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BIODIVERSITY
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THE WEIRD AND WONDERFUL WORLD OF WORMS

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YOUNG REVIEWERS:

ELI
AGE: 12

MIA
AGE: 14

Animals with long, skinny bodies are often called "worms," but there are many kinds of worms—even in the ocean. Annelids (segmented worms) include garden earthworms, but their ocean relatives come in many colors, shapes, and sizes. Some are so small that they live between grains of sand, while others can be longer than a human and eat fish! Marine worms are essential to the ocean food web, as both predators and prey. They help create homes for plants and animals by burrowing and building tubes in ocean sediments. Scientists are still discovering new worm species, and there are still many mysteries about how worms eat, why they live in the places they do, and what roles they play in ocean ecosystems. Worms are a fascinating and important part of ocean communities.

WHAT IS A WORM?

When we think about worms, we usually think about the earthworms we see in the garden or wiggling on the sidewalk after it rains. Or we might think about parasitic worms that live inside other animals, or leeches that feed on blood. While these are the worms we see most often, worms first evolved in the ocean and most species of worms still live there today.

When scientists first began classifying animals by grouping them together according to their physical features, these **taxonomists** created a group called "Vermes," which means "worms" in Latin. "Vermes" included "all animals that are longer than wide," without backbones [1]. This meant that many distantly related animals with a worm-like shape were included in this group. Later, scientists began to recognize and describe many distinct groups of worms. One of these groups, which includes earthworms, is called Annelida, and it is the focus of this article. When we say "worm" from now on, we are talking about **annelid worms**.

TAXONOMIST

A type of scientist who discovers, names, describes, and classifies species.

ANNELID WORMS

A major group of worms with rings of repeating segments along their bodies. One familiar example of an annelid worm is an earthworm.

"Annelida" means "ringed animals." This refers to the repeating segments along their bodies, which distinguish them from other worms. Having many segments means that some can be used for special functions. Imagine if you had 20 sets of arms and legs—you could use some of your arms for juggling, while you flipped pancakes with the other ones, all while riding your bike. Some annelids divide jobs along their bodies—for example, they might use some of their segments for special kinds of feeding, while other segments can build a tube, get rid of waste, or make eggs.

Annelids are an ancient group, with ancestors going back to the time when the very first complex animals began to appear on Earth. Fossils of whole worms are very rare because their bodies are soft and squishy and do not preserve very well. The worm fossils we usually see are from worms that have hard parts, like jaws and teeth, inside their bodies. These parts have been present in the fossil record for over 500 million years.

HOW MANY KINDS OF WORMS ARE IN THE OCEAN?

Scientists do not know exactly how many species of worms live in the ocean, because there are still many to discover. Currently there are about 14,000 known species of annelid worms [2], but many new species are described every year by taxonomists. More than 120 species of Annelida were described in 2021 alone, so we still have a lot to learn about the **diversity** of these worms (Figure 1).

DIVERSITY

The variation in forms of life. Diversity can be the number of kinds of organisms, for example worm species, or the number of different jobs or "functions" in the ecosystem.

Figure 1

Worms come in all shapes and sizes and have special body parts for unique kinds of feeding, defense, and reproduction. Here are a few examples of the diversity of Annelida.

