, wings*, and 1 pair antennae [FIGS. 11 & 12].

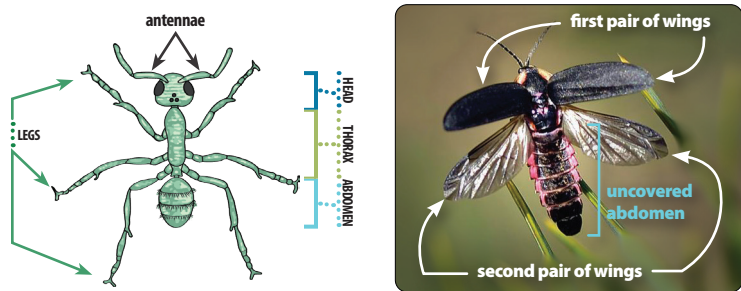


FIG. 11: Wingless insect body plan example, worker ant FIG. 12: Winged insect body plan example, beetle

* Nymph and larval stages are wingless; some species lack wings as adults or have wingless castes

ROOT-FEEDING BEETLE LARVAE (FAMILIES ELATERIDAE, SCARABAEIDAE)

ROLE: Herbivores; MINOR ROLE: Soil Engineers; Pollinators

ADULTS are found above ground, most often on vegetation on which they may feed, with some click beetles also found under loose tree bark [FIG. 14]. Adults are not considered to be pests; in fact, some scarabs are pollinators [FIG. 16]. However, Japanese beetles (*Popillia japonica*) are an introduced species of scarab beetle that are often present in urban areas. Their feeding on plants may be limited to aesthetic damage or may reach levels of economic damage.

LARVAE are root feeders and are found among plant roots in the soil. Some are root pests of crops and ornamentals. Wireworms can also be found near deadwood or in the leaf layer [FIG. 13]. Grubs are frequently encountered when digging in turfgrass [FIG. 15].

Continued below...

CLICK BEETLE WIREWORMS (FAMILY ELATERIDAE)

KEY FEATURES OF LARVAE [FIG. 13] (ADULT SHOWN FIG. 14):

- » Many have hard, smooth bodies that are yellow to brown
- » Others are soft, white, with a hard yellowish head
- » Elongated bodies, segmented in appearance



FIG. 13: Wireworm, 10–60 mm (0.4–2.4") FIG. 14: Click beetle adult, 10–60 mm (0.4–2.4")

SCARAB BEETLE GRUBS (FAMILY SCARABAEIDAE)

KEY FEATURES OF LARVAE [FIG. 15] (ADULT SHOWN FIG. 16):

- » Soft, white, c-shaped bodies
- » Hardened brown head and legs
- » Chewing mouthpart



FIG. 15: Grub, 20–50 mm (0.8–2.0"). FIG. 16: Scarab beetle adult, 20–62 mm (0.8–2.44")

GROUND BEETLES (FAMILY CARABIDAE)

ROLE: Predators; Decomposers; Herbivores (seeds)

ADULTS are found within the soil, on the soil surface, in the leaf layer, under stones or logs, and occasionally on vegetation; some species are active at night. Adults feed on prey at the soil surface or on plants, including caterpillars, grasshoppers, aphids, snails, and slugs; some will also eat carrion, fungi, or seeds.

KEY FEATURES [FIG. 17]:

- » Dark and shiny, some species with green, blue, or purple iridescence
- » Threadlike antennae
- » Long legs
- » Extended, oval abdomen
- » Prominent eyes on the side of the head
- » Head narrower than their thorax
- » Powerful jaws, pointing forward
- » 1st pair of wings hardened as wing covers [FIG. 12]; ridged
- » May pretend to be dead if they encounter potential predators (such as people)

LARVAE are found within the soil, on the soil surface, or in the leaf layer, and feed under the soil surface on rootworms, caterpillars, and more.

