

Millipedes Made Easy

A. Introduction

The class Diplopoda, or the millipedes, contains about 10,000 described species. The animals have a long distinguished history on our planet, spanning over 400 million year. Their ecological importance is immense: the health and survival of every deciduous forest depends on them, since they are one of the prime mechanical decomposers of wood and leaf litter, especially in the tropics. Despite their importance they are very poorly known and have long been neglected in all areas of biological research. Even basic identification of specimens is a challenge.

We hope to make millipede identification accessible to many. The first challenge may be to distinguish a millipede from other members of the Myriapoda. Section B demonstrates the differences between the four myriapod groups. Section C provides a very short introduction to millipede morphology. Section D lists a number of tips on how to deal with millipede specimens under the dissecting scope. The illustrated identification key to orders can be found in the section: Key to Orders in several languages. The key was constructed with purely practical considerations in mind. We tried to use characters that are easy to recognize and will allow non-millipede specialists to find the right path to the order quickly. Several couplets are not dichotomous, but are organized on the multiple choice principle: discrete, mutually exclusive alternative characters are listed and the user must choose one of them. After you have become familiar with the identifying features, you may often just use the flow chart at the end of the Identification Key to identify a millipede to order.

The section Identification Tables contains tables for the verification of the identified specimens. Table 1 lists a few key characters for each of the orders, and Table 2 gives the geographic distribution for each order. Your identified specimen should show the characters listed in Table 1 for that order and should be from the geographic region listed in Table 2. Any mismatch may indicate a problem with the identification. Table 3 presents the list of all currently valid millipede families with their geographic distribution. For example, if you identified a specimen from southern Africa to the order

Polydesmida, you can look up in Table 3 which polydesmid families have been found in southern Africa to date. This information will narrow down the number of families you have to look up to identify your specimen further. But you should keep one fact in mind: you may very well have a specimen of a family that has never been reported to occur in southern Africa. It may have been imported by human activities and established thriving populations quite recently. Or, alternatively, the family and this particular species lived in southern Africa for a very long time, but nobody ever found it before, identified it before and thus, the occurrence of members of this particular family in southern Africa may be new to science. Technical terms are explained in the [Glossary](#). A list of important millipede literature is presented in the [Bibliography](#) in the Section [Products and Tools](#) of the MILLI-PEET Web site.

B. What is a millipede?

All millipedes have a long body, and two leg pairs attached to every body ring. Millipedes belong to a group of animals called Myriapoda. In the Myriapoda are four distinctly different groups, the millipedes, the centipedes and the dwarf myriapods. Besides millipedes you may know only the centipedes (Figs 2, 3). Centipedes have long antennae, whereas millipedes have short antennae. Centipedes have on one leg pair at each body ring, although the legs may be long as in the American house centipede (Fig. 3). While most millipedes are vegetarians, centipedes are predators and hunt for prey. They possess a set of poison claws close to their head (Fig. 4). Only the biggest among them can bite humans (Fig. 2). The other two members of the Myriapoda, the Pauropoda and the Symphyla (Fig. 5) are small and live in the leaf litter and in rotting wood. You would find them in soil and litter samples. A group of land-living crustaceans, Isopoda (Fig. 1). The saw bugs and pill bugs belong into this group. Isopods have long, thin antennae, which are pointing backwards. Isopods have never more than 7 pairs of legs, while adult millipedes always have more. There are always apparently leg-less segments at the body end in Isopods. Rolled up pill-bugs have many small segments at the end of the body, while millipedes of the Orders Glomerida and Sphaerotheriida, which also roll into a ball, have a large solid anal shield.