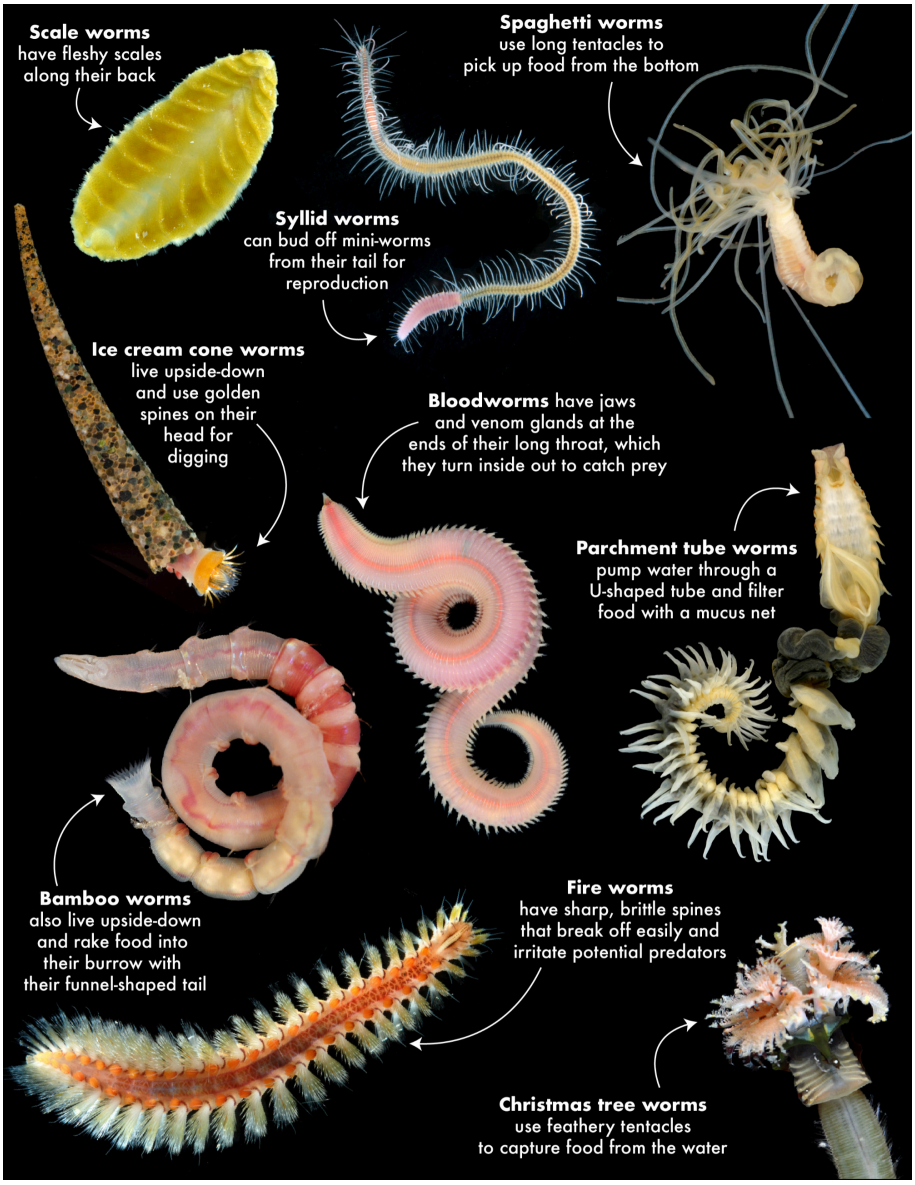

Figure 1

Worms are found in every ocean habitat, from shallow mud to coral reefs, and even in the deepest parts of the ocean. They are common in warm, tropical places, the coldest polar places like Antarctica, and everywhere in between. Worms come in a huge array of shapes and sizes, from microscopic species to the fearsome-jawed "sand-striker" worm that eats fish and can grow longer than a human. Some worms live in very harsh environments, like the super-hot water of hydrothermal vents. Some worms are parasitic and live on or inside other animals, for example, on lobster gills or on feather stars, in sponges or corals, or even inside other worms. Some worms bore holes into solid rock; some are so tiny that they crawl between sand grains as if they were giant boulders; and some swim freely in open water. If you look carefully *anywhere* in the ocean, you will find a worm.

WHAT IS IT LIKE TO BE A WORM?

Although worms live in environments that are very different from those of humans, they need to do the same basic things that people must do to survive: breathe, eat (and poop!), avoid being eaten, and reproduce to make more worms.

SEDIMENT

The mixture of inorganic (particles of rock and shell) and organic (living microbes and dead stuff from the overlying water) materials that accumulates on the seafloor.

Many marine worms live in **sediment**, such as mud or sand. If you have ever gone to a muddy seashore, you might have noticed that the mud is black and smelly just under the surface. This is because the sticky, goopy mud prevents oxygen from getting very far under the surface. So, if you are a worm that lives in mud, getting oxygen to breathe is a big challenge. Some worms stick feathery external gills up into the water where there is more oxygen, and others pump water into their burrows to bring oxygen down to them (Figures 2A, 3A). Some worms have blood just like ours that can store oxygen, which gives them their red color.

