



SPRINGTAILS—WORLDWIDE JUMPERS

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YOUNG REVIEWERS:



ANSHUL

AGE: 9



LUVANA

AGE: 11



MILES

AGE: 8



PRANATEE

AGE: 12

Springtails are tiny, six-legged animals that you meet every day, but hardly notice. They can survive in big cities, on ice in Antarctica, in the deepest caves, and in rainforest canopies. Some scientists call them the earliest known and the most numerous insects on Earth. Springtails are famous jumpers—if they were as large as humans, they would easily be jumping over 10-story buildings. This ability allows them to escape from danger. Every day, springtails are very busy, improving soil health and supporting numerous species of spiders, beetles, ants, and other small predators on our planet. They are a key part of soil biodiversity, but we still need to learn a lot about them and many of these beautiful animals are yet to be discovered.

WONDERFUL DIVERSITY OF SPRINGTAILS

If you walk out of your house, you will probably meet a springtail, but you might not notice it because most of these animals are only one millimeter long. Springtails, also called Collembola, are insect relatives that can be found in soils all over the world. The best

Figure 1

Springtails in their natural environments all over the world. **(A,B)** Most springtails live in dead leaves or wood. **(C–E)** Some springtails are associated with living plants. **(F)** A number of species can be found in extreme environments, like the snow surface shown here (Photo credits: **A**—Dunmei Lin from China; **C–E**—Marie Huskens from Belgium; **F**—Ferenc Erdélyi from Hungary; **B**—Andy Murray from the UK).

