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## Parasites: The Inside Scoop

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# PARASITES THE INSIDE SCOOP

By Scott L. Gardner, Judy Diamond, Gabor Racz  
Illustrated by Brenda Lee

# **PARASITES**

## **THE INSIDE SCOOP**

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We dedicate this book to all young investigators  
of the natural world.

## WHAT IS A PARASITE?

Parasites are organisms that live inside or on another species, called the host. Parasites depend on their hosts for food and a place to live. They may harm the host in small or large ways.

Parasitism is the most common mode of life on Earth. Humans, other animals, and all plants have parasites, usually two or more kinds. Even parasites can have parasites.

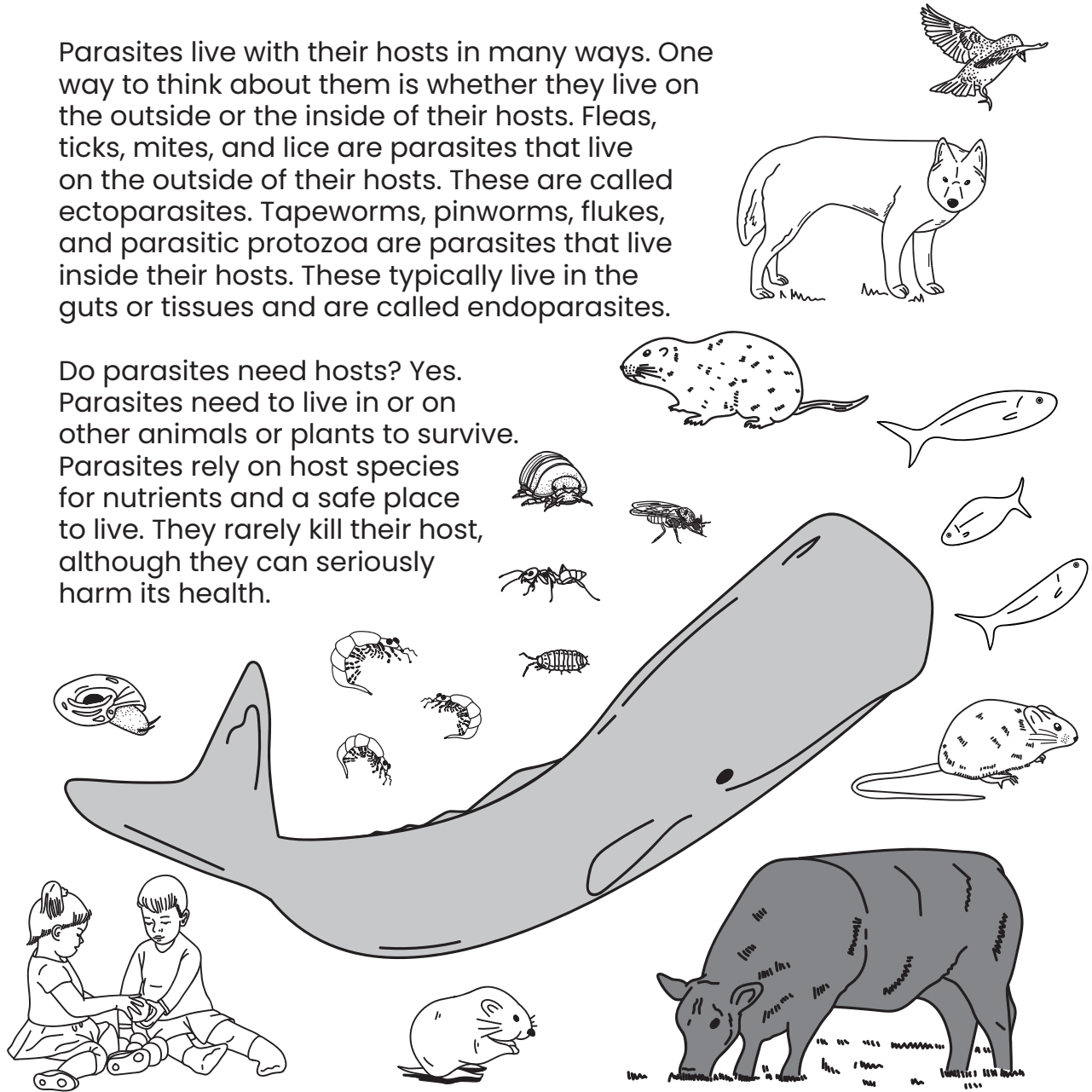
There are millions of species of parasites, and scientists discover new ones every day. Parasite specimens are stored in museums all around the world. One of the world's largest collections is in the H. W. Manter Laboratory of Parasitology at the University of Nebraska State Museum.



## PARASITES AND HOSTS

Parasites live with their hosts in many ways. One way to think about them is whether they live on the outside or the inside of their hosts. Fleas, ticks, mites, and lice are parasites that live on the outside of their hosts. These are called ectoparasites. Tapeworms, pinworms, flukes, and parasitic protozoa are parasites that live inside their hosts. These typically live in the guts or tissues and are called endoparasites.

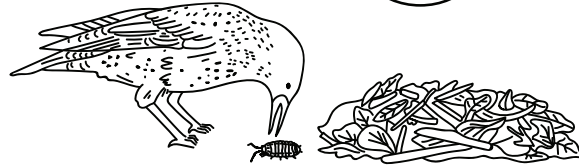
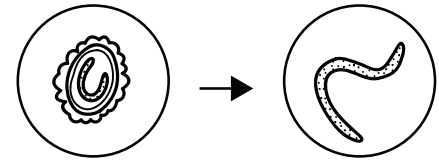
Do parasites need hosts? Yes. Parasites need to live in or on other animals or plants to survive. Parasites rely on host species for nutrients and a safe place to live. They rarely kill their host, although they can seriously harm its health.



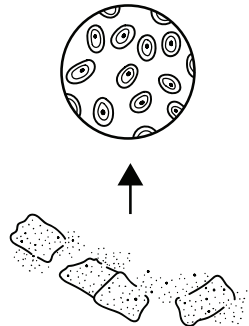
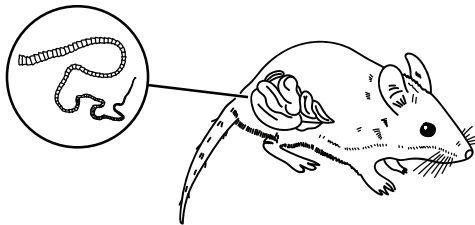
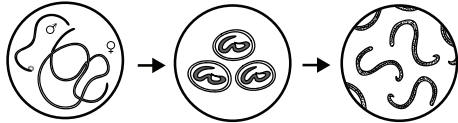
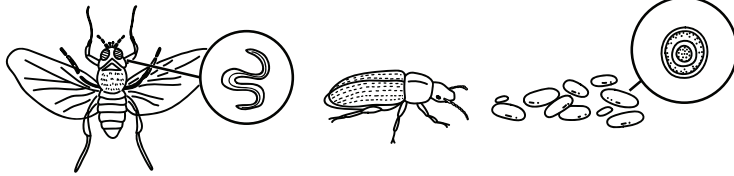


## PARASITE LIFE STORIES

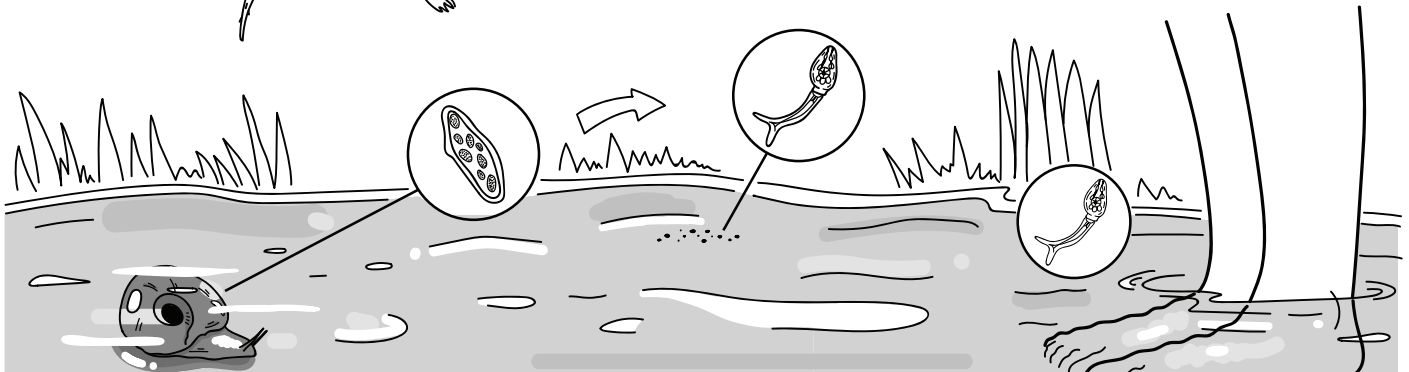
Many parasites take a long journey, passing from one host to another while they develop from eggs, to larvae, and then into adults. In their definitive or final hosts, the adults reproduce sexually and produce eggs.



The eggs are passed to the next host species in a variety of ways. The next host may eat the eggs when they are passed in feces. Some parasite larva live in intermediate hosts, where they may reproduce asexually by splitting. There can be multiple intermediate hosts.

