Parasites That Attack Animals and Man

SOME of the parasites that occur in animals also attack people.

Some have to develop in an animal or in two different animals before they can invade human beings. Man then is the definitive, or final, host. He usually acquires the parasites by eating the intermediate animal hosts or (if they are small insects) by swallowing them accidentally. For some parasites, human beings are the intermediate hosts and animals are the final hosts.

Even the few parasites that live only in man are related closely to others that live in animals. Farm animals, dogs and cats, and rats and mice contribute to man's burden of parasites. That burden tends to become lighter as our civilization advances, however, largely because the sanitary barriers that have come into existence impede the spread of parasites from parts of the world where standards of sanitation and hygiene are imperfect.

Some of the major parasites that man shares with animals are discussed here. The examples illustrate that parasites can be acquired by eating infected food of animal origin and by being in close contact with animals that harbor the kinds of pests that can be transmitted to human beings.

The beef tapeworm derives its name from the fact that in its immature, or cystic, stage it lives in the flesh of cattle. The adult (or strobilate) tapeworm, which arises from the cystic stage, lives in the intestine of man, where it can attain a length of 40 feet or more. An infested person usually harbors only one tapeworm.

The adult tapeworm is whitish in color. It is a chain of hundreds of proglottids, or segments, which are anchored to the intestinal wall by four cup-shaped suckers on its head. A unique feature is that the head lacks the microscopic hooks that most tapeworms have. It is therefore known also as the unarmed tapeworm of man.

The immature stage, known as a bladderworm, or cysticercus, occurs mainly in the muscles, including the heart, and in other internal organs of cattle. It is grayish white. It is about one-fifth to three-fifths of an inch long and about half as wide. It has thin walls and contains a fluid into which the head of the future worm is pushed, just as the tip of a finger might be pushed into a glove.

Before the middle of the 19th century it was not known that a bladderworm was the intermediate stage of a strobilate tapeworm. Bladderworms were regarded as distinct parasites without sex organs and were therefore given scientific names of their own. The name given to the bladderworm of the beef tapeworm was Cysticercus bovis, which no longer has any scientific validity. Parasitologists retain that name in their writings for convenience in differentiating the bladderworm from the adult tapeworm. The valid scientific name of the unarmed, or beef, tapeworm of man in all stages of its development is Taenia saginata.

The life history of the beef tapeworm involves an alternation of hosts. Man, the definitive host, discharges the ripe, or gravid, segments with the excreta, or the segments may pass out independently and be discovered in the bed linen of infected individuals. Once outside the body, the gravid segment begins to disintegrate and release the eggs it contains.

A single gravid segment may contain several thousand eggs. Several segments may become gravid and be expelled almost every day for several years by one tapeworm carrier. If the
segments reach pastures, barnyards, feed lots, and other places where cattle graze or feed, the animals may swallow some of the eggs and become infected with bladderworms.

Inside the body of an animal, the microscopic egg hatches, and the tiny larva bores into the intestinal wall. From there it reaches the blood stream and is carried to all parts of the body. It localizes mainly in the flesh and heart. The parasite develops rather slowly and becomes a bladderworm in about 2 to 4 months.

A person who happens to eat raw or rare beef that harbors a single live bladderworm can become infected with a tapeworm. The tapeworm head inside the bladder is already fully developed. In the stomach it becomes evaginated, or everted, and the bladder wall is digested. When it gets into the intestine, the head of the future tapeworm attaches itself to the intestinal wall and grows by producing more and more segments. The newly formed segments are the ones right below the head. New ones, as they form, push the older ones down, so that the first segment to be formed comes to occupy the lowest position in the chain that constitutes the strobilat tapeworm.

About 10 to 12 weeks after the bladderworm has been swallowed, the oldest segment becomes gravid and detached from the rest of the chain. The others follow this pattern in rapid succession. The process continues as long as the tapeworm remains in the intestine. The affected individual meanwhile passes many thousands of eggs with the detached segments nearly every day.