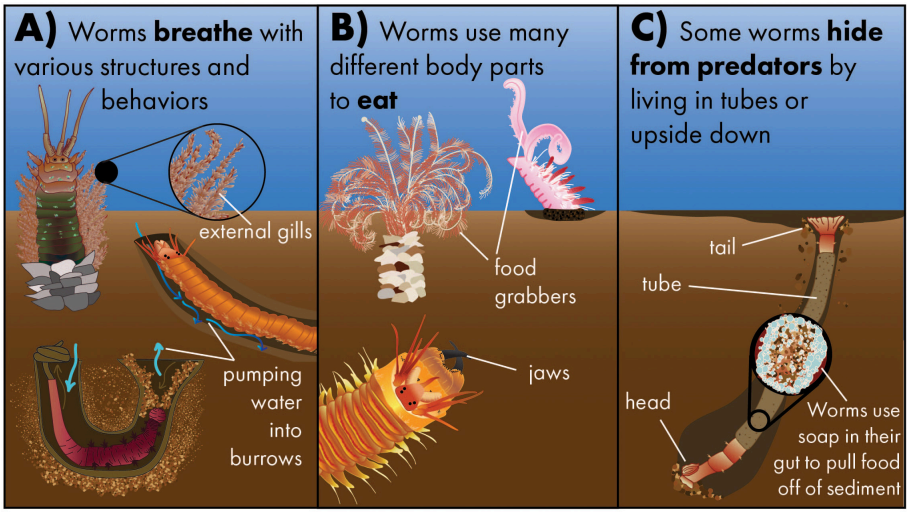

Figure 2

Worms have many special adaptations that help them to **(A)** breathe with various structures and behaviors, **(B)** use many different body parts to eat, and **(C)** hide from predators by living in tubes or upside down.

Just like the earthworms in a garden that eat dirt, many worms on the ocean floor eat sediment. Some of the best worm food on the ocean floor comes from dead plankton, fish poop, and other goo produced by organisms in the water that sinks to the sediment surface. Scientists call this material **detritus**. Worms have special guts with a kind of soap that helps them digest the detritus that coats the sand grains. However, marine worms do not eat just detritus—some of them are carnivores or scavengers, some are herbivores, and some are parasites. Some worms have teeth, jaws, or even venomous fangs for capturing prey or grazing on plants. Some vegetarian worms scrape algae from rocks with special teeth. Compared to the earthworms in a garden, worms in the ocean have evolved a spectacular variety of body parts used to find, grab, and hold onto food (Figure 2B).

DETRITUS

Pieces of organic material such as dead plankton, algae, and fish poop that are an important food source for many organisms.

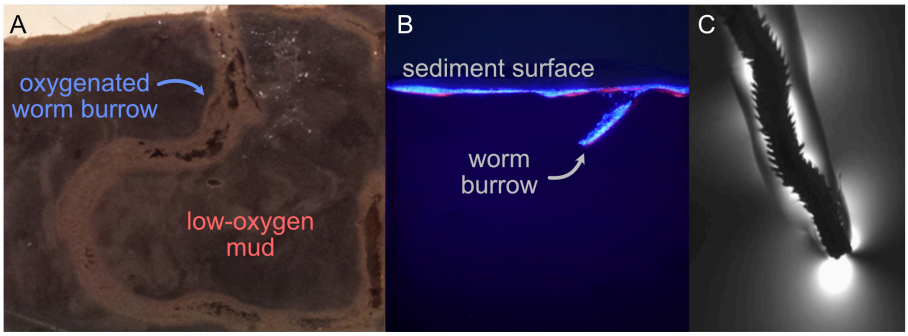

Figure 3

Figure 3

Worms can be challenging to study in their natural habitats because scientists cannot see through the mud to observe them. **(A)** Side-view of a "worm farm"—a worm has burrowed and oxygenated the sediment. **(B)** Side view of "worm farm" in the dark, with colored sediment grains, called luminophores, illuminated by ultraviolet light. Luminophores placed on the sediment surface were mixed down by a burrowing worm. **(C)** A worm burrowing in Jell-O made with seawater, which has similar properties as sediment but is see-through. Scientists shine light through the Jell-O to observe how the worm burrows.

Many animals like to eat worms, so worms have evolved numerous ways to avoid predators. Worms that swim in the water or crawl around on the seafloor surface are more exposed, so they often have venomous or irritating spines or use stinky or poisonous chemicals to be less tasty (Figure 1). Some worms hide from predators by building burrows or tubes in sediment (Figure 2C). To resist getting pulled or sucked out of their homes, worms use stiff hairs on their bodies to hold onto their tubes or burrows. It is common to find worms that are growing back their tails or even their heads after having those parts bitten off by a passing fish!

Breathing, eating, and avoiding predators are all important, but reproduction has kept worms on our planet for millions of years. Some worms just throw their eggs and sperm into the water, but others turn their tails into a zombie mini-worm that carries eggs or sperm, complete with a new head and eyes (see the syllid in Figure 1). Sometimes worms keep their babies inside or on their bodies or inside their burrows until they are almost grown up. Sometimes worms can clone themselves by splitting in half and regrowing a new head and tail.

HOW DO WORMS CHANGE THEIR ENVIRONMENTS?