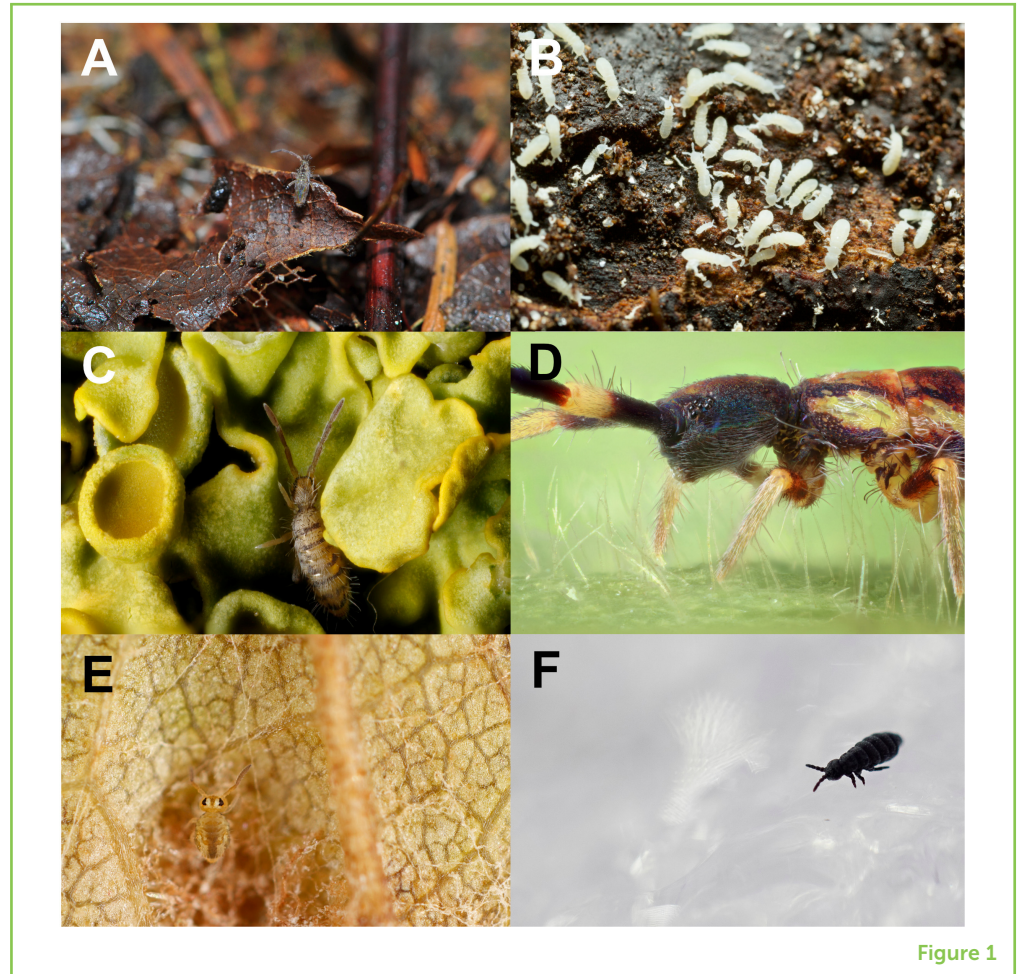


Figure 1

place for a springtail to live is the forest floor, where you can find thousands of them in a handful of fallen leaves. But they can also live in other environments, often in moist places where fungi are growing (Figure 1). In fact, springtails live almost everywhere: they are numerous in Antarctica on snow and rocks, they are diverse in tree canopies of tropical forests, they are found on the highest mountains and down in the deepest caves. Several years ago, scientists found the springtail *Plutomurus*, which lives two kilometers below the land surface in a cave in the Caucasus mountains [1]. They lured it out with the help of a smelly cheese. In winter, some springtails jump and wander on the snow surface, which earned them the name “snow fleas.” Snow fleas like *Hypogastrura* (Figure 1F) can exist in herds of millions, making the snow gray with their bodies! As masters of survival, springtails also live with us—in gardens, backyards, parks, and sometimes flowerpots.

Springtails were surviving and thriving on the planet long before dinosaurs, and they are among the first animals that walked on land. We know this because scientists found a fossil springtail in prehistoric rocks dated about 410 million years old. This springtail was named *Rhyniella praecursor*, “the earliest known insect.” Interestingly, some

Figure 2

Beautiful springtails from Australia, Tasmania, and New Zealand. **(A)** Masterpiece *Katianna*, with spotted coloration. **(B)** Shiny *Lepidocyrtus*, covered with scales. **(C)** Dragon *Womersleymeria*, large and horned. **(D)** Baby *Neelides*, only about half a millimeter in size (Photo credits: **A,B,D**—Andy Murray from the UK <https://www.chaosofdelight.org>; **C**—Cyrille D’Haese from France).



Figure 2

MASS EXTINCTION

Widespread and rapid decrease of biodiversity on Earth during evolutionary history. Five main mass extinctions are recognized.

¹ <http://www.collembola.org>

FURCA

A forked tail-like appendage attached to the abdomen of many springtail species.

modern springtails look very similar to *Rhyniella*, which means that springtails survived on Earth through four out of five **mass extinctions** without changing much in appearance. We know of about 9,000 species of springtails living now, which are all listed in a web catalog,¹ but scientists think that there are at least four times as many unknown springtail species on our planet [2]. Some remote areas in Tasmania and New Zealand are inhabited by beautiful and unusual species (Figure 2) and many more are yet to be discovered.

Springtail species can look quite different from each other. Some species have a round shape, while other species are elongated. Some do not have coloration, others are blue, or black, or have colorful spots and stripes, such as the ball-like *Katianna* (Figure 2A). *Lepidocyrtus* (Figure 2B) has shiny scales, just like fish do. Most springtails are about 1 mm long, but there are tiny and giant species. For example, *Neelides* (Figure 2D) is only about half a millimeter long, while *Womersleymeria* (Figure 2C) can be longer than a centimeter! Most of these giants live on the dead wood of wild tropical forests and are called “dragon springtails.”

WHAT DOES A SPRINGTAIL LOOK LIKE?

The name “springtail” comes from the organism’s **furca**, which looks like a forked tail and allows many springtails to spring away from danger, just like tiny grasshoppers (Figure 3). The furca can be found under the body, on the abdomen, but not all springtails have one. If a springtail is walking or eating, the furca is attached to the body under high tension, like a compressed spring. As soon as springtail wants to jump, the furca is released and the animal catapults itself

Figure 3

What are the parts of a springtail? This sketch of a springtail was made by taxonomist Mikhail Potapov, who has described more than 200 springtail species new to science.