The tapeworm carrier who happens to live on a farm, ranch, cattle-feeding establishment, or wherever he has contact with cattle is the source of infection for them—especially if sanitary facilities are primitive. The carrier might deposit waste matter on a pasture or in a place where wind and rain can disperse it on a pasture or feed lot or wash it down to ponds and sloughs from which cattle drink.

“Beef measles” is the name applied to the condition in beef infected with these bladderworms. The economic loss from the condemnation of cattle on account of “measles” at times may be considerable, even though the percentage of infested cattle is small. About 16,500 to 27,000 beef carcasses were found annually in 1948–1954 to be infected with bladderworms out of a total annual slaughter of 12 million to 15 million head and 5.5 million to 7.5 million calves.

Infected carcasses in which the bladderworms are readily found are condemned as unfit for human food and consigned to the tank. If one dead or degenerated cyst, usually located in the heart, is discovered, the carcass is passed for food after the cyst is removed. Cattle carcasses that have a somewhat greater infestation also may be passed for food after the few visible cysts are cut away. Such carcasses, however, must be refrigerated at temperatures and for periods known to be fatal to all the parasites, or they must be thoroughly cooked at a temperature of 140° F. Such cooking also kills the parasites.

The control of “beef measles” will control the beef tapeworm in man. Detection by physicians of human carriers of tapeworm, especially those who live in rural areas, and prompt treatment to remove the parasites, however, will end the hazard of infection of cattle with bladderworms. In simpler terms: Improvement in rural areas in ways of disposing of human wastes will prevent cattle from becoming infected; that, in turn, will ultimately eliminate the carrying of tapeworms by people.

The pork tapeworm, *Taenia solium*, also lives in the human intestine. It is a long, whitish, strobilat tapeworm. It resembles the beef tapeworm in most respects, but it is usually shorter and is about 2.5 to 5 feet long. Another difference is that the pork tapeworm has a double row of tiny hooks, besides the four suckers, on its head. The pork
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The tapeworm is also known as the armed tapeworm of man.

The cystic stage of the pork tapeworm, known for convenience only as *Cysticercus cellulosae*, is like that of the beef tapeworm. The bladderworms occur in swine, but they also can live in man. They occur in various parts of the body. They tend to localize in the muscular part of the diaphragm, the loin muscles, heart, the jaw muscles, muscles between the ribs, muscles of the hind legs and shoulders, brain, eyes, liver, lungs, and other organs.

The pork tapeworm alternates between man and the hog in its developmental cycle. Swine become infected by swallowing, with feed or water, the tapeworm eggs freed from the gravid segments passed in the excreta of a human carrier. Man, in turn, acquires the strobilate tapeworm by eating raw or incompletely cooked pork infected with the bladderworms.

Persons harboring the pork tapeworm in the intestine could get tapeworm eggs on their hands. The hands might transfer the eggs to the mouth and thus pave the way for an infection of the muscles and the heart, brain, and eyes. The pork bladderworm in the brain of man is known to produce symptoms like those of epilepsy.

Very few persons in this country harbor the pork tapeworm.

Hogs so infected also are rare in the United States, but they might harbor thousands of bladderworms in their organs and muscles. Only 11 infected swine carcasses were found by Federal inspectors in more than 57 million carcasses inspected in 1953. Only four such infected carcasses were found in 1954 in more than 50 million inspected. Federal meat inspectors condemn as unfit for human food all hog carcasses in which are bladderworms.

We can prevent bladderworms in swine and the pork tapeworm in man by not eating raw or undercooked pork and by improving rural sanitation.

The hydatid tapeworm, *Echinococcus granulosus*, lives as an adult parasite in the intestines of dogs and related wild carnivores and as a larva in man, cattle, sheep, goats, swine, horses, and wild animals. The larva localizes in the liver, lungs, spleen, kidney, brain, and other organs.

The adult tapeworm in the intestine of a dog or other carnivore is about one-eighth to one-fourth inch long and about one-eighth inch wide. It attaches itself to the wall of the intestine by four cup-shaped suckers on its head, which also has small hooks. Behind the head and neck are two segments. The second segment contains the eggs, which start new infections.