KEY FEATURES [FIG. 18]:

- » Elongate, segmented, hardened body that is dark in color
- » Powerful jaws, directed forward
- » Legs visible beyond the thorax



FIG. 17: Ground beetle adult, 3–35 mm (0.12–1.37")



FIG. 18: Ground beetle larva, 3–60 mm (0.12–2.4")

FIREFLIES, LIGHTNING BUGS, GLOWWORMS (FAMILY LAMPYRIDAE)

ROLE: Predators; MINOR ROLE: Herbivores; Pollinators

ADULTS of species that are active during the day are found above ground on flowers or vegetation, while night-active species rest during the day on leaves, within the leaf layer, under loose tree bark, or in underground burrows. Adults may not feed, may be predators on other fireflies, or may feed on nectar or plant tissues.

KEY FEATURES [FIG. 19]:

- » Brown or black in color, with yellow, red, or orange accents; glowworm females are pale
- » 1st pair of wings are hardened to form leathery wing covers [FIG. 12]
- » Abdominal segments at the end of the body are luminous (except for day-active species)
- » Soft, flattened body
- » Antennae are threadlike or serrated (branched in a few species)
- » A “head shield” (pronotum) extends over the top of the head

LARVAE are found in moist areas, within the soil, on the soil surface, in the leaf layer, or under bark pieces on the soil or rotting logs. Larvae primarily eat earthworms, slugs, or snails.

KEY FEATURES [FIG. 20]:

- » Dark in color
- » Powerful jaws, directed forward
- » Elongate body, with hardened plates that give the appearance of segmentation
- » Head can be retracted so that it is not visible from above
- » All described larvae have bioluminescent organs at the tip of their abdomen



FIG. 19: Firefly adult, 5–20mm (0.2–0.8")



FIG. 20: Firefly larva, 5–20mm (0.2–0.8")

ANTS (FAMILY FORMICIDAE)

ROLE: Soil Engineers; Predators; Decomposers

ADULTS are found within the soil, on the soil surface, in the leaf layer, under stones or logs, and occasionally on vegetation. They feed on small arthropods, dead animals, fungi, sap, nectar, and honeydew. Ants are social insects that excavate and construct soil nests that house sizable colonies, with division of labor and roles for each ant. While excavating their nests, ants aerate and hydrate soil, and mix nutrients and microorganisms throughout soil layers. Especially in woodlands, ants help wildflowers reproduce by moving seeds where they can grow. Signs of ants include small holes in the ground, with excavated soil surrounding nest entrances in piles (often mounded). Nests usually have multiple entrances in close proximity, and ant activity in and out of the holes is typically visible, especially when disturbed. Ants in general have a misapplied reputation as pests; only a few groups are harmful to human activities or health.

KEY FEATURES [FIGS. 21 & 22]:

- » Brown or black in color
- » Elbowed antennae
- » Head and jaws angled downwards
- » Narrow waist between thorax and abdomen; 1st segment of abdomen has a humped projection, “petiole”
- » Worker ants are wingless
- » Queens and males usually winged; wings are membranous; 2 pairs

NOTE: A number of ant species have been introduced to North America. Some have become pests, including the red imported fire ant (*Solenopsis invicta*) and the Argentine ant (*Linepithema humile*).

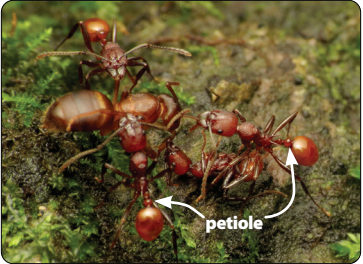


FIG. 21: Workers carrying a queen, 1–25 mm (0.04–1")



FIG. 22: Winged male ant adult

GROUND-NESTING BEES (FAMILIES ANDRENIDAE, APIDAE, COLLETIDAE, HALICTIDAE, MELITTIDAE)

ROLE: Pollinators; Soil Engineers

ADULT ground-nesting bees visit flowers to drink nectar; females also collect pollen. Female bees construct nests within a variety of soil types at varying depths, and provide pollen and nectar for their young. Signs of ground-nesting bees include a small hole in the ground, sometimes surrounded by excavated soil [FIG. 23]. Females may shelter within the nest and may be seen with their head at or just below the soil surface. Most ground-nesting bees are solitary and do not defend their nest.