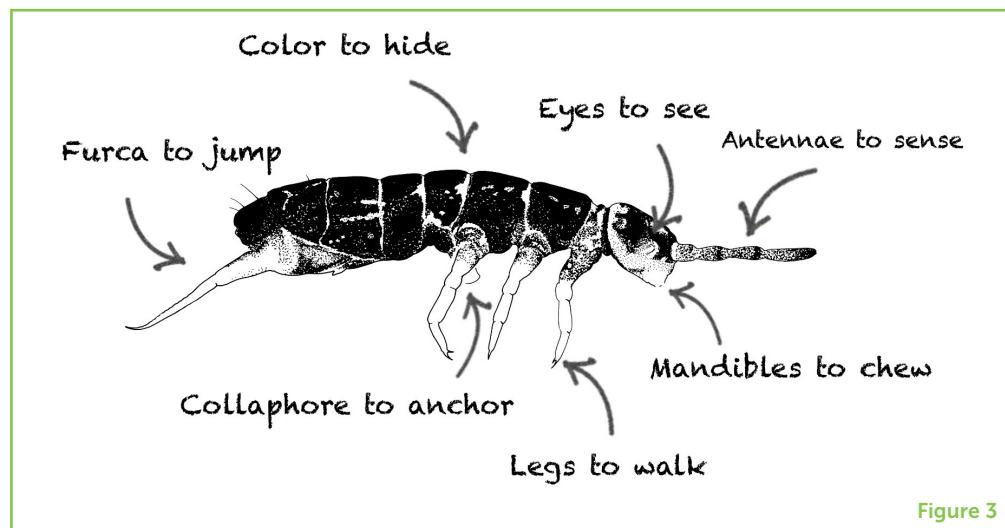


Figure 3

² Check out “trash can springtails” doing 22,440 rotations per minute in slow motion on this video <https://www.youtube.com/watch?v=Qu01EUeE5PM>.

COLLAPHORE

A tube-like structure that is used by springtails to attach to surfaces.

MANDIBLES

Lower jaws, used to bite and chew the food. Unlike humans, arthropods chew horizontally, not vertically.

away from predators, or curious scientists. While jumping, springtails flip over many times, so it looks like they are doing a fantastic acrobatic trick before they crash into something.² Springtails are champions at jumping—if they were the size of humans, they could jump over 10-story buildings! As you can imagine, after such a jump it is not easy to land without a parachute. Instead, springtails use a special tube called **collaphore**, which allows them to stick to the surface (for example to a leaf or a stone) when landing.

Like insects, springtails are hexapods, meaning that they have six walking legs. Unlike insects, they never have wings. Springtails can have from two to sixteen eyes (Figure 1D), but species living in soil are often blind. To orient themselves in the environment and communicate with others, many springtails use antennae, which are long organs on their heads. They move the antennae to touch and check the surfaces in front of them. If they find some food, they grasp it and chew it with their **mandibles**.

HOW DO YOU CATCH A SPRINGTAIL?

If you are interested enough to look for a real springtail, you need to know where to look and how to do it. Springtails like wet places, like moist fallen leaves or mosses. Some large species can be found hiding under the bark of decaying fallen trees. Others are found on stream banks, rocks, mosses, or flowers. If you are lucky, you can also find springtails in flowerpots—if so, chances are it will be the white *Folsomia candida*—one of the most commonly used soil animals in laboratory experiments. While searching for a springtail, be very patient—they are everywhere, but they are masters of hiding and often are colored like things in the environment around them (Figure 1E).

³ <https://www.inaturalist.org>

⁴ <https://www.flickr.com>

ENTOMOLOGICAL ASPIRATOR

Aspirator used to collect small organisms visible to the naked eye [[https://en.wikipedia.org/wiki/Aspirator_\(entomology\)](https://en.wikipedia.org/wiki/Aspirator_(entomology))].

TULLGREN FUNNEL

Device used to extract living organisms, particularly arthropods, from soil, detritus, moss, and other substrates (https://en.wikipedia.org/wiki/Tullgren_funnel).

DETRITUS

Dead organic material, for example dead leaves or wood, bodies of dead animals, and excrements. Detritus is inseparable from the microorganisms that decompose it, such as bacteria and fungi.