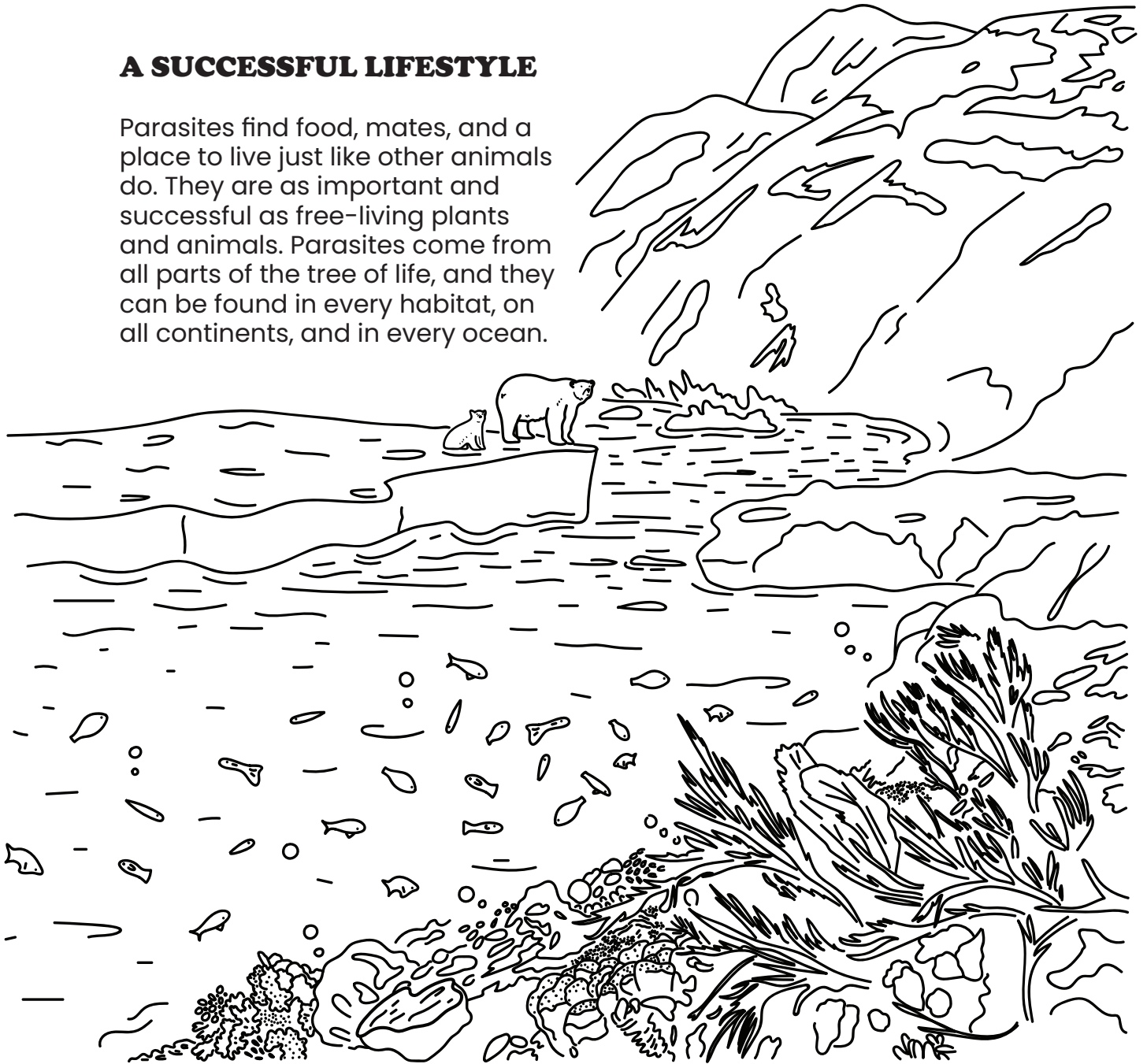


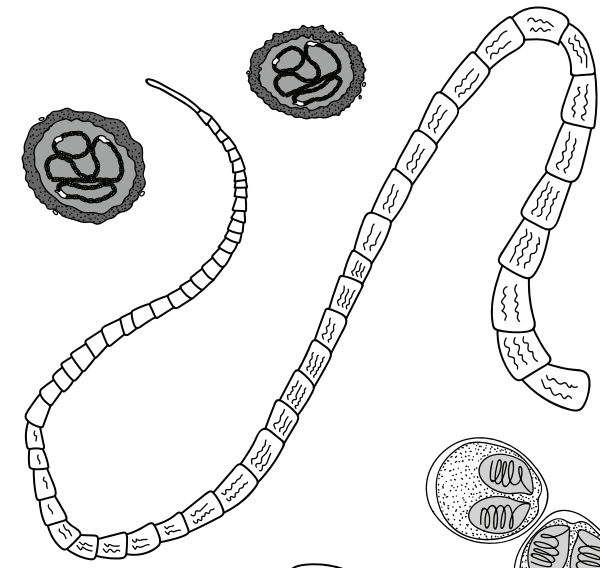
Parasites that pass from wild animals to humans can be very harmful. The illnesses caused by these parasites are known as zoonotic diseases.



## A SUCCESSFUL LIFESTYLE

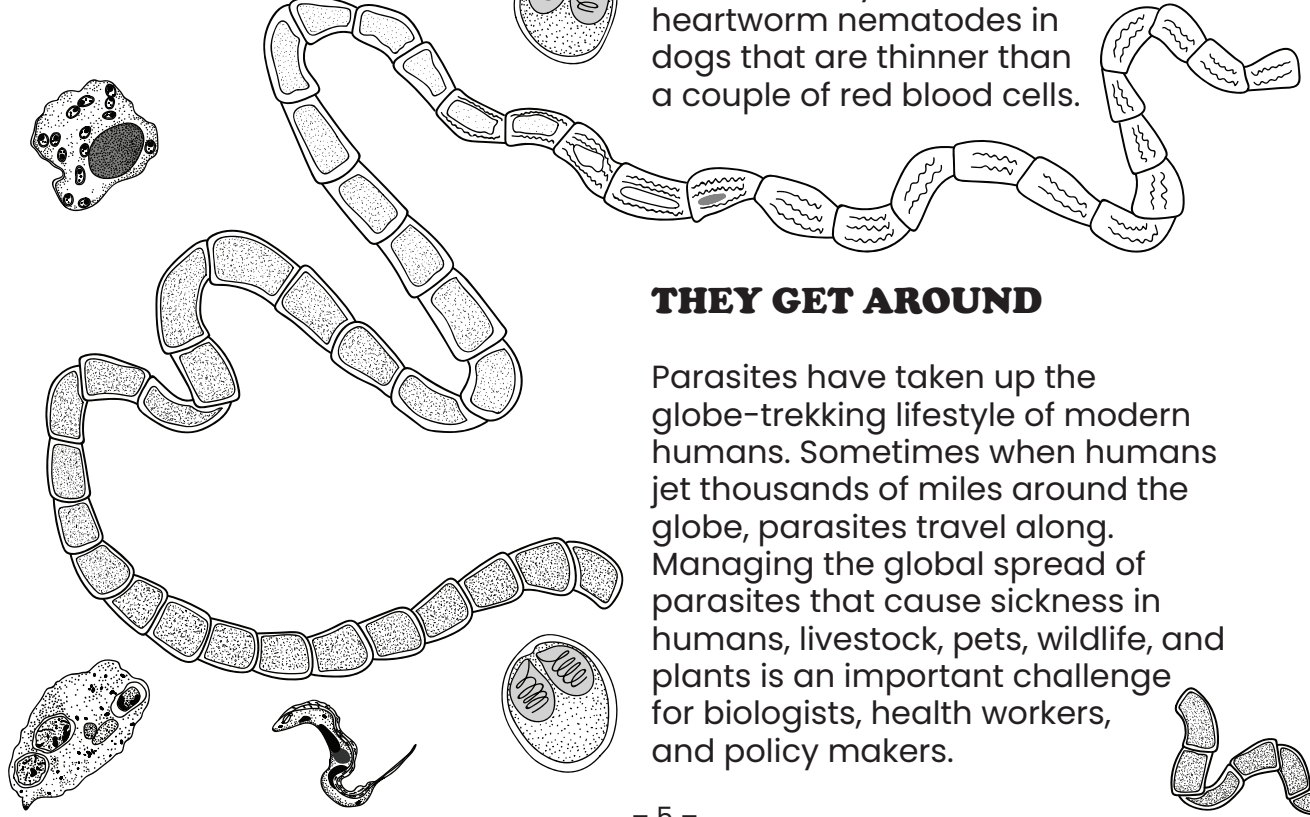
Parasites find food, mates, and a place to live just like other animals do. They are as important and successful as free-living plants and animals. Parasites come from all parts of the tree of life, and they can be found in every habitat, on all continents, and in every ocean.





## PARASITES LARGE AND SMALL

Parasites can range in size from the microscopic to the downright massive. For example, the broad fish tapeworm can live in bears and humans and reach lengths of thirty feet or more. The whale tapeworm can exceed one hundred feet in length. That's about as long as three school buses! Compare this to the tiny microfilariae of heartworm nematodes in dogs that are thinner than a couple of red blood cells.



## THEY GET AROUND

Parasites have taken up the globe-trekking lifestyle of modern humans. Sometimes when humans jet thousands of miles around the globe, parasites travel along. Managing the global spread of parasites that cause sickness in humans, livestock, pets, wildlife, and plants is an important challenge for biologists, health workers, and policy makers.