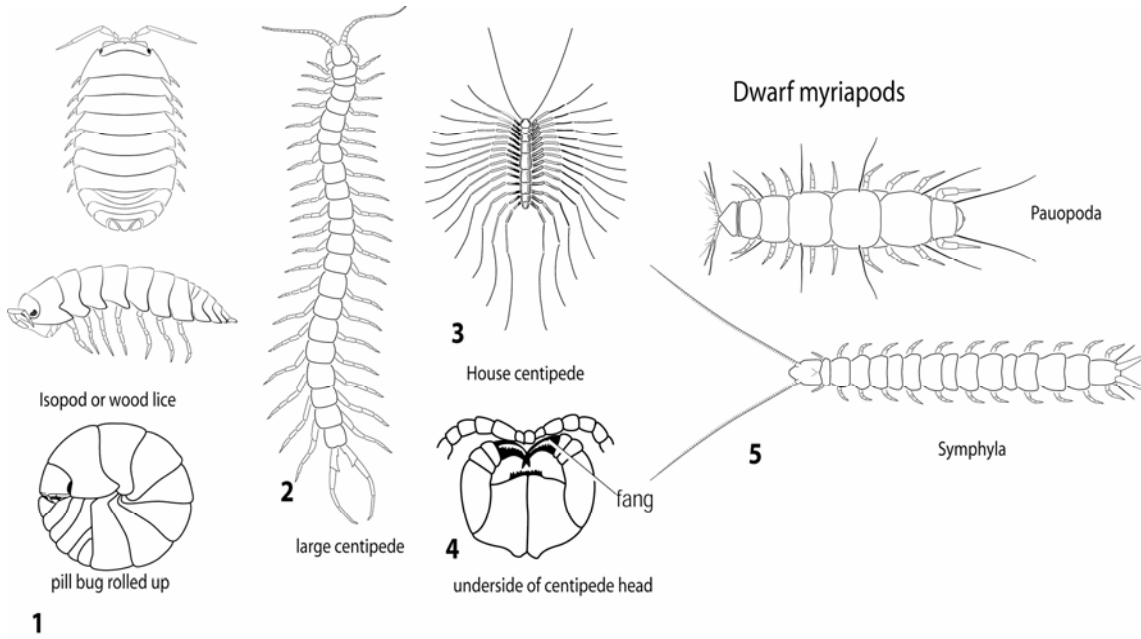


Fig. 1. – Isopod or wood lice, also known as saw bugs. bottom: rolled-up pill bug. Fig. 2. – Large, scolopendromorph centipede. Fig. 3. – The long-legged American house centipede. Fig. 4. – The poison fangs on the underside of the centipede head. Fig. 5. – the dwarf myriapods, Pauopoda and Symphyla.

C. Millipede Morphology: A Short Course

Millipedes have a body divided into two regions, an anterior head and a long posterior trunk. The trunk is made up of body rings (Fig. 6). Adult millipedes carry two pairs of legs on most body rings (Figs 6, 7). The first body ring right after the head, the **collum**, is legless (Fig. 6). The collum counts as the first body ring. The following three rings (body rings 2 through 4) carry one leg pair each (Fig. 6). A juvenile millipede often has legless rings at the end of its body. It is very difficult to identify juvenile millipedes. Therefore, select **adult millipedes**, those without or only a few legless rings at the end of their body for further identification.

Mouthparts (Fig. 6): millipedes have only two sets of mouthparts, the **mandibles** used for chewing and a plate behind them, the **gnathochilarium** (Fig 6; Figs 43, 44 in the identification key). To identify certain orders of millipedes it is important to look at the underside of the gnathochilarium. Put the millipede on its back, legs up, and search for the first pair of legs. Insert a scalpel in front of the 1st leg pair and detach the head. Now

you are looking onto the underside of the gnathochilarium. It may be possible to see the gnathochilarium without detaching the head.

Tömösváry organ: This is a sense organ located on the head of many millipedes. It forms a raised ring, a horse-shoe, or may be only a small pore. It is found behind the antenna sockets (see Fig. 11 in the identification key). Not all millipede orders have this organ.

Ozopores: In many orders, some trunk segments carry ozopores, the openings of the stink glands. These may be very obvious or hard to see. In most groups that have them they occur along both sides of the trunk, starting at the 6th ring (Fig. 7); in a few groups the pores are located along the dorsal midline.

Paranota: The back of each ring of the millipede is covered with a hard plate termed a **tergite**. Lateral extensions of the tergites are called **paranota** (see Fig. 14 in the identification key).