One of the most important jobs performed by many worms is recycling detritus so that nutrients are available for other organisms. **Microbes** actually do most of the work of breaking down detritus, but they are tiny and can not move much, so it is difficult for them to reach the sediment surface where detritus and oxygen are most plentiful. That is where worms come in. When worms burrow through sediment, they move detritus from the sediment surface to deeper down, where more microbes can find it. This process is called **bioturbation**. Worms also pump oxygenated water into their burrows to breathe, and this brings oxygen to microbes deeper in the sediment [3].

The strategies that worms use to survive also change their habitats. When worms build tubes or burrows, they create homes for other

MICROBES

Single-celled organisms invisible to the naked eye. Sediment microbes are incredibly diverse and do the bulk of the work to break down detritus.

BIOTURBATION

The process of animals mixing sediments by burrowing through them and feeding on them.

animals. This is why we often find larger and more diverse animal communities in areas with tube-building worms. Worms can also serve as an important food source for fish, birds, crabs, and other predators. So, by eating, burrowing, and being eaten, worms transform the detritus that sinks to the ocean floor into nutrients and energy that can be passed up the food web once again.

Though the things worms do are important, these processes can be difficult to study because scientists can not look through the sediment to see worms in action. Scientists must use creative methods to study what worms are doing (Figure 3). For example, scientists use glowing particles to track how much worms mix sediments, put worms in clear Jell-O to observe how they move, and even detect worm activities with sound waves.

Scientists study communities of worms by grouping them based on the different "jobs" they do in the ecosystem [4]. For example, the groups may be based on whether worms find their food below the sediment surface vs. catching particles floating by in the water, or whether worms build a tube as a home vs. making a burrow. Diversity can refer to the number of species, but diversity can also mean the number of unique jobs or functions worms have in the community. Ecosystems with higher functional diversity, meaning more jobs being done, are often healthier and more productive.

CONCLUSION

The ocean contains many habitats to be explored and many thousands of species yet to be discovered. The next time you are looking for shells on a beach, digging by the seashore, or visiting an aquarium, turn over rocks or look inside crevices and keep your eyes open for wiggling and shimmering worms. The puzzle of figuring out which worms are present and what they are doing will keep scientists busy for many years to come.

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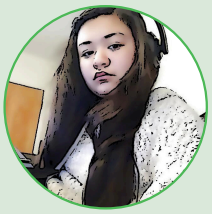
CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ELI, AGE: 12
Eli is 12 years old and will be attending the seventh grade. In his spare time, Eli enjoys playing soccer and running. Eli also plays the cello. He has two dogs, a Chocolate lab named, Gunner and a Cavapoo named Oki. Eli wants to be a scientist someday but is still undecided on the field of science.



MIA, AGE: 14
Mia is 14 years old and will be attending the ninth grade. Mia's hobbies include listening to music, playing soccer, baking and performing in a marching band. She plays the flute. Mia wants to get into the arts upon finishing high school.

AUTHORS

KARA J. GADEKEN

I am a marine ecologist and I study how sediment chemistry and ecology interact and affect each other. I am particularly interested in what happens in the sediments when stressful environmental conditions occur, such as low oxygen, and how the sediment's ability to "recycle" changes in response. One of my favorite things to do in my research is design and build new scientific tools to better observe what goes on in the mud. Sediments are cool, weird ecosystems with so many mysteries left to uncover, and I cannot wait to keep digging! *kgadeken@disl.org

ERIN KISKADDON

I am a coastal ecologist specializing in worms and other animals that live in sediments. I am particularly interested in communicating science that can help people manage coastal resources, which is especially important in my home state of Louisiana. Worms are some of my favorite critters because so many other valued natural resources, including the fish and shrimp we put on our plates, depend on them. If we want to sustain our ecosystems and economies, we must consider the worms!

JENNA M. MOORE

I am a museum curator, and I study worm evolution and diversity. Museum curators are a bit like librarians, except instead of collecting books, we create a record of life on earth by preserving specimens for research. In my own research, I use museum collections to study how feeding structures like jaws and mucus nets have evolved in worms. As a taxonomist, I also name and describe species. Worms are my favorite animals because they do so many different and cool things, and they live in secret worlds that humans know very little about.

KELLY M. DORGAN

I am an oceanographer and, for over two decades, I have been studying how worms and other animals that live in sediments interact with their environments. I started working with marine worms in high school and became fascinated by their diversity and curious about what they were doing in the mud. In trying to answer those questions, I have spent many hours watching worms burrow in Jell-O, clear sand, and thin aquariums of mud. I work with engineers to learn their tools and techniques and use them to understand what life is like for worms.