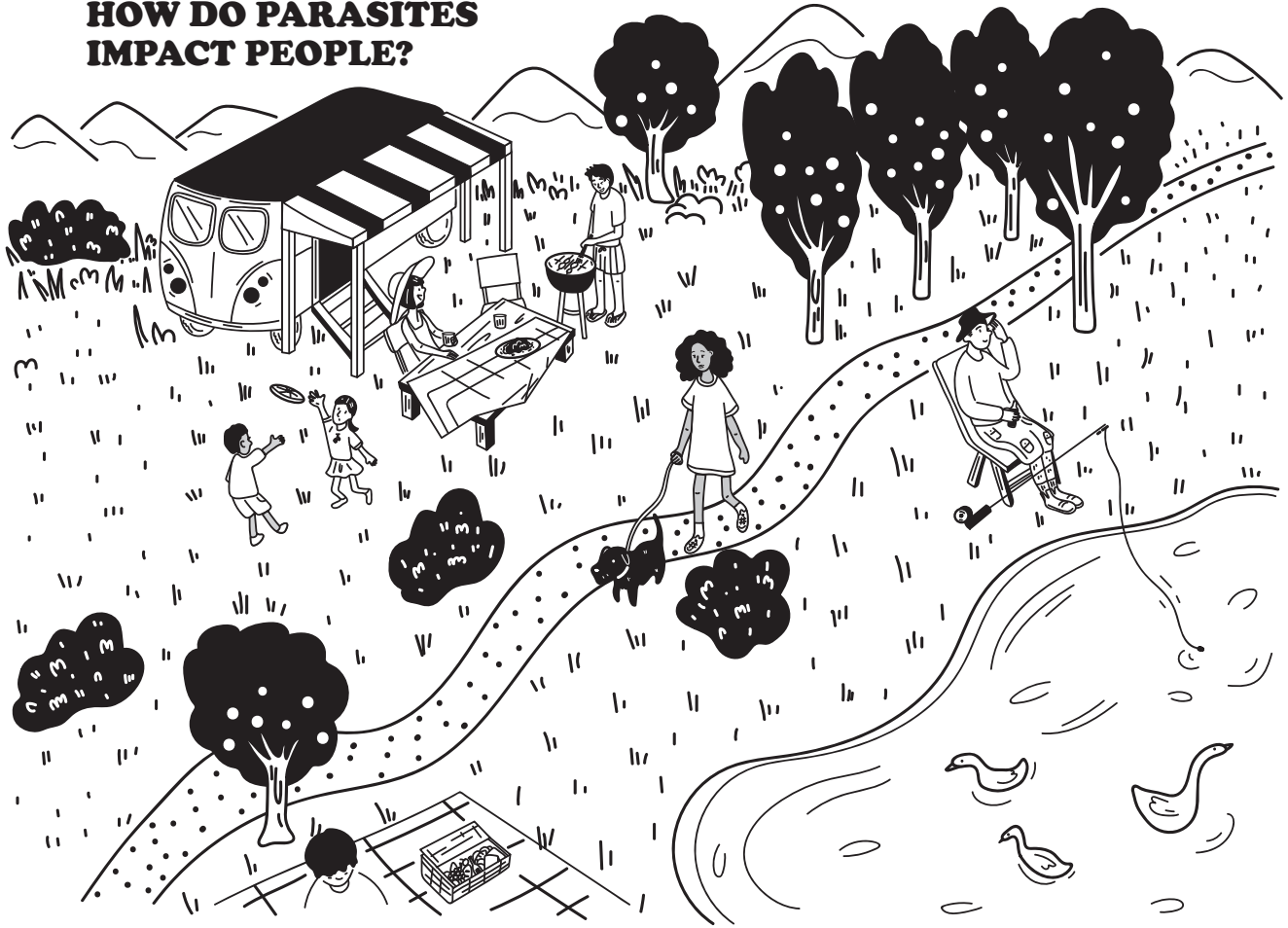
## PARASITES TELL US ABOUT THE HEALTH OF ECOSYSTEMS

The presence of parasites in an ecosystem can indicate a healthy and diverse environment. Because parasitism is a natural and common way of life, scientists expect to find parasites when they study ecosystems. A missing parasite can be a sign that something is wrong in the environment. Parasites often rely on multiple host species to complete their life cycles. Finding a parasite in an area in one host tells

us that healthy populations of that parasite's other hosts are probably also present. The world's climate is changing rapidly, forcing animals and plants to move to new areas. As host animals migrate, their parasites come along with them. Sometimes parasites switch hosts in order to survive. This is one way parasites escape the fate of a host species bound for extinction.

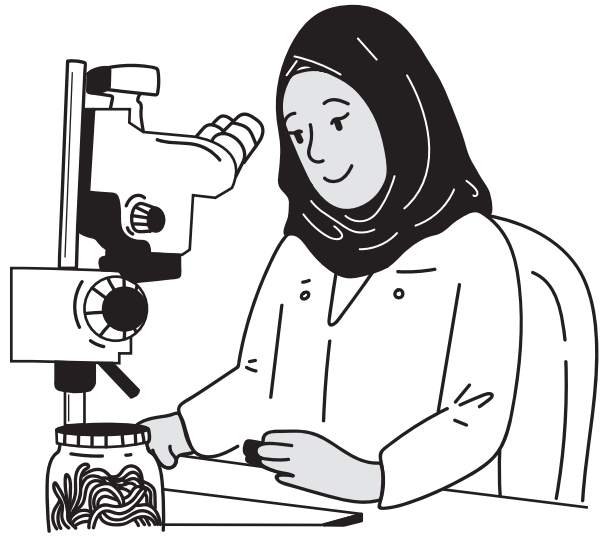


## HOW DO PARASITES IMPACT PEOPLE?



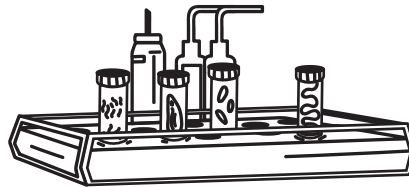
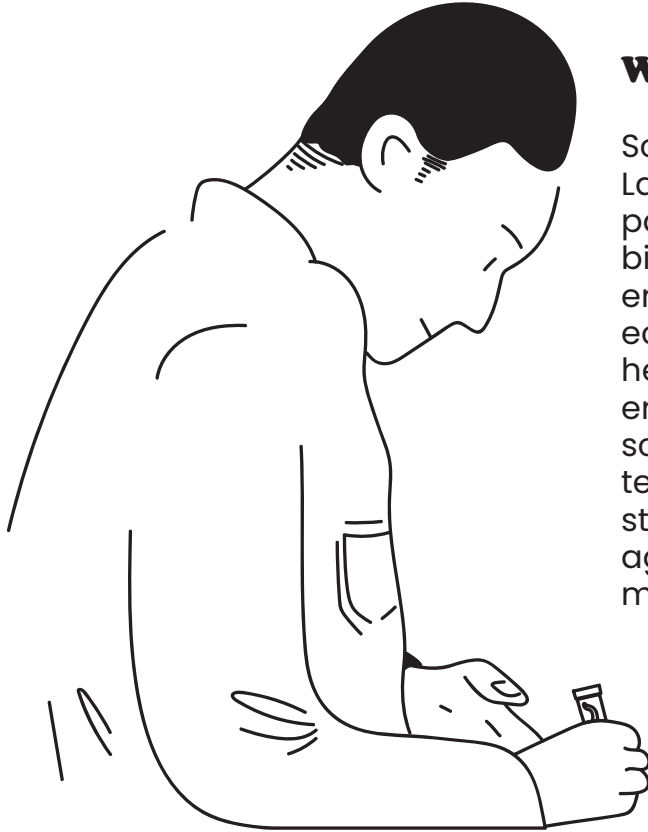
There are many parasitic diseases that affect human health. Lice occur worldwide, Rocky Mountain spotted fever occurs in North America, and Lyme disease occurs in North America, Europe, and Asia. Chagas disease occurs in North and South America. Humans' past interaction with parasites affects human health

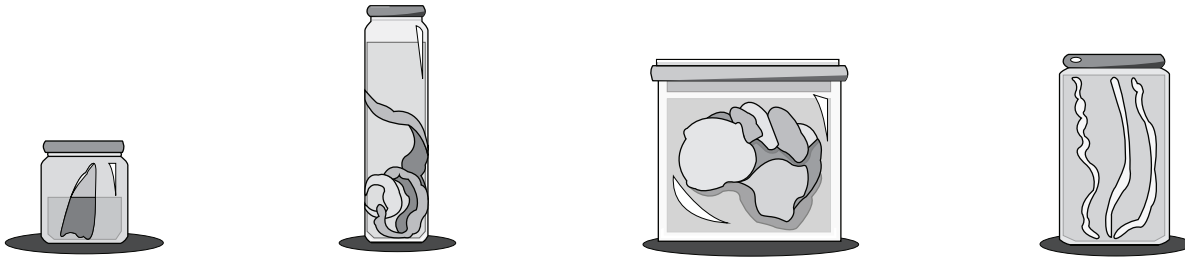
today. For example, some people of African descent possess sickle cell genes. Their ancestors were exposed to the malaria-causing parasite, *Plasmodium falciparum*. People with these genes get a milder form of malaria than others. However, they pass this gene on to their children who may suffer from sickle cell anemia.



## WHO STUDIES PARASITES?

Scientists at the H. W. Manter Laboratory of Parasitology study parasites to understand global biodiversity, evolutionary relationships, emerging diseases, and the health of ecosystems. Their worldwide research helps to discover how parasites emerge as health concerns. These scientists also train students and teachers about parasites. The students go on to careers in agriculture, wildlife ecology, medicine, teaching, and other fields.



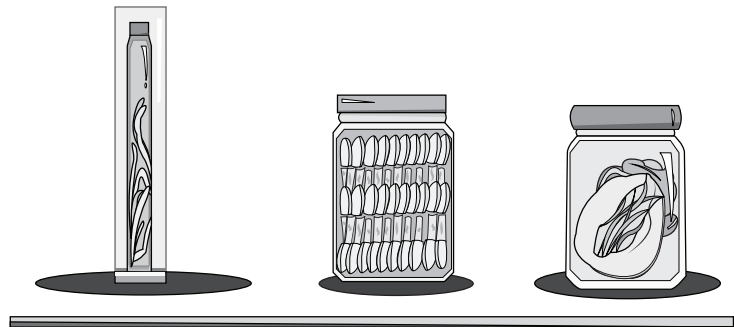


## PARASITES ARE WORTH CARING ABOUT

Science is the process of discovering new things. We know a lot about the parasites of humans, but we know far less about the parasites of other animals. Parasites are among the most numerous creatures on Earth.



On a summer's day, it may seem like getting rid of all ticks and chiggers would be a great thing. But getting rid of all parasites would not make the world a healthier place. This would have unintended and unknown consequences. For example, parasites can regulate the populations of their hosts and they can positively affect soil health. Parasites are an essential component of biodiversity!