KEY FEATURES [FIG. 24]:

- » Coloration is variable; some dark with stripes on abdomen; others black, green, or dark blue metallic; bumble bees are large with black and yellow hairs, sometimes with red, orange, white, or brown color pattern—queens dig in the soil and nest in cavities.
- » Threadlike antennae, often elbowed
- » Tongues extend beyond jaws
- » Narrow waist between thorax and abdomen
- » Membranous wings (2 pairs)
- » Hairy bodies (males less so)
- » Females with pollen-carrying hairs or structures, predominately on hind legs but sometimes on thorax or abdomen
- » Size: 4–26 mm (0.16–1.0")



FIG. 23: A group of bee nest entrances



FIG. 24: Bee exiting a nest

EARTHWORMS

ROLE: Soil Engineers; Decomposers

Though common, **EARTHWORMS** have complex life histories. Of the roughly 150 species in North America, ~33% are introduced. Native earthworm species are only found in unglaciated areas; they spread slowly on their own and haven't re-established in glaciated areas. Non-native species have been introduced by human activities such as discarding fishing bait, vermicomposting, and purchasing “beneficials,” or by moving soil, compost, or potting media. Depending on the context, the activity of non-native earthworms degrades or improves the soil habitat. In woodlands, non-native species consume the leaf layer, exposing bare soil that becomes too dry or warm and lacks leaf cover important to many native plants and animals. In compacted agricultural soils, earthworm activity improves conditions for crop growth, creating places for air and water in the soil and mixing the mineral and organic matter.

KEY FEATURES [FIG. 25]:

- » Soft, segmented, tube-like, no legs
- » Clitellum, a smooth or thickened band near the head; the rest of the body segmented, with rows of grooved rings
- » Earthworms excrete distinctive droppings, called castings, in dark, bumpy, small piles or short strings

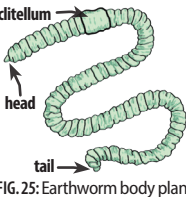


FIG. 25: Earthworm body plan

COMMON INTRODUCED EARTHWORMS (*LUMBRICUS*, *EISENIA* spp.)

NIGHTCRAWLER (*LUMBRICUS TERRESTRIS*)

Introduced from Europe; widespread and conspicuous in yards, gardens, and urban places. These worms dig and live in deep burrows, and come to the soil surface to eat leaf layers and soil. Frequently seen on the surface after heavy rainfall when burrows are temporarily flooded.

KEY FEATURES [FIG. 26]:

- » Red-brown in color; tail end is flattened



FIG. 26: Nightcrawler, 15–25 cm (5.9–9.8")

Continued below...

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- » Clitellum slightly raised, often pinker than the rest of the body
- » Forward movement appears like a wave through the body

RED WIGGLERS (*EISENIA* spp.)

Introduced from Europe, these worms are widespread, due to their use as fishing bait and in vermicomposting. They live where organic matter is concentrated, often near the soil surface.

KEY FEATURES [FIG. 27]:

- » Red-brown in color
- » Clitellum slightly raised, often paler than the rest of the body
- » Forward movement appears like a wave through the body



FIG. 27: Red wiggler, 26–133 mm (1.0–5.2")

JUMPING WORMS (*AMYNTHAS*, *METAPHIRE*, *PHERETIMA* spp.)

Introduced from Asia, these worms are considered invasive because their shorter reproductive cycle (compared to native earthworms) leads to accelerated decomposition of leaf layer, changing the soil surface environment so it isn't suitable for the plants and animals that depend on the leaf layer for food and habitat. Also called snake worms, crazy worms, wrigglers, jumpers, and Asian jumping worms.

KEY FEATURES [FIG. 28]:

- » Grey-red-brown in color
- » Clitellum is not raised and is pale in color, almost white
- » Body is firmer than other earthworm groups
- » Thrash, wiggle, or jump when disturbed
- » Forward movement appears as side-to-side “S” motion



FIG. 28: Jumping worm, 3.8–20.3 cm (1.5–8.0").

IMPORTANT: If you see or think jumping worms are at a site, reduce the threat of spreading them elsewhere by not sharing or moving plants, soil, or compost. Also, wash soil from tires, tools, and shoes before leaving the site. Contact your local extension service or conservation office for additional information.