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Worms

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Defining the worm

What is a worm? Of the thirty-odd phyla in the animal kingdom, at least a third are generally referred to as worms. If you include the more exotic, lesser-known phyla described as "worm-like," it's well over half. So, evolutionarily speaking, it might be easier to narrow down what's not a worm.

If you think worms are relatively "primitive" or simple animals, consider *Riftia pachyptila*, the hydrothermal vent worm. Discovered in 1977 at the Galapagos Rift (Jones 1981), adults are nourished entirely by symbiotic bacteria that feed on sulfur compounds found at hydrothermal vents. The Pogonophora (beard worms), the group to which *Riftia* belongs, are closely related to earthworms and the other segmented worms. Yet earthworms and vent worms have evolved strikingly different feeding strategies, anatomies, and physiologies. Earthworms have colonized dry land and have mouthparts, a digestive tract, and the capability to move around in search of food. *Riftia* lacks (as an adult) a mouth and gut, is sessile, and has acquired a chemosynthetic partner—all traits that enable *Riftia* to thrive in what seems to be an inconceivably hostile environment. That's just one example.

Habitat, physiological characteristics, and behavior

Ecologically, worms have the whole range covered. Name any habitat—there's almost certainly a worm there. Tropical rainforest, polar ocean, the digestive tract of an insect or a mammal—they're all worm habitats. Worms also observe an array of different feeding strategies. Parasites, predators, grazers, detritivores, filter-feeders— there are worms enjoying every menu in nature. How big are worms? Worms in the phylum Nemertea (ribbonworms) can be 1 mm or up to 50 meters long (the longest, though not the biggest among living species of animals). What color are worms? Well…

Not all worms are colorful. Many species, like the *Greeffiella* roundworm, have no pigment and are therefore transparent—convenient for examining their anatomy under a microscope. And then there are the bioluminescent worms, like this marine polychaete. There are many arrow worms, ribbon worms and segmented worms that glow using a variety of chemicals (Haddock et al., 2010).

So, which worms are you looking for?

Formal worms

Acorn worms (Hemichordata)—Two centimeters to two meters length, these worms can be found attached to the seafloor, most of them in coastal shallows and the intertidal zone. Some burrow in the sediment to find food, while others capture food particles from the water using a sticky proboscis. Actually, the acorn worms aren't the only Hemichordata; their sister group, the Pterobranchs, look very different.

Arrow worms (Chaetognatha)—Most species are planktonic and many migrate daily, from the relative safety of deeper water during the day, to the surface at night, where food is more abundant. They are predators and seize their prey with sharp hooks on their head before stunning it with neurotoxin. Chaetognaths can be very abundant in some locations and form an important link in the marine food chain. They are hermaphrodites.

Beard worms (Pogonophora)—These tube dwellers live on the seafloor on various substrates, including whale skeletons, and have been found as deep as 10,000 meters. Larvae, however, can be found at the sea surface; only later do they swim to the bottom to build tubes and grow into adults. They seem to have no digestive tract and it is possible that they feed directly on dissolved nutrients in the water column. Recent research shows that this group belongs within the segmented worms.

Flatworms (Platyhelminthes)—These animals tend to be as flat as you would expect, but can vary widely in breadth and length, from millimeters to meters. Some exhibit spectacular colors and patterns. They can inhabit fresh water, seawater, and other animals. See below for more about some subgroups: tapeworms, acoelomorphs and flukes.

Goblet worms (Entoprocta)—Small, transparent, and attached to the substrate, these worms can easily be mistaken for hydroids or bryozoans. The substrate they grow on can be rock, sediment, or a sponge; tunicate; or other animal. Many other worms are host species for goblet worms.

Horsehair worms (Nematomorpha)—These parasites develop inside terrestrial arthropods, but adults inhabit fresh water or moist soil (a few species are found in coastal marine habitat). Hosts such as crickets are infected by drinking water containing larvae or by preying on another infected host. When the larvae are ready to emerge, they are substantially longer than the host and fill most of its body cavity.

Horseshoe worms (Phoronida)—These small, tube-dwelling worms live mostly in shallow water. Their narrow bodies are crowned by a magnificent lophophore used for filter feeding and also for breathing. Unusually for invertebrates, Phoronids use hemoglobin in their blood to transport oxygen.

Jaw worms (Gnathostomulida)—These microscopic marine worms live between the sand grains from the intertidal to the deep sea floor. Most species have "forceps-like" jaws and prey on other microbes, including bacteria, fungi, and protists. The jaw worm's digestive tract usually has a single opening—the mouth. Food waste may leave via the mouth or a temporary anus, which disappears when not in use. These animals are hermaphrodites.