Only rarely has the adult hydatid tapeworm been found in dogs in this country—perhaps because most dogs that have been autopsied were from pounds in cities, where they had little chance of acquiring the tapeworm. Country dogs could more easily become infected by eating offal from unsupervised slaughterhouses.

The larval stage of the hydatid tapeworm is the largest of its kind. The adult tapeworm is the smallest. The larva is several inches to almost a foot in diameter. Its size alone would make it unusually dangerous to man, because it localizes in the liver and lungs. Persons so affected require surgery.

Human beings acquire hydatids by fouling their hands in some way with the excreta of infected dogs or by picking up food or by swallowing food or water contaminated with the tapeworm eggs. Petting an infected dog is one way of contaminating the hands; dogs often roll in excreta, which may contain the eggs. The eggs hatch into larvae when they reach the human intestine. These larvae can penetrate the intestinal wall. They enter small blood vessels and so reach various organs and tissues, where they develop rather slowly and attain a diameter of about one-half inch or so after several months. Many tapeworm heads occur in a single hydatid cyst. Each head can develop into an adult tapeworm when the cyst or part of it is swallowed by a dog or other final host.
Human infections with hydatids are rare in this country but are common elsewhere, especially in Iceland, Australia, New Zealand, Argentina, and Uruguay. Campaigns to arouse the public to the danger of acquiring hydatids from dogs have been organized in some countries.

Nearly 12,000 livers from more than 50 million cattle slaughtered under Federal meat inspection and 1,133 calf livers out of 5.5 million inspected in 1937–1942 had hydatid cysts. We lack precise figures on the extent of infection of swine, but there is evidence that in some parts of the country hogs are frequently infected.

Adequate inspection could control the hydatid tapeworm. The condemnation and proper disposal of parts of affected carcasses, a practice enforced by Federal and other competent inspectors, breaks a link in the life cycle of this dangerous parasite. When inspection is lacking or is imperfect, discarded lungs and livers of affected animals might be eaten by dogs or wild carnivores and so spread the parasite.

The fish (or broad) tapeworm, Diphyllobothrium latum, is a human parasite that spends part of its early life—the plerocercoid stage—in some species of fresh-water fish. It is rather common in man in some European countries. It has been found in man and animals in an area that extends across the Great Lakes and the upper Mississippi Basin, into Manitoba, and almost to the Rockies.

The adult tapeworm in man may attain a length of 25 feet or more. It lives also in the small intestine of dogs, cats, foxes, and other flesh-eating, warm-blooded animals.

The eggs, microscopic in size, are eliminated from the ripe segment of the tapeworm into the host's intestine. The eggs reach the outside with the excreta and continue their further development only if they get into fresh water. There they hatch. The tiny larvae develop minute appendages that propel them through the water.

The larvae continue to develop in certain copepods, or fresh-water fleas, which are the first intermediate host. Certain fresh-water fish, in which the tapeworm can reach a still further stage of development, become infected in turn by swallowing the infected copepods. The pike, the walleyed pike, the sand pike, and other lake fishes are therefore the second intermediate hosts.

Human beings, the final hosts, acquire the fish tapeworm by eating raw, nearly raw, cold-smoked, or salted fish in which are live plerocercoids. Carnivorous animals become infected by eating infected fish.

Presumably the fish tapeworm was introduced into North America by the immigrants from northern Europe, where this tapeworm is common. Eggs of the tapeworm passed with their excreta into lakes.

One infected person may discharge a million tapeworm eggs a day.

Furthermore, since dogs, cats, foxes, and other wild carnivores also are definitive hosts, links have been added to the chain that conveys this parasite from several final hosts to water fleas, with which our lakes are teeming; from there to suitable species of lake fish; and finally back to man and other mammals that eat raw fish.

Other tapeworms living in animals also can be transmitted to man. One tapeworm from dogs and two from rats and mice are especially important because they are more likely to be found in children than adults.

The dwarf tapeworm, Hymenolepis nana, is about 2 inches long. It occurs in the intestine of rats and mice all over the world. It is more common in warm countries. In the Southeastern States, about 10 percent of the schoolchildren whose excreta was examined for some evidence of parasitic infections were infected.

