

# LESSER-KNOWN INVERTEBRATES: POSSIBLE ARTHROPOD RELATIVES

## THREE PHyla OF UNCERTAIN AFFILIATION: THE ONYCHOPHORA, PENTASTOMIDA, AND TARDIGRADA

Animals in the phyla Onychophora, Pentastomida, and Tardigrada show a combination of arthropod and nonarthropod characteristics.

### PHYLUM ONYCHOPHORA: THE ONYCHOPHORANS, OR VELVET OR WALKING WORMS

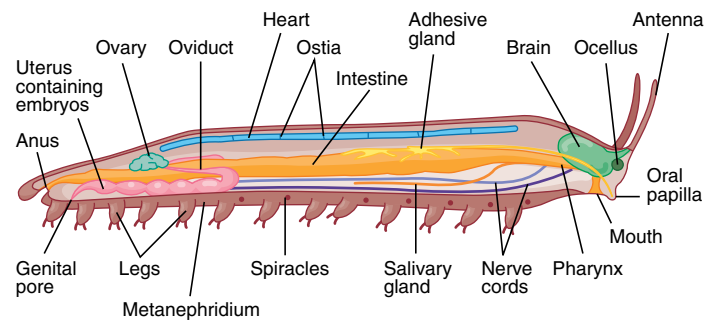
The onychophorans (on-e-kof'ō-rans) (Gr. *onyx*, claw + *pherein*, to bear), also known as velvet or walking worms, are free-living terrestrial animals that live in certain humid, tropical regions. Their ancestors have been considered an evolutionary transition between annelids and arthropods because of their many similarities to both phyla. These interesting worms may live up to 6 years. Zoologists have described more than one hundred species, with *Peripatus* being the best-known genus.

Onychophorans usually come out at night and move by using their unjointed legs to crawl (figure 1). Most species are predaceous and feed on small invertebrates. To capture fast-moving prey, onychophorans secrete an adhesive slime (that their adhesive gland produces) from their oral papillae. Some species can eject a stream of slime with enough force to strike a prey animal 50 cm away. The slime hardens immediately, entangling the prey, which is then masticated with the mandibles and sucked into the mouth.

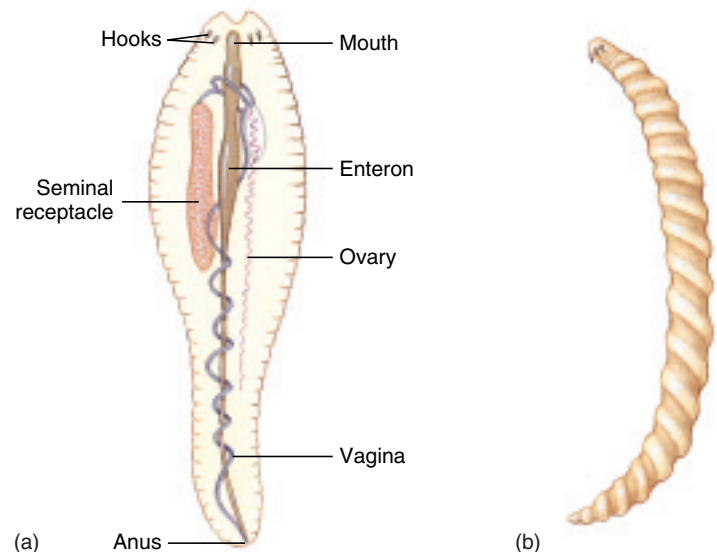
The sexes are separate, and fertilization is internal. Onychophorans are either oviparous or viviparous. The oviparous species lay large, yolkly eggs, each enclosed in a shell, in moist places; cleavage is spiral. The viviparous species retain the embryos in the uterus.