Peanut worms (Sipuncula)—Sipunculans are marine worms, distributed throughout the world's oceans from tropical intertidal water to cold, deepwater habitats. They are common but inconspicuous creatures, living burrowed in different kinds of sediment, hidden in coral rubble, among oyster beds, or occupying empty gastropod shells (hermit worms!) They are normally confused with other worm-like invertebrates such as sea cucumbers, spoon worms, ribbon worms, and even with anemones. However, sipunculans have some characteristics that can easily separate them from the other groups. A sipunculan's body is divided in two parts: a cylindrical trunk and a retractable introvert that can be completely invaginated inside the trunk. At the front end of the introvert there is a tentacular crown surrounding the mouth. A peculiar characteristic of this group is that the anus is not at the opposite end of the body from the mouth as in many other worm-like creatures. Instead the anus is located toward the front of the trunk. In other words we can say that a sipunculan's anus is on its neck (Cutler 1994).

Penis worms (Priapulida)-- Very few species are known from this group (approximately 20 as of this writing), but they are very widely distributed. They can be found from the tropics to the poles, from the deep trenches to the intertidal zone. Like the sipunculans, priapulids have a retractable introvert. The priapulid's introvert is toothy and useful for snatching soft-bodied prey in the soft sediment, where most priapulids live.

Ribbonworms (Nemertea)—These worms, usually ranging in length from 1 mm to 5 meters, may be the most elastic animals, with some able to change diameter as much as ten-fold (for a potential 100-fold change in length). That enables them to swallow prey much thicker than themselves and squeeze into and through very tiny holes and crevices. There are approximately 1400 described species. Though they appear simple and defenseless, they are very effective predators (some also scavenge dead animal remains). They are armed with an eversible proboscis that, at rest, lies in a long, fluid-filled, internal chamber. The proboscis may be longer than the worm's body and is everted to capture prey. Some use neurotoxins to subdue prey. They avoid becoming prey by secreting noxious chemicals into their mucous coats. A few tens of species inhabit terrestrial or freshwater habitats but most are marine, where they can be found in almost every type of benthic habitat as well as throughout the pelagic realm. Two groups are obligate ectosymbionts: one in the mantle cavity of clams and stealing food (kleptivory) that the clam is filtering from the water for its own use; the other on crabs, where they prey on the developing embryos carried by female crabs, which has had significant adverse effects on some populations of popular commercial crab species. Similarly, a large burrowing nemertean can impact the productivity of soft-shell clam beds in the Gulf of Maine.

Roundworms (Nematoda)—Nematodes have tremendous ecological diversity and a huge size range. Nematodes can be tiny microscopic worms that live in ocean sediments like *Greeffiella minutum*, just 0.08 mm long, to the largest parasitic nematode, *Placentonema gigantissimum*, that can be up to 8 m long and lives in the placenta of sperm whales! Free-living nematodes are generally sediment-dwelling animals, living in every type of soil, sand, or mud imaginable. They are found in most habitats on Earth,

from your backyard to freshwater streams and lakes, deserts, rainforests, beaches, and even the deep sea. They are among the most abundant animals on Earth; thousands can live in a handful of soil. Many soil nematodes are also important parasites of plants in agriculture and nature. While most of the thousands of nematode species are free-living, many are parasites of every animal imaginable, including insects, birds, mammals—even humans.

Segmented worms (Annelida)—Annelids are a large and functionally very diverse group. Many types of worms that you may know are found in this group: earthworms, freshwater leeches, and tube-dwelling marine feather-duster worms are all Annelida. The body of an annelid is composed of many identical short segments plus a head at the front and a tail segment at the back. Some have a pair of leg-like appendages on each segment, called parapodia. Even those that lack parapodia are well adapted for locomotion by coordinated undulations of their body, and they can be very motile. The behavior of earthworms fascinated Charles Darwin; he wrote a book about their role in mixing and transporting soil. Among the less active subgroups, sedentary tube builders such as filigree worms can be important habitat constructors at sea.

Spiny-crown worms (Kinorhyncha)—These tiny animals (most less than a millimeter long) are also known as mud dragons and can live in sediment, algal mats, or on hydrozoans, bryozoans, or sponges. The spines on their heads are important for locomotion. They burrow and crawl by reaching forward with this spiny crown, using the pressure of fluid in their body cavities, then anchoring the crown by the spines and hauling the rest of the body forward.

Spiny-headed worms (Acanthocephala)—The retractable spines on the heads of these parasitic worms are for anchoring to the intestinal wall of the vertebrate animals they live in. Adult acanthocephalans infest all major groups of vertebrates on land and at sea. The larvae exit the vertebrate host in its feces and must then be ingested by an intermediate host: an insect, pillbug, or millipede on land; a decapod or other crustacean at sea. Once the acanthocephalan larva has developed sufficiently, it needs the intermediate host to be consumed by a vertebrate that it can inhabit as an adult. There is some evidence that insects infected with acanthocephalan larvae behave in ways more likely to get them eaten, for example, moving more slowly.