The life cycle of the dwarf tapeworm is unusual in that no intermediate host is required. Rats and mice become
infected by eating feed or drinking water contaminated with the droppings of other infected rodents. The droppings contain the tapeworm eggs.

Children and adults become infected, apparently with a human strain of this parasite, by soiling their hands or contaminating their food with human excreta that contains the tapeworm eggs. Whether persons commonly acquire the tapeworm from rodents is doubtful, but almost certainly that could happen at times.

**The Rat Tapeworm, Hymenolepsis diminuta**, also occurs in the household rodents. It is much larger than the species we named. It also is widely distributed, but it is less common in man than the dwarf tapeworm.

Some insects, including fleas and other external parasites of rodents and some that infest cereals, can serve as the intermediate hosts. Human beings acquire the rat tapeworm by accidentally swallowing an infected intermediate host.

**The Carnivore Tapeworm, Dipylidium caninum**, occurs in the intestine of dogs, cats, wildcats, jaguars, foxes, and other carnivores. It also may occur in children and less often in adults. It is localized in the small intestine of its final hosts.

Its life cycle involves intermediate hosts, including the dog flea, the cat flea, and the human flea. The insect becomes infected while still a larva by ingesting the tapeworm eggs passed with the droppings of infected carnivores. The final host, including man, acquires the tapeworm by accidentally swallowing an infected intermediate host.

**Trichinæ (Trichinella spiralis)** and trichinosis, the disease these roundworms cause, are gotten by people from eating the uncooked flesh of an animal that harbors the parasites. Animals become infected in the same way. Only carnivorous and omnivorous animals can transmit trichinae to man and to one another. Of the animals slaughtered for human food in the United States, none is carnivorous, and only the hog has omnivorous habits. Therefore, pork is the common source of human trichinosis. The only other source in this country is the bear, the flesh of which is eaten occasionally.

Swine become infected by eating offal or garbage containing scraps of raw infected pork or by eating infected rats, mice, or other animals that harbor trichinae. Rats, mice, and other small animals, in their turn, acquire trichinae by eating raw infected pork or other infected meat in garbage or elsewhere, or through cannibalism. Likewise dogs, cats, and wild carnivores acquire trichinae by eating the raw flesh of animals already infected. As long as trichinae exist in any animals likely to be eaten by hogs, man runs the danger of acquiring trichinosis.

The developmental cycle of trichinae is:

As the meat is digested in the stomach of a person, a hog, or other animal, the microscopic worms lodged therein are freed from the minute cysts, or sacs, in which they are enclosed. The worms then pass rapidly into the intestine, where they become localized by boring part way into its wall. They become sexually mature in about 2 days. Following mating, the worms continue to grow and attain their maximum size 4 or 5 days later, or a week or so after they have been swallowed.

The full-grown female worms are between one-eighth and one-sixth inch long. The males are half that long. The fertilized eggs are retained in the uterus, where they develop and hatch. They finally escape from it as larvae. The larvae may continue to be born for several weeks. Afterwards the adult parasites die and pass out of the intestine.

The newborn larvae, of which several hundred may be deposited by one
female worm, pass into the blood stream and to all parts of the body. About 250 of these minute parasites measure an inch. They reach various tissues and organs, but they become localized mostly in the voluntary muscles or flesh by penetrating the muscle fibers. There they grow. Gradually they become surrounded by a thin capsule, or cyst, in which they remain dormant until the flesh is eaten by another animal. The completion of their life cycle therefore depends on the eating of the flesh of an infected animal by another animal.

Whether one can see the symptoms of trichinosis and whether symptoms develop at all depend on the number of trichinae that have been eaten with infected pork or other meat. If slightly infected pork is eaten in small or moderate amounts, no symptoms (or mild, vague symptoms of short duration) may be apparent. Regardless of the severity of the symptoms, however, they are due to the activities of the parasites as they grow in the intestine of a person or animal and deposit their broods of larvae, which penetrate the muscles and become encysted in them.

An affected person may become nauseated, vomit, develop a diarrhea, and suffer from abdominal pains. Sometimes those symptoms are partly or entirely absent. When