If you find a springtail, you can simply observe it crawling around or jumping, and maybe you can take a photo. Web platforms like iNaturalist³ or Flickr⁴ have thousands of springtail photos from around the world. Such observations can help scientists to understand where species live, and may even help them to discover new species.

To catch a springtail, you can also use what is called an **entomological aspirator**. But if you want to keep the springtail, remember that springtails do not like dry conditions. After several minutes in an aspirator, some species may die. Many scientists collect springtails from leaf litter, soil, rotten wood, and mosses using a **Tullgren funnel**, which can be built with relatively little effort at home. Springtails can be closely inspected under a microscope. Scientists also keep springtails as laboratory pets—they need a permanently moist surface (for example, a jar with fallen leaves, soil, or clay), some food (baker's yeast would be a good choice), and air (make holes in the lid). Unfortunately, only a few dozen species like to live at home or in the laboratory—and we do really not know why.

BUSY SPRINGTAILS RUN THE WORLD

What are all these springtails doing in nature and why should we care about them? Springtails have an important role in ecosystems: as ecosystem “cleaners” they recycle dead material called **detritus**, and they feed on microbes, such as bacteria and fungi [3]. By doing this, they improve soil structure and make nutrients available to plants. Springtails can also pollinate mosses, just like bees pollinate flowers [4]. Being delicious food for many predators is also important—numerous species of spiders, beetles, ants, and other invertebrates survive by hunting springtails. Sometimes springtails are also directly useful to humans. In agricultural fields, they may help plants by feeding on the microbes that cause plant diseases, or they may support other predators that can kill plant pests. However, scientists have only recently started to explore these functions of springtails, and there is a lot to learn yet.

In the modern world many ecosystems are changing. Cities are growing, tropical forests are being cut down to grow food, and increasing temperatures are making frozen places like Antarctica and the northern tundra melt. These changes affect springtails as well as other soil organisms. The most remarkable species are often also the most vulnerable and can become extinct if their natural environments are destroyed. The number of springtails on our planet is likely to decline in the future, since they are numerous in the cold, Polar regions that will be strongly affected by climate change. One hectare of tundra can be inhabited by as many springtails as there are humans on the entire planet. As masters of survival, springtails will adapt to the changing world and live in the new ecosystems. However, many species are likely to become extinct even before being

discovered. Studying springtails and sharing the knowledge about them as a hidden but very important part of biodiversity can help us to understand how the nature is organized and how we change it with our actions. Sharing your new knowledge with your friends and family can help with this—the more people who will know about the importance of hidden biodiversity, the better we will be able to understand and protect the nature and our future as a part of it.

AUTHOR CONTRIBUTIONS

AP developed the idea and wrote this manuscript.

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YOUNG REVIEWERS



ANSHUL, AGE: 9

Hello! My name is Anshul and I am a fourth grader in North Wales, Pennsylvania, which is close to Philadelphia. I am very interested in Biology and Entomology. I am an active member of the John Hopkins CTY program, and my favorite hobby is to read.



LUVENA, AGE: 11

Hi, my name is Luvena! I love music, sports, and food. My favorite subjects in school are math and language arts. In my spare time, I enjoy playing piano and reading books with my sister. When I grow up, I would like to be a neurosurgeon.



MILES, AGE: 8

I am a boy who lives in San Francisco. I love sports, games, and playing with my friends. I like eating French fries and chocolate.



PRANATEE, AGE: 12

Hello! I love to bake, especially tarts and pies. In school, my favorite subjects are science, lunch, and recess. I like spending time outdoors and going hiking. I also love going to the beach and have an interest in photography. Watching my favorite TV shows, painting, listening to music, singing, and hanging out with friends are my favorite things to do in my free time. In the future, I would like to either like to be a scientist, or a singer/songwriter and actress.

AUTHOR

ANTON POTAPOV

I am a soil ecologist working at the University of Göttingen, Germany. I particularly enjoy studying springtails, which I am doing in different environments, from Russian taiga to tropical rainforests. I want to understand how springtails and other small animals form complex food webs and drive biodiversity and functioning of ecosystems. *potapov.msu@gmail.com