Spoon worms (Echiura)—Most of these marine or brackish-water worms are detritivores. Some search for food in the substrate using their nimble proboscis. Some, in the genus *Urechis*, inhabit U- shaped burrows, line them with nets made of mucus, and siphon water through the burrow in order to filter food particles out of the net.

Tapeworms (Cestoda in the phylum Platyhelminthes)—These are parasitic flatworms living in the intestine of vertebrates as adults. Many produce long chains of proglottids, each with male and female reproductive organs, which make them look like long stretches of tape anchored by an attachment organ to the inside of the intestine wall of their host.

Velvet worms (Onychophora)—Initially mistaken for mollusks when they were first discovered in 1826, these worms do have a slug-like preference for moist habitat. They capture prey Spider Man style, by squirting jets of sticky slime that entangle the insects, arachnids, worms, and snails they pursue on their nocturnal hunting expeditions.

Worms nevertheless

These animals often are described as vermiform or worm-like. They don't have common names that incorporate "worm" but most are referred to as worms by the pros who study them.

Acoelomorphs—mostly small worms (typically less than 1 mm long) living in marine sediments, between sand grains or in the loose surface layers of mud. Some are relatively large (the size of rice grains or up to half an inch) and live on corals or swimming freely in the plankton. Many are predators, swallowing other small animals whole; others feed on single-celled algae.

Flukes (certain members of the phylum Platyhelminthes) —Parasitic flatworms. The common name "fluke" has been applied to trematodes; these are parasites living in the internal organs of vertebrates as adults (younger developmental stages parasitize snails and some other invertebrates). It may also refer to "monogeneans" (Monopisthocotylea or Polyopisthocotylea), most of which live on the gills of fish or on their skin.

Gastrotrichs—Small worms (most just tenths of a millimeter long) living between sand grains in marine beaches or in fresh water. They move by gliding with bands of cilia on their ventral surface and are presumed to graze on bacteria, diatoms, and small protozoa. You can tell different gastrotrich species apart by the patterns of scales and spines on their bodies.

Mesozoa- The Mesozoa are a good example of a polyphyletic group: they are not all more closely related to each other than to non-Mesozoa. Once thought to be a separate kingdom from the Animalia, they are now believed to include several unrelated groups of animals. What do they have in common? In the 19th century, species were placed in the Mesozoa based on embryo development. They were all observed to be missing a stage where the Blastula, a single-layered sphere of cells, folds in on itself to form the trilayered Gastrula, a key step for most animals in which their cells become organized into the different body tissues.

Myxozoa- Most of these microscopic parasites infest fish, segmented worms, and bryozoans. A few species have been found in terrestrial vertebrates, including mammals. In a typical life cycle, a myxozoan may infect both a worm host and a fish host. Myxozoan infection can be an important cause of mortality among farmed fish.

Planarians (order Tricladida in the phylum Platyhelminthes) —Free-living, large-bodied flatworms, most of which live in fresh water or in moist niches (soil, dense vegetation) on land. Most feed on small animals such as small worms or crustaceans; land planarians prey on animals like earthworms.

Polyclads (order Polycladida in the phylum Platyhelminthes) —Free-living, large-bodied flatworms, most of which live in the sea, especially in reef environments or rocky or shelly areas. They are predators on other animals or browse on attached animals such as tunicates or corals.

Xenoturbellida—Very simple, sac-shaped worms, 1–3 cm long, living in deep ocean muds. The mid-ventral mouth is the only opening in the body. These worms appear to feed on other mud-dwelling animals, especially small bivalves.

A worm by any other name...

Scientists don't refer to these animals as worms. They may have worm-based nicknames and can resemble worms, but they all have formal names of their own that you may recognize:

Insecta (what? insects?)—Lots of insects have picked up worm- related common names, which usually apply to their juvenile forms (maggots or larvae) when they appear worm like. These include inchworms, glow worms, silkworms, cotton-bollworms, tequila worms, and many others.

Caecilians—Don't be fooled! The appearance is quite similar to a segmented worm, but these animals are amphibians!

Tongue worms (Pentastomida)—Tongue worms are crustaceans and obligate parasites that live in the respiratory tracts of vertebrates, usually reptiles in the tropics. The "worms" moniker describes the long, soft body of the animal (2—15 cm in length).

Shipworms—Long, vermiform clams that drill their way into ships, piers, and other wood at sea. They may look like worms and act like termites, but they're mollusks!

***Anguis* (Slow worms)—**This genus of legless lizard really doesn't look much like any of the official worms, especially if you get a look at the head. Still, like many lizards, they sometimes shed their tails to escape predators, so if you pick one up and it tries this tactic, the end you're left holding might do a convincing worm impression.

References

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