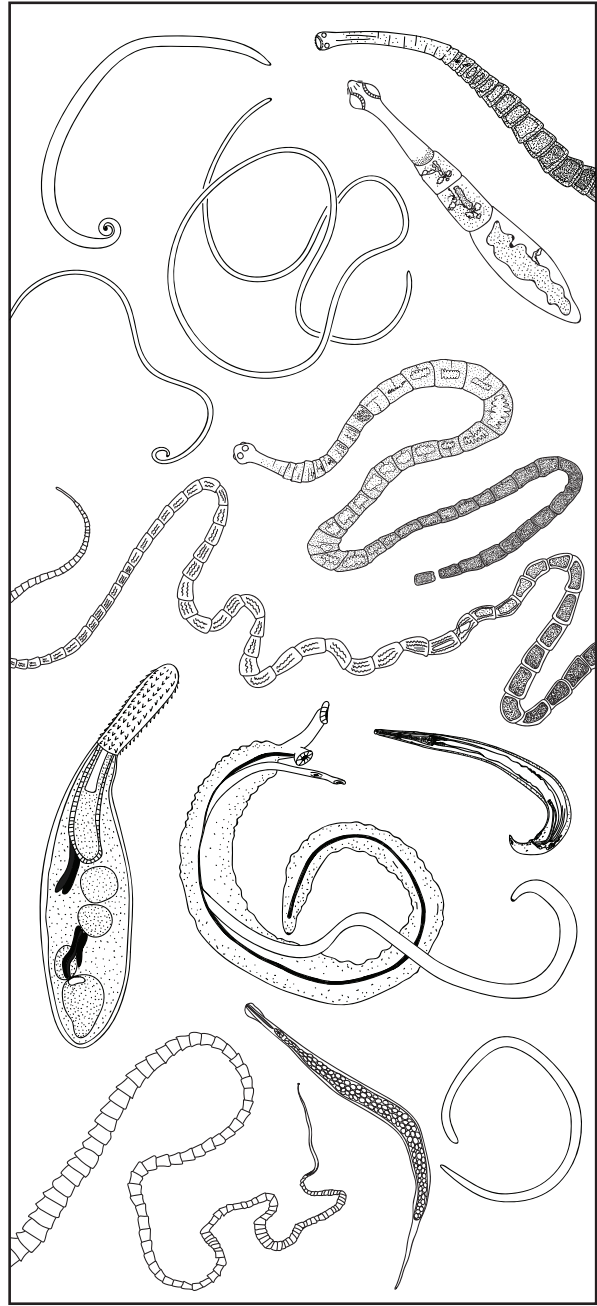
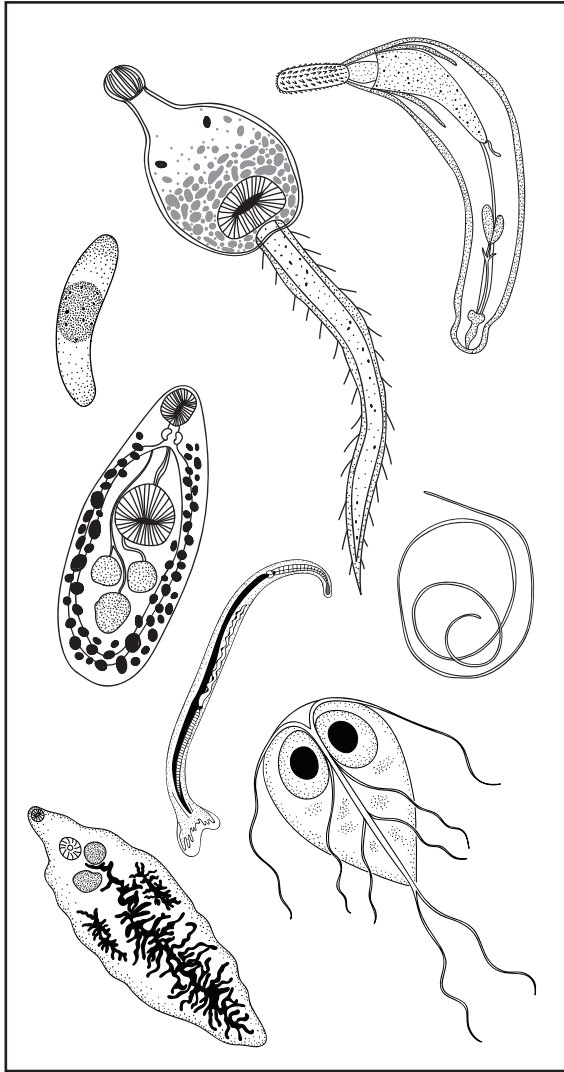
## THE H.W. MANTER LABORATORY OF PARASITOLOGY

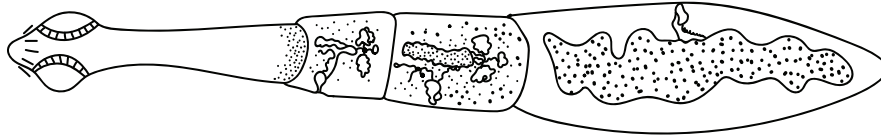


The H. W. Manter Laboratory of Parasitology is housed at the University of Nebraska State Museum. The lab conducts and supports research in parasite systematics and taxonomy with emphasis on parasites of mammals. It fosters studies in parasite biodiversity and provides state-of-the-art laboratories for research and long-term conservation studies. It also supports training and collects, archives, and distributes information about parasites throughout the world. For more information about the Manter Lab, go to [hwml.unl.edu](http://hwml.unl.edu)



## MEET SOME PARASITES





## ***Echinococcus multilocularis***

Fox tapeworm

Platyhelminthes

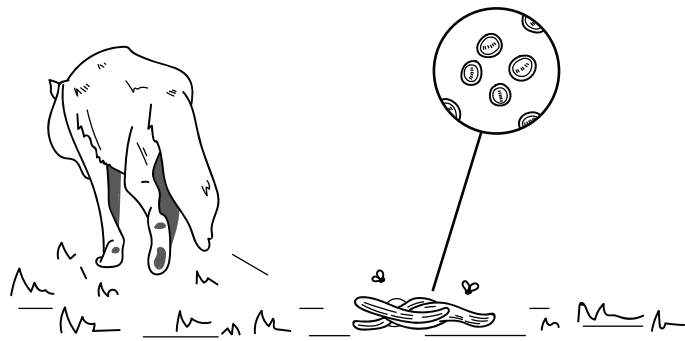
Size: 2-4 mm

Intermediate host: voles, lemmings, mice

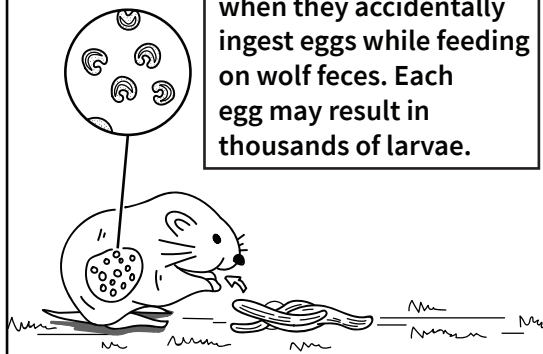
Definitive host: wolves, coyotes, foxes

Fox tapeworm eggs are passed in feces, where they are accidentally ingested by rodents. Larvae penetrate the intestine of the rodent and migrate to the liver, where they form a continuously growing cyst. When a fox, dog, or coyote eats an infected rodent, it acquires hundreds of tapeworms. Children can become infected when they play with a dog that has the tapeworms. When a tapeworm egg is eaten by a person, it can develop in almost any body organ. Infection can go unnoticed for many years as the cysts grow slowly. The disease is becoming more common in areas where fox populations are increasing.

Thousands of worm eggs in feces.



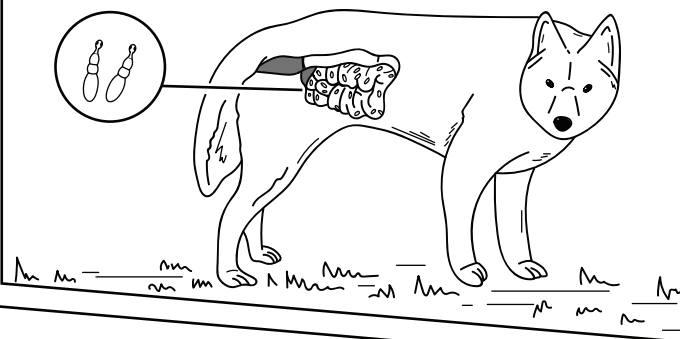
Voles are infected when they accidentally ingest eggs while feeding on wolf feces. Each egg may result in thousands of larvae.



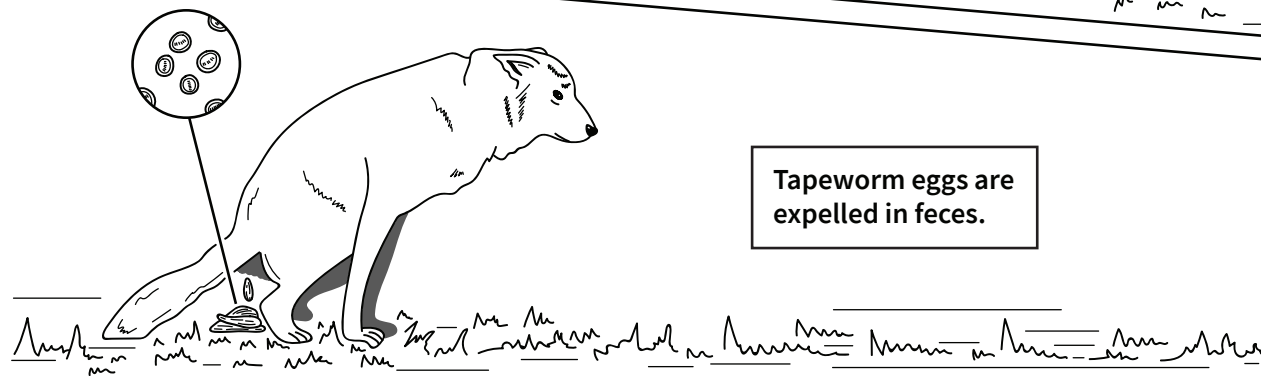
Wolf eats vole with tapeworm larvae.

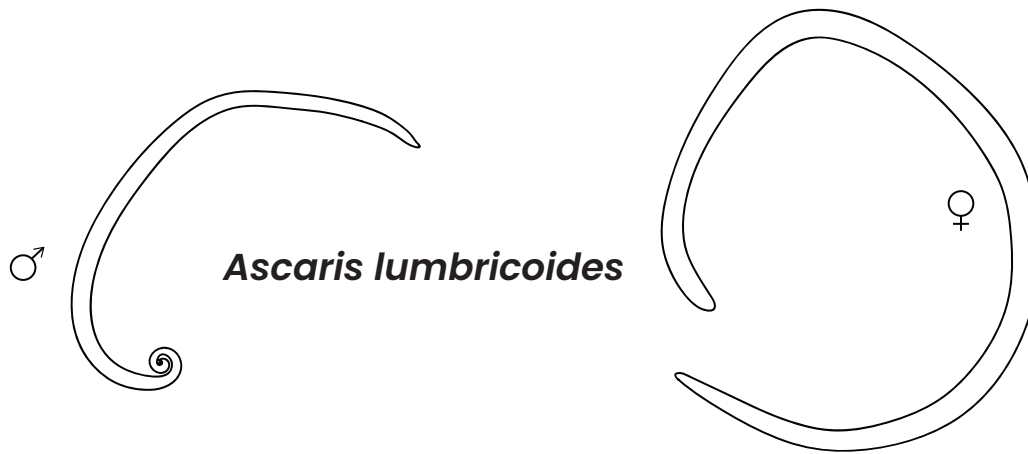


Larvae grow into tapeworms in the gut, where they develop and produce eggs.