Many millipedes have 'eyes' at the side of the head. These consist of few to many individual **ocelli** grouped together in an **ocular field**. Some millipedes, like the Polydesmida, never have ocelli. This character is used in the key several times. Cave-living millipedes of many orders have lost their eyes, even when their above-ground living cousins have well-developed eyes. Thus, cave millipedes may not key out to the correct order using this key.

Adult millipedes of many groups have distinct **sexual organs**, which can be easily seen with a dissecting microscope. These sexual organs occur in both sexes, but are most obvious in males. Modified legs occur in males in two body areas, either around the 7th body ring (Figs. 16, 34 in the identification key) or at the end of the body, comprising the two last pairs of legs. The latter are called **telopods**. The modified legs on the 7th ring are sometimes withdrawn into a pouch in the body. In such groups the adult male appears to lack legs on the 7th ring (see below under 'Practical Tips'). The modified legs of the 7th ring are called **gonopods** and are very important in making species identifications. Females have sex organs (sometimes called **cyphopods**), found just behind the second pair of legs. The female organs are rarely used for identification.

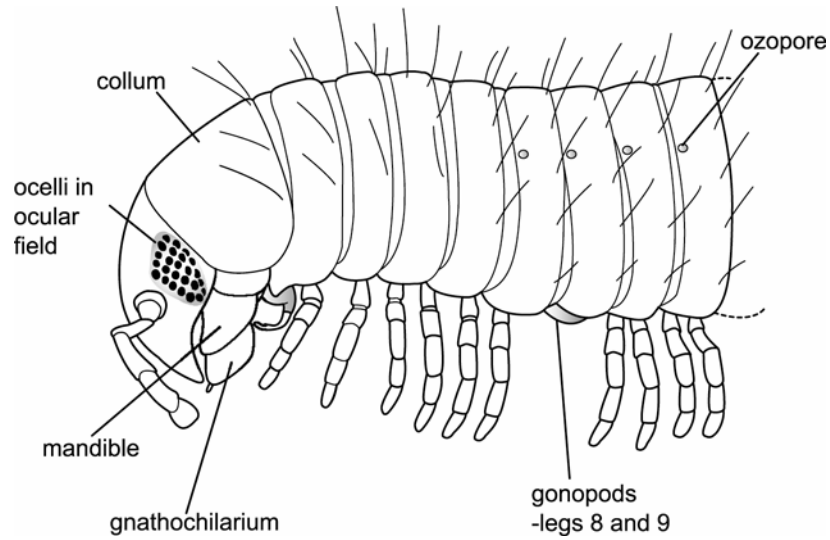


Fig. 6. – Body parts of a male millipede of the order Julida. In side view, the anterior legs appear to emerge from the ring in front of that to which they actually belong (after Blower, 1985).