### PHYLUM PENTASTOMIDA: THE PENTASTOMIDS, OR TONGUE WORMS

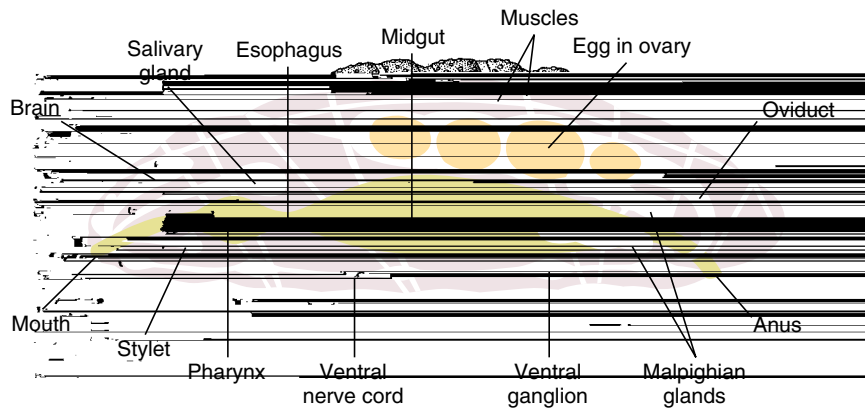
The pentastomids (pen-tah-stom'ids) (Gr. *pente*, five + *stoma*, mouth), or tongue worms, are all endoparasitic in the lungs or nasal passageways of carnivorous vertebrates (figure 2). Ninety percent of pentastomid hosts are reptiles (e.g., snakes, lizards,



**FIGURE 1** Phylum Onychophora. Lateral view of the internal anatomy of a female. The anterior end consists of two large antennae and a ventral mouth. Oral papillae and clawlike mandibles analogous to those of arthropods surround the mouth. The legs vary in number from 14 to 43 pairs; each leg has a pair of terminal claws. Small scales cover large and small tubercles that are arranged in rings or bands over the entire body surface. Miller/Harley: *Zoology*, 5<sup>th</sup> ed. © The McGraw-Hill Companies.



**FIGURE 2** Phylum Pentastomida. (a) The internal structure of a female *Linguatula*, a pentastomid found in the nasal passages of carnivorous mammals. (b) The external structure of a female *Armillifer*. Adults live in the lungs of snakes and immatures are parasites of humans in Africa and Asia. From Hickman, et al., *Animal Diversity*, 2<sup>nd</sup> ed., New York. © The McGraw-Hill Companies.



**FIGURE 3** Phylum Tardigrada. Internal anatomy of a tardigrade. From Hickman, et al., *Integrated Principles of Zoology*, 11<sup>th</sup> ed., New York. © The McGraw-Hill Companies.

crocodiles). There are about 90 species; two of the more well-known genera are *Linguatula* and *Raillietiella*.

Pentastomids are dioecious, and females are larger than males. Gonads are unpaired, and gonopores open to the outside. Male and female pentastomids mate in the final host. Following internal fertilization, females lay millions of shelled eggs, which pass out in the host's nasal secretions, saliva, or feces. If one of a variety of vertebrate intermediate hosts eats the eggs, the larvae develop. The larva has four to six arthropod-like jointed appendages. When a final host eats the intermediate host, digestive enzymes free the larva, and it migrates up the esophagus to the lungs, trachea, or nasal sinuses. Just as in the arthropods, pentastomids possess a brain and ventral nerve cord with ganglia and a hemocoel.

## PHYLUM TARDIGRADA: THE TARDIGRADES, OR WATER BEARS

The tardigrades (tar-di-gra'ds) (*L. tardus*, slow + *gradus*, step) are commonly called water bears because of their body shape and legs and the way they lumber over aquatic vegetation (figure 3). These small animals (less than 1 mm in length) live in marine intersti-

tial areas, in freshwater detritus, and in the water film on terrestrial lichens, liverworts, and mosses. There are about five hundred species; the most common genera are *Echiniscus*, *Echiniscoides*, and *Macrobiotus*.

Tardigrades are dioecious, with a single gonad dorsal to the midgut. A single oviduct or sperm duct empties into a gonopore. Fertilization is internal. The female lays several dozen ornate eggs. After about 2 weeks, a juvenile hatches from the egg, molts, and develops into an adult. In some moss-dwelling species, males are rare or have never been observed, and parthenogenic reproduction presumably occurs.

Tardigrades (as well as nematodes and many rotifers) can enter a period of suspended animation termed cryptobiosis (Gr. *kryptos*, hidden + *bios*, life). This ability offers great survival benefit to these animals, which live in habitats where conditions can suddenly become adverse. If a tardigrade begins to dry out (desiccate), it contracts into a shape that produces an ordered packing of organs and tissues to minimize the mechanical damage that the desiccation causes. Overall metabolism slows. Rehydration reverses these events. Interestingly, repeated periods of cryptobiosis can extend a life span of approximately 1 year to 60 to 70 years.