Tapeworm eggs are expelled in feces.





***Ascaris lumbricoides***

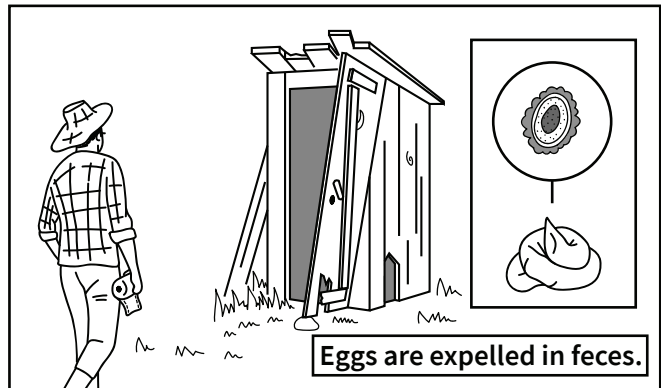
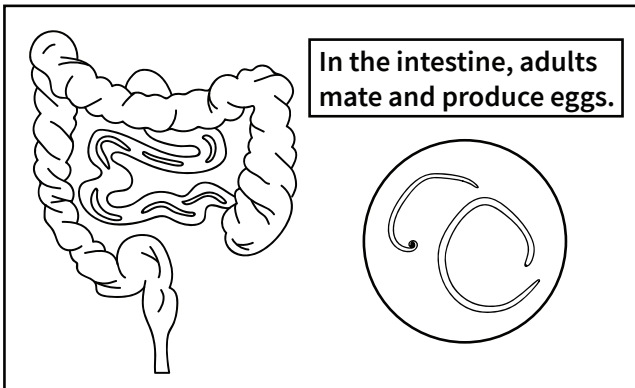
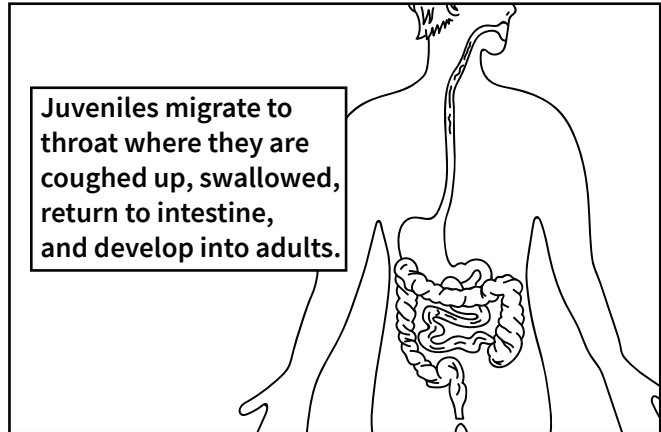
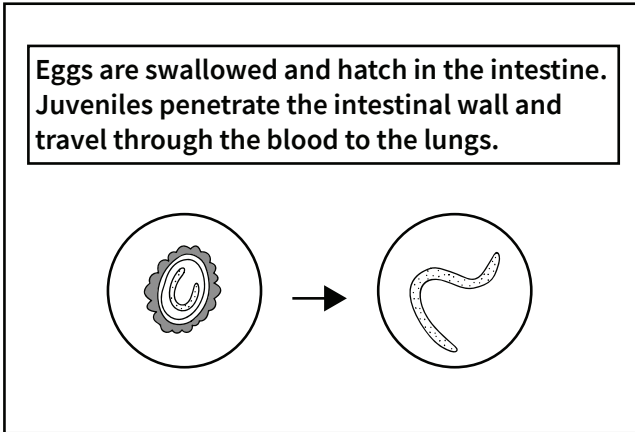
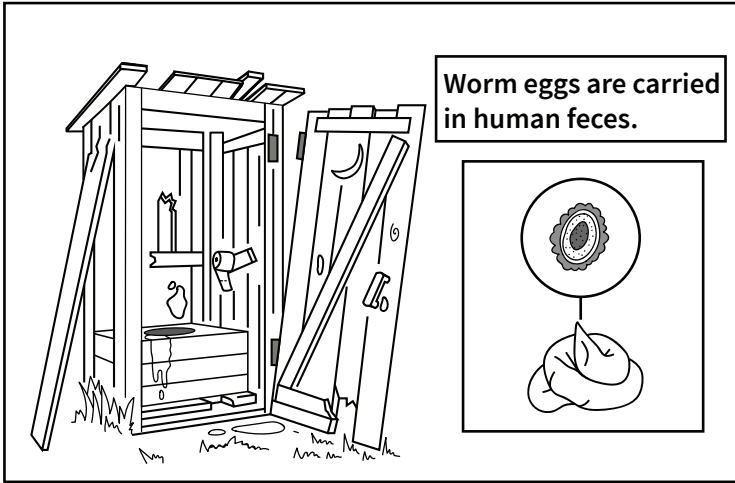
Large human nematode

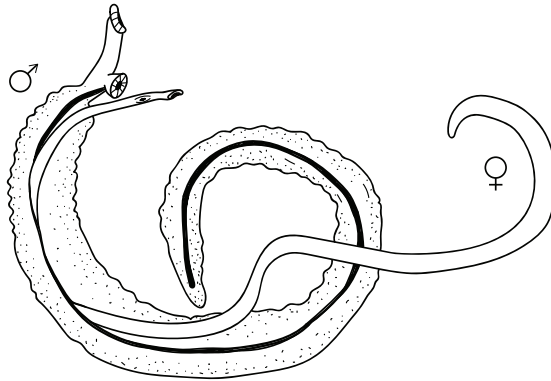
Nemata

Size: 15-50 cm long, 2-5 mm wide

Host: humans

In the human intestine, female *Ascaris* worms produce eggs that are passed in feces. People become infected by consuming contaminated food or water. These worms are common in tropical and some temperate regions, and more than two billion people are infected. Some infected people show no symptoms, while others have mild discomfort. Children infected with numerous *Ascaris* have serious problems that can turn deadly. In areas lacking adequate sanitation, infections are common.





***Schistosoma mansoni***

Blood fluke

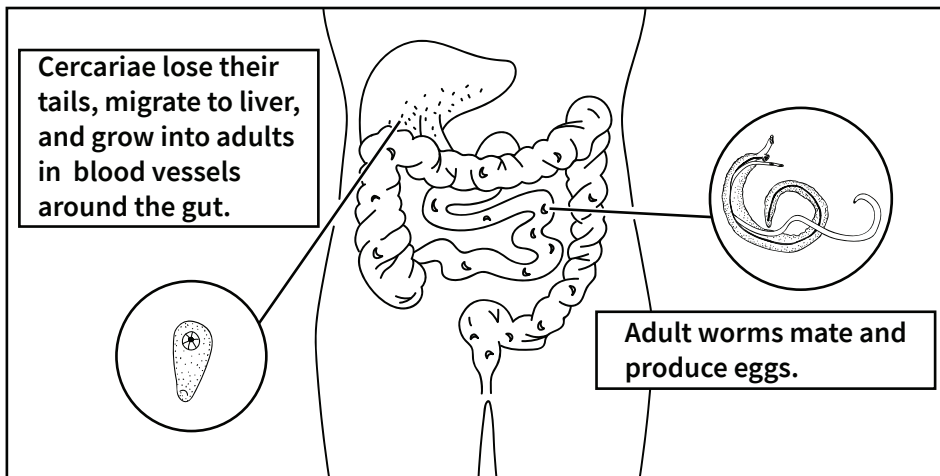
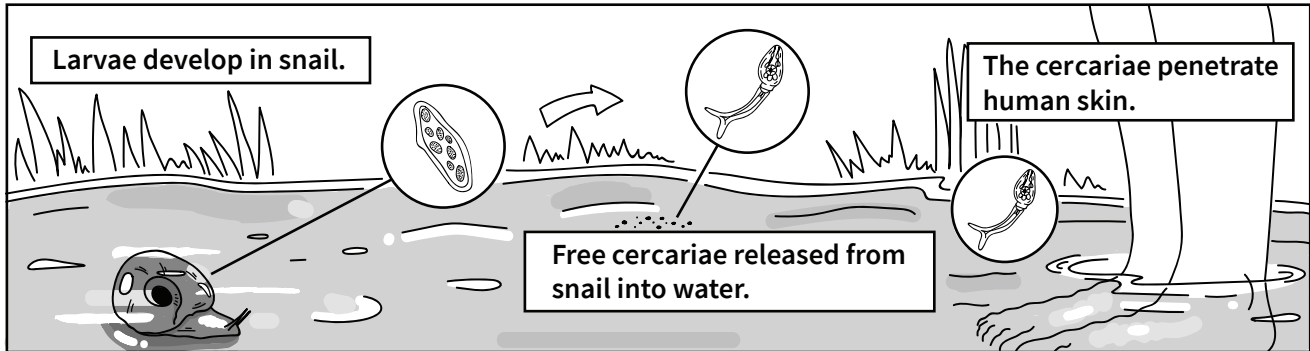
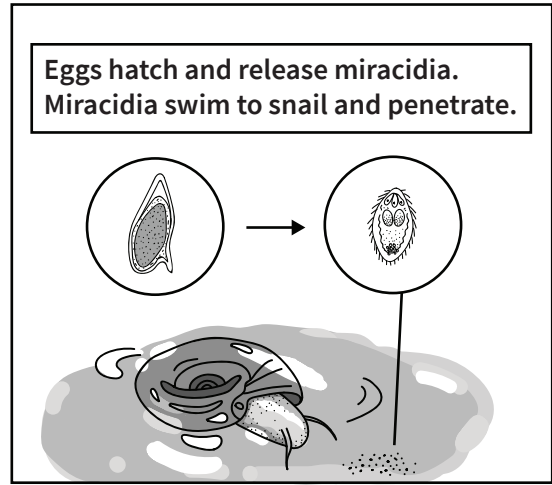
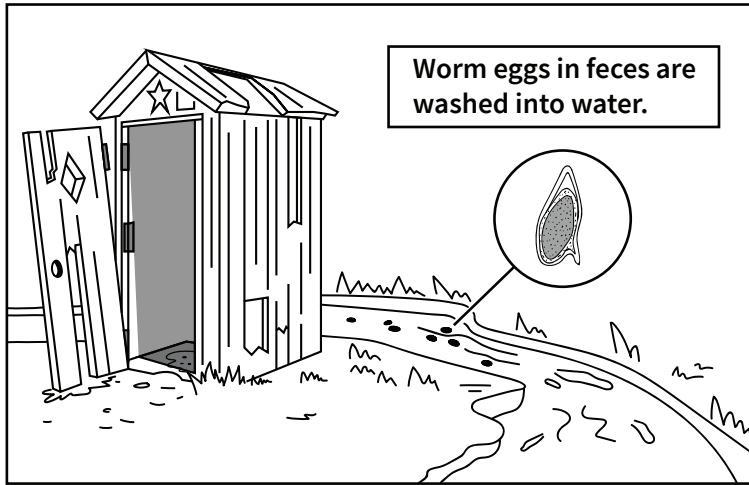
Platyhelminthes