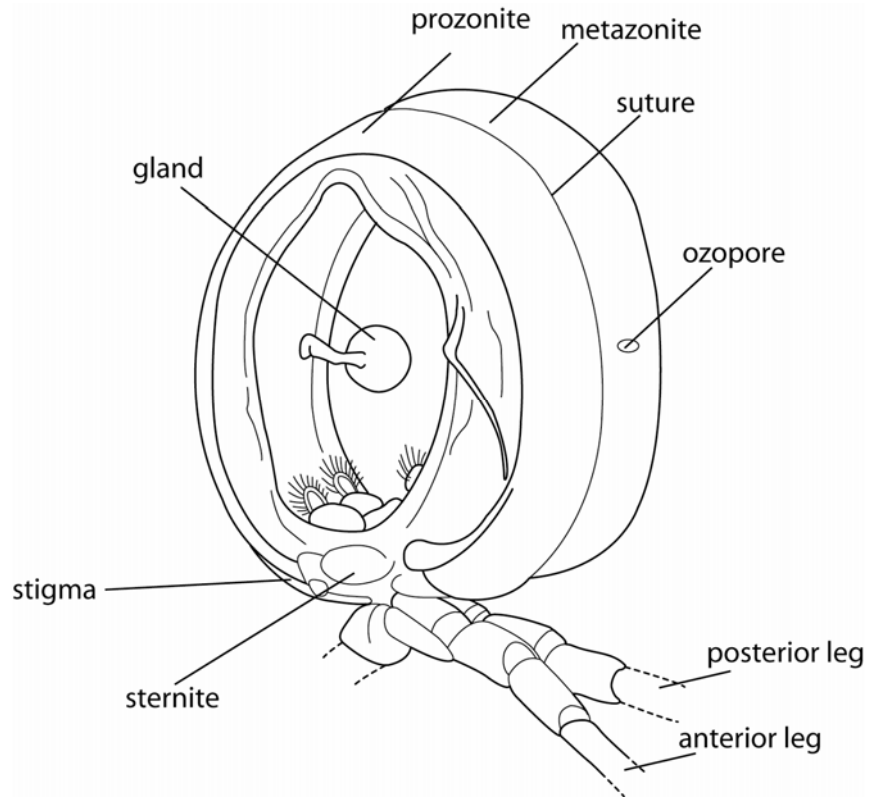


Fig. 7. – Structure of a body ring (diplosegment) (after Demange, 1981)

D. Identifying millipedes: practical tips

1. If you have never looked at millipedes before, but have some identified material available, select a few millipedes from your collection that are already identified to order. Place a specimen in a dish, submerged in alcohol under a dissecting scope. Use the steps in the key to identify the specimen. Through this procedure you will gain practice using the identification key. If the key does not lead to the correct answer, try another millipede of a different order. Keep in mind that the identification in your collection may be wrong.
2. It is much easier to identify adult male millipedes than juveniles or females. Juvenile millipedes often have legless rings at the end of their body. If you have several millipedes of apparently the same species in your sample, select **adult millipedes**, the largest and those without or only a few legless rings at the end of their body for further identification. Adult male millipedes have prominent sexual organs. These are highly modified legs (gonopods) on the 7th ring (see illustrations in the section Body Organization). In some groups, the last two pairs of legs are modified in adult males. You can best view the legs by turning the animal on its back. The male gonopods on the 7th ring may be withdrawn into the body, so your millipede would appear at first to lack legs on the 7th ring. Males and females may carry penes or ovipositors on or near the 2nd pair of legs.
3. Millipede individuals vary, even specimens of the same species. If there is more than one specimen in the sample, look at several and confirm each character in the key on at least two different specimens.

Potential Problems

4. As mentioned earlier, cave-living species may have lost their ocelli, even if the order to which they belong has ocelli. Cave species often have also lost their pigment and may have long legs and long antennae. This key may not work for many cave species.
5. Juvenile millipedes usually have fewer than the adult number of rings; the identification key will most likely only work for adult specimens.

Specimen handling and microscope tips

6. Use a dissecting microscope. You may need magnification of 40X and above.
7. Use good lighting. Keep the ocular lenses clean. Use both the white and the dark background under the microscope objective to view details. Some details stand out better against a dark background. Always start with the lowest magnification and low light level. Focus. Increase magnification, increase light level and refocus.
8. Keep the specimens submerged in alcohol as much as possible during the examination. Cover them completely to reduce reflections. Reflections hinder the view.
9. Specimens must be removed from their vials or bottles for comparison. When comparing specimens from different vials, make sure never to place them in the same dish and keep the label with each specimen at all times. A specimen without or with the wrong label is worthless for future work.
10. Millipedes often curl up during preservation. Use small pieces of cotton to prop-up specimens to see details on the head and on the body. Prepare a small sausage-shaped cotton roll and place a curled millipede over it to stabilize it for examination. K-Y Jelly works well to secure specimens in a dish. However, be aware the jelly leaves an invisible residue on the specimens, which shows up under the scanning electron microscope. Specimens secured in K-Y jelly must be washed.
11. Millipedes often harden and it may be necessary to break them in half to view certain details or to detach the head. Make sure to keep all parts of the specimen and return all parts back to the correct vial with all the labels associated with that specimen.
12. Many millipede species live among leaf litter or in the soil. Even preserved specimens may be covered with soil particles, especially around the head area. Use a soft clean paint brush to wipe soil particles off. You may also use a gentle alcohol stream from an eyedropper.