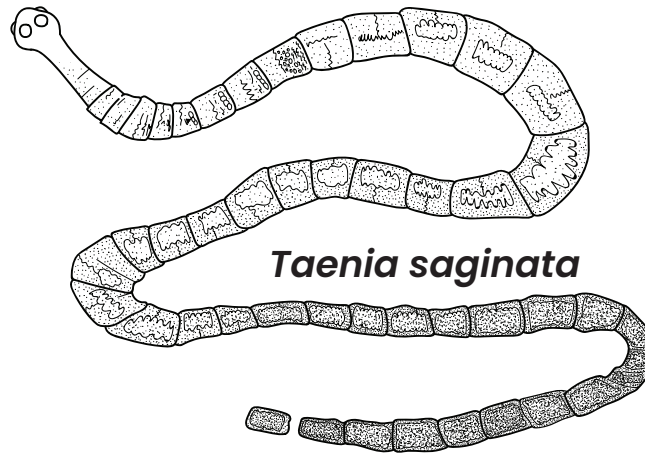
Size: 10-20 mm long, 800 micrometers to 1 mm wide

Intermediate host: *Biomphalaria* snails

Definitive host: rodents and primates

In humans, the adult schistosome worms live in the portal veins that drain the large intestine. Unlike other trematodes, these worms have separate sexes that are permanently attached to one another. Females lay hundreds of eggs per day that are passed into the blood. About two thirds of the eggs remain in the host, trapped in the liver and other organs. The rest are expelled in feces. In water, the first-stage larvae hatch and swim until they find a *Biomphalaria* snail. In the snail, they migrate to the digestive gland, multiply, and eventually produce second-stage larvae with Y-shaped tails. These larvae break out of the snail and swim to the surface of the water. They penetrate soft parts of the skin when people, usually kids, wade or swim in the water.





Beef tapeworm

Platyhelminthes

Size: 4-12 m long, 1 cm wide

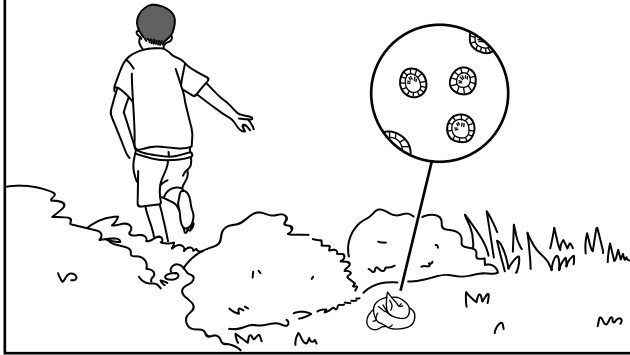
Intermediate host: cattle

Definitive host: humans

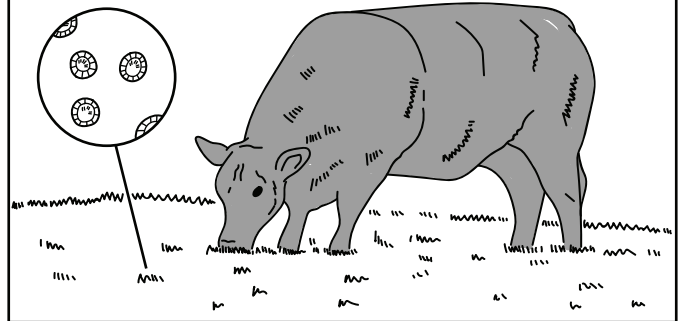
Adult *Taenia* worms produce tens of thousands of eggs per day in the small intestine of humans. Eggs passed in feces can contaminate grazing areas in regions with poor sanitation. When cattle ingest the eggs, they hatch, penetrate the intestine, and travel to muscle tissue. When a person eats raw or undercooked meat, they may ingest the infective tapeworm larvae, which then grow into adults in their intestine.



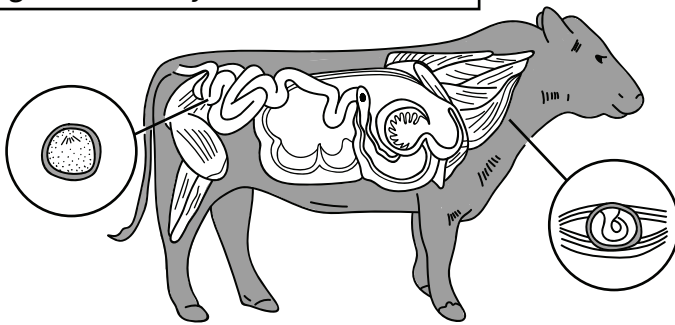
Parasite eggs are released in human feces.



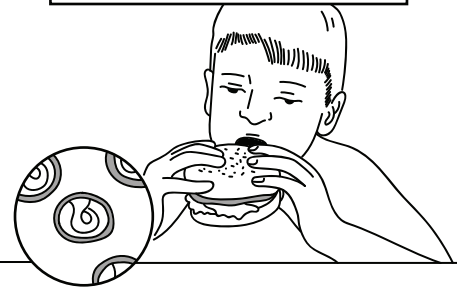
Cow eats contaminated grass.



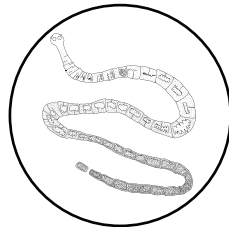
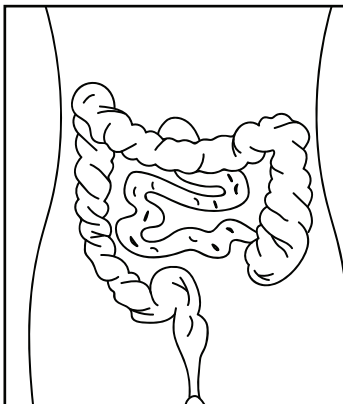
Eggs hatch in cow. Larvae penetrate gut and form cysts in muscles.



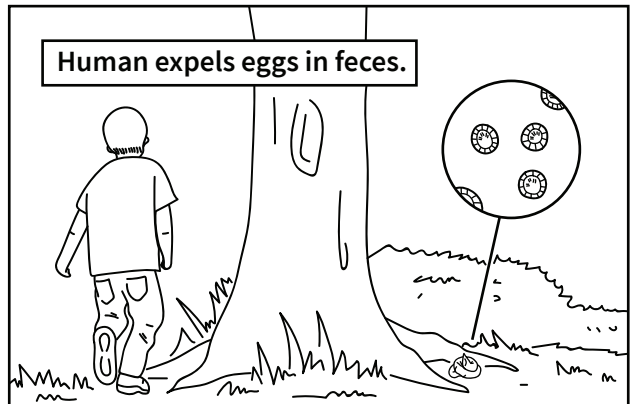
Human eats undercooked meat and swallows cysts.

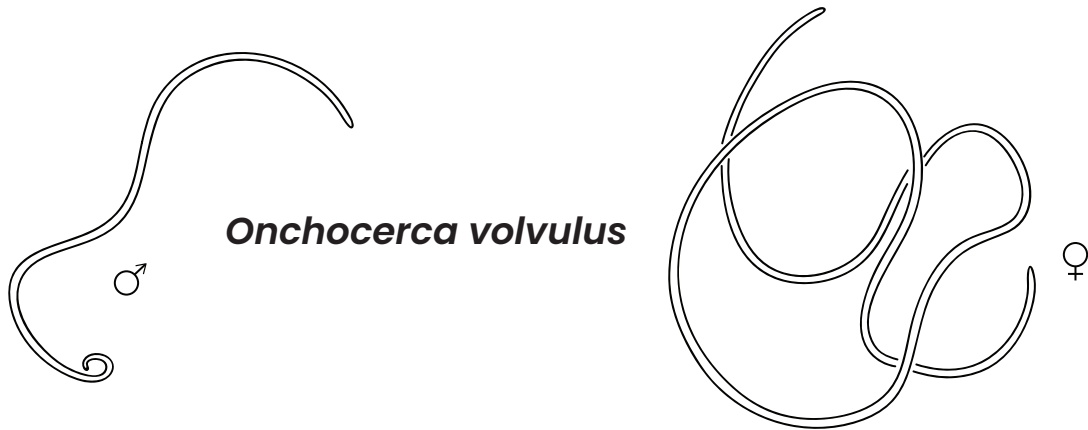


Larvae are released and develop into adults in small intestine.



Human expels eggs in feces.





River blindness worm

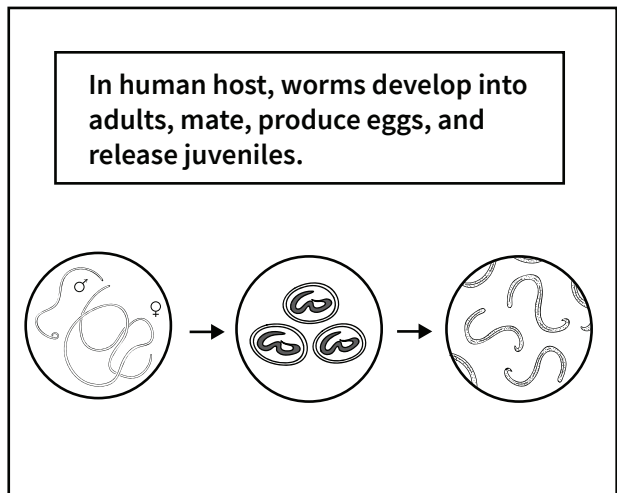
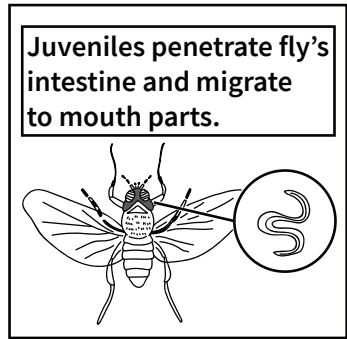
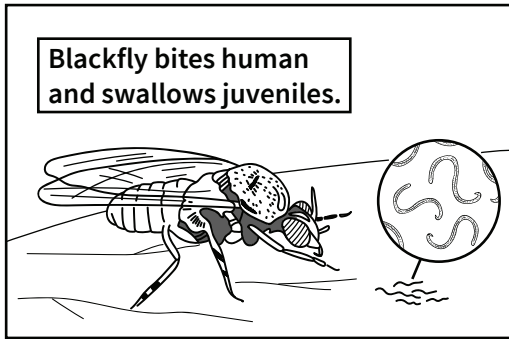
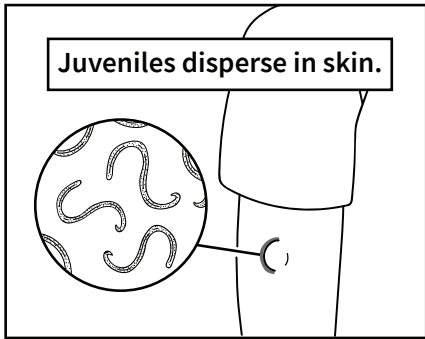
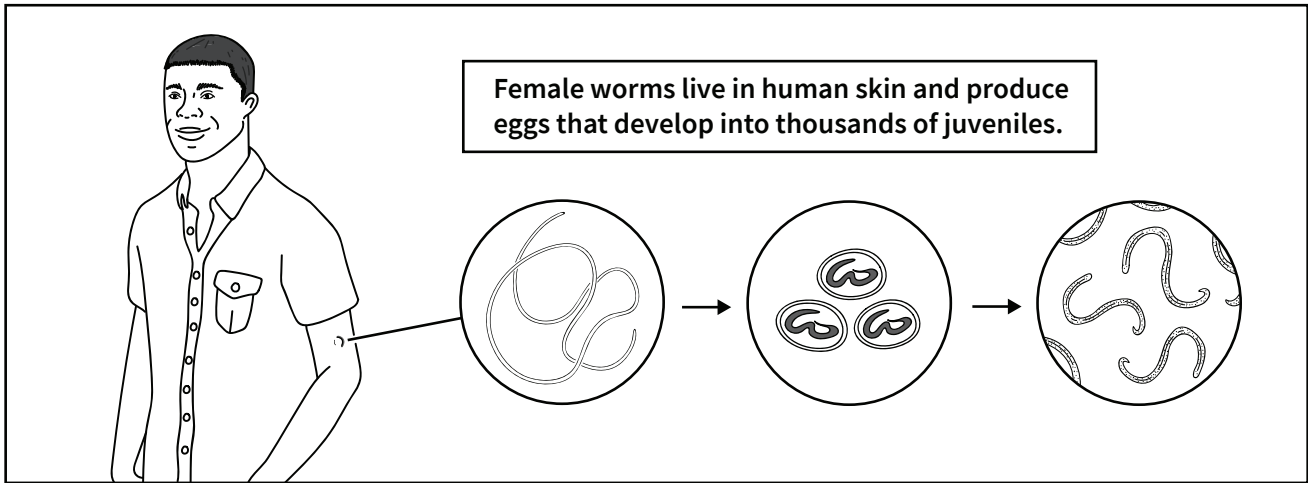
Nemata

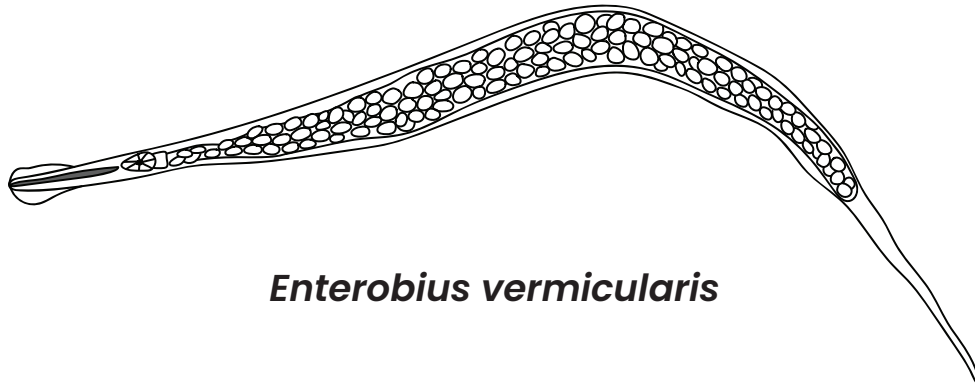
Size: 23-70 cm (females), 1.5-5 cm (males)

Intermediate host: blackflies

Definitive host: humans

Adults of this nematode live in fibrous nodules in the skin of their human hosts. Eggs hatch into juveniles that circulate in the skin. When a female blackfly takes a blood meal, the juveniles are ingested, go through three molts, and migrate to the fly's salivary glands. When the blackfly bites another person, the juveniles pass via the saliva into the host. The worms produce skin lesions in people, and severe effects occur when the juveniles cause inflammatory damage to the eyes, eventually resulting in blindness.





***Enterobius vermicularis***

Human pinworm

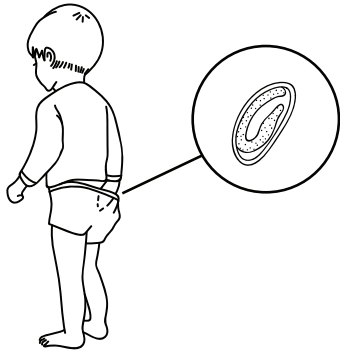
Nemata

Size: 3-13 mm

Host: humans

Pinworms are one of the most common parasites of people. Pinworms live in the large intestine of the host, where they feed on bacteria. Females often migrate out the anus and lay eggs on the surrounding skin. The eggs cause itchiness, so when people scratch themselves, eggs are picked up on their hands and can be dispersed easily in the environment. Once pinworms are established in households with children, eliminating them requires thorough cleaning.

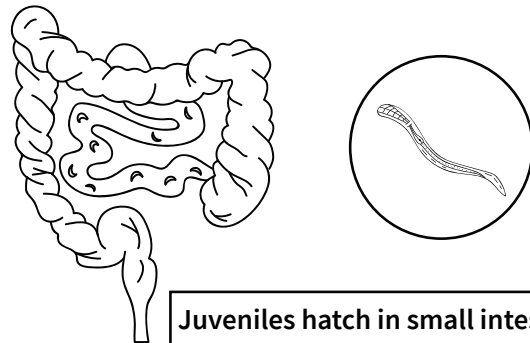
Female worms migrate out to lay eggs.



Eggs are transferred to hands and other surfaces.

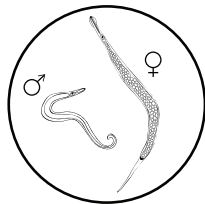


Eggs are ingested.

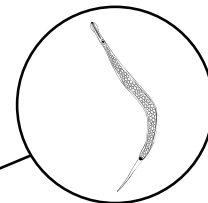


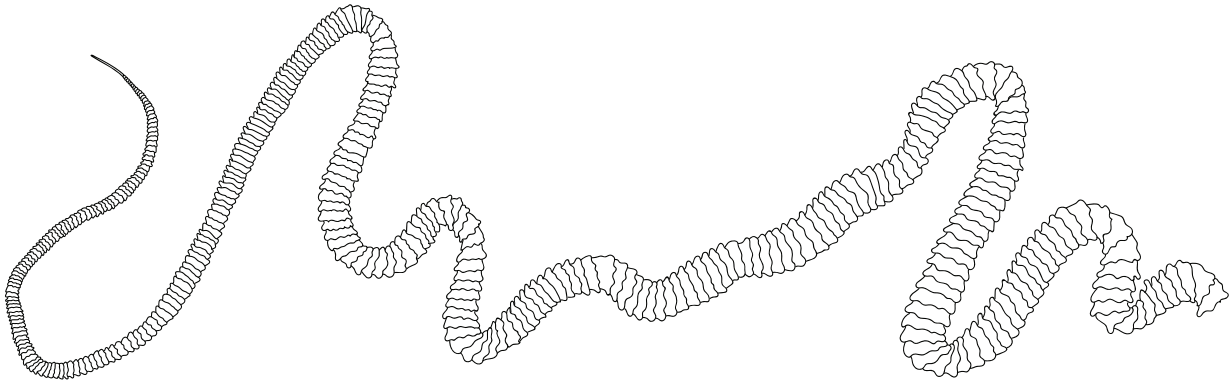
Juveniles hatch in small intestine.

Adults mature and mate in large intestine.



Female worms migrate out anus to lay eggs.





### ***Tetragonoporus calyptocephalus***

Whale tapeworm

Platyhelminthes

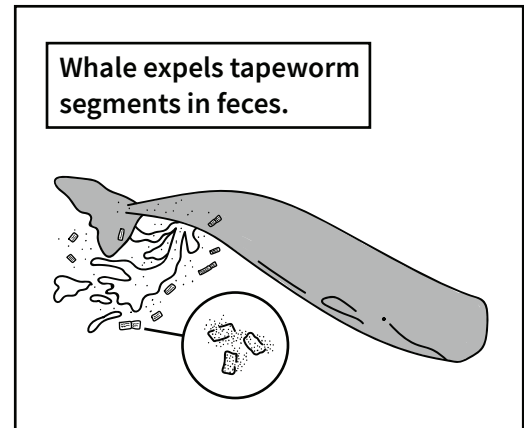
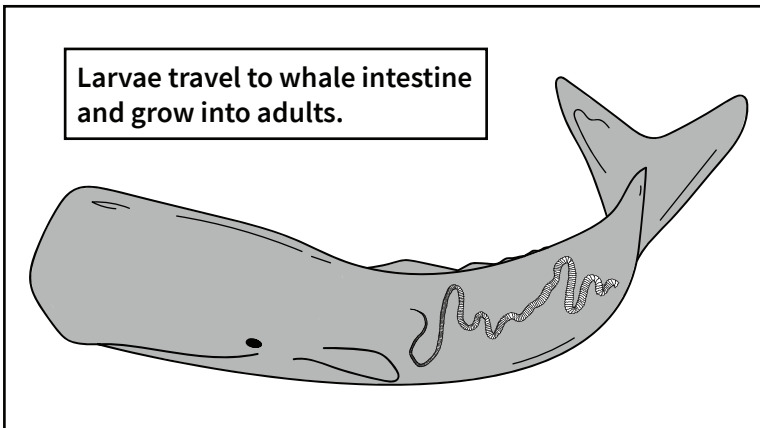
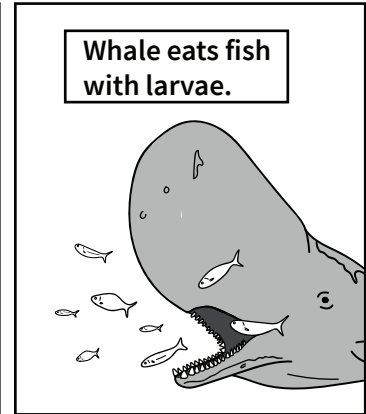
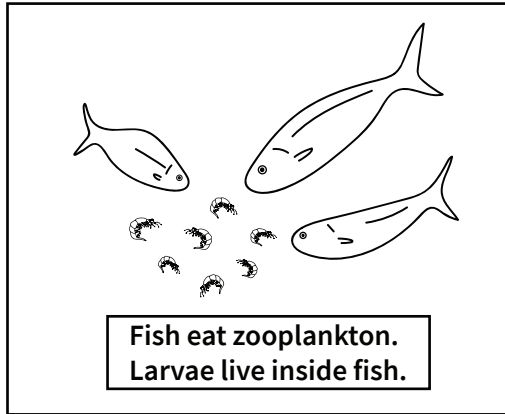
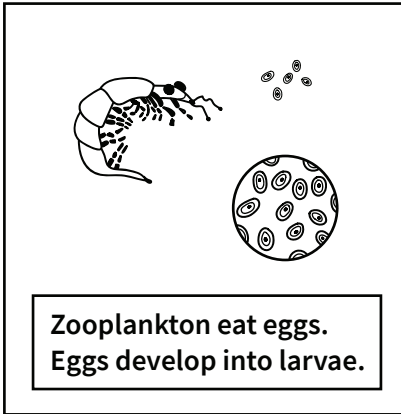
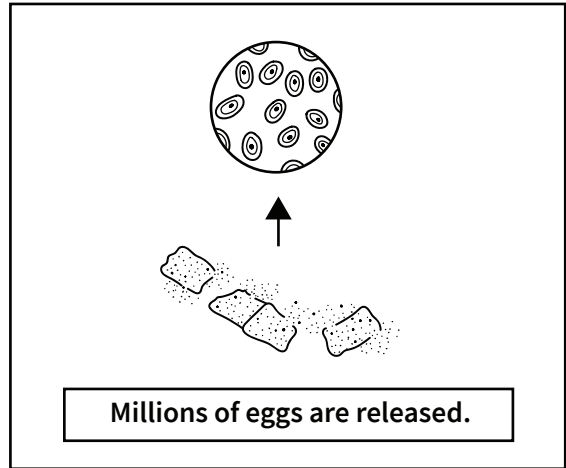
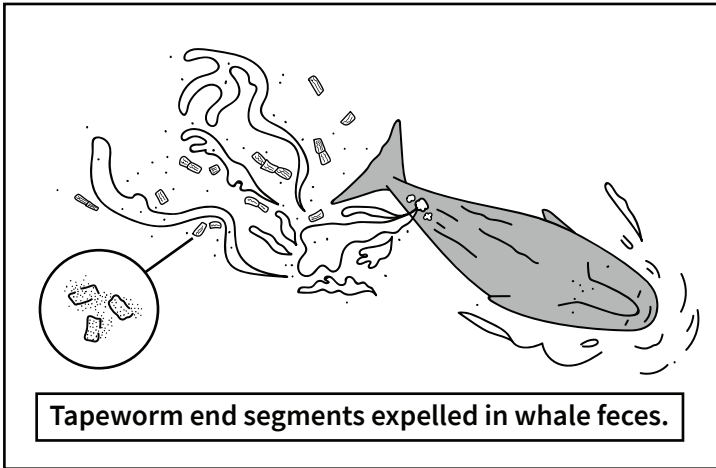
Size: Up to 30m

1st intermediate host: marine crustaceans

2nd intermediate host: marine fishes or squid

Definitive host: sperm whales

This parasite is one of the longest tapeworms known. Little is known about its ecology, but related species have two intermediate hosts: the first are small zooplankton and the second are fish or squids that feed on them. When these hosts are eaten by sperm whales, the tapeworms mature in the small intestine and grow to their colossal size. Fecal analysis of sperm whales has shown that this tapeworm is more common in some regions, suggesting differences in the diet of these top marine predators.



## Glossary

**anus** is the opening from the intestine where waste products are expelled.

**asexual reproduction** is the process of producing offspring without a sex partner.

**biodiversity** measures the variety and abundance of living organisms.

**blackfly** in the genus *Simulium* carries the worm that causes river blindness.

**carnivore** is the group of mammals that includes dogs, cats, bears, and hyenas.

**cercaria** is the 3rd developmental stage of a parasitic trematode.

**cestodes** are tapeworms.

**Chagas disease** is caused by the parasitic protozoan *Trypanosoma cruzi*.

**chiggers** are blood feeding mites, small relatives of ticks.

**climate change** refers to the process of human-caused warming of Earth.

**cyst** is a pocket within the tissue of a host that can contain a parasite.

**definitive host** is the host in which parasites reproduce sexually.

**ecosystem** includes the living and nonliving components of an environment.

**ectoparasites** are parasites that live or feed on the surface of their host.

**emerging diseases** are new diseases caused by parasites or pathogens.

**endoparasite** is a parasite that lives and feeds inside its host.

**evolutionary relationships** describe how one organism is related to others.

**extinction** is the loss of a species from the local or global biological community.

**feces** are the undigested remnants of animal food, expelled as waste.

**filarioids** are long, thin nematodes adapted to live in the tissue of their host.

**fluke** is a common name for parasitic flatworms in the group *Trematoda*.

**host** is an organism that is infected with or is fed upon by a parasite.

**intermediate host** is the host for immature parasites.

**kissing bugs** are triatomid bugs, a group of insects that feed on blood.



**large intestine** is the end part of the intestine, where feces are produced.

**larvae** are the young and immature forms of worms, nematodes, and many insects.

**lifeline** is the life story of a parasite from the egg to the adult form.

**Lyme disease** is caused by a bacteria, *Borrelia burgdorferi*, and is transmitted by ticks.

**malaria**, caused by single-celled *Plasmodium*, is transmitted by mosquito bites.

**microfilariae** are the microscopic larvae of certain filarioid nematodes.

**miracidia** are the first larval stage of parasitic flatworms.

**nematodes** are very common smooth, string-like worms that live in soil and water.

**parasitism** is an evolved relationship in which one species benefits and the other is harmed.

**platyhelminths** are flatworms, a group that includes tapeworms and flukes.

**population** is a group of individuals of a species that forms a breeding community.

**proglottids** are the egg-producing segments of tapeworms.

**protozoa** are a group of single-celled microorganisms that belong to the phylum Protista.

**Rocky Mountain spotted fever** is caused by bacteria transmitted by ticks.

**sexual reproduction** is when two individuals mate and generate offspring.

**sickle cell anemia** is caused by a gene that changes red blood cells, making them less efficient at carrying oxygen.

**small intestine** is part of the gut where nutrients are absorbed.

**species diversity** measures the richness of species at a particular location.

**tapeworms** are long, segmented flatworms that live in the intestine of their hosts.

**ticks** are eight-legged arthropods that feed on the blood of a host.

**trematodes** or flukes are parasitic flatworms that look like small leaves.

**zoonotic diseases** are caused by pathogens that come from wild animals.

**zooplankton** are microscopic animals that float in lakes, rivers, and oceans.

## Resources for Youth

### Books

**Belly-Busting Worm Invasions! Parasites That Love Your Insides!** By T.E. Lewis Tilden. 2008. Franklin Watts.

**Nasty Parasites.** By Roxane Troup. 2019. Enslow Publishing, LLC.

**New Guinea Tapeworms and Jewish Grandmothers: Tales of Parasites and People.** 1987. By Robert D. Desowitz. W.W. Norton & Co.

**Parasite Rex: Inside the Bizarre World of Nature's Most Dangerous Creatures.** By Carl Zimmer. 2001. Simon and Schuster.

**Parasites: The Inside Story.** By Scott Gardner, Judy Diamond, and Gabor Racz. 2022. Princeton University Press.

**The Gross Science of Lice and Other Parasites.** By Keith Olexa. 2018. The Rosen Publishing Group.

**What's Eating You? Parasites – The Inside Story** by Nicola Davies. 2007. Candlewick Press.

**Watch Your Mouth! And Discover your Amazing Microbes.** By Linda Allison, Rebecca Smith, and Judy Diamond. 2016. Bitingduck Press.

### Comics

**C'Rona Pandemic Comics.** 2021. By B. Hall and team. U. of Nebraska Press.

**Mosquitoes Suck.** 2021. By K. Bruna, S. Erikson, L. Bartholomay. U. of Nebraska Press.

**Occupied by Microbes.** 2019. By J. Diamond and the Biology of Human team. Zea Books.

**Carnival of Contagion.** 2017. By B. Hall, C. Zimmer, J. Diamond. 2017. U. of Nebraska Press.

**World of Viruses.** 2012. By J. Diamond and team. University of Nebraska Press.

### Activities

Download the free WONDERWISE Parasite Sleuth activity book at <http://wonderwise.unl.edu/12parasi/parasite.htm>

### Cool activities for kids.



Wonderwise was awarded First Place for the Advancement of Learning Through Broadcasting by the National Education Association for Children's Programming 1998. Wonderwise is based upon work supported by the National Science Foundation under Grant No. 9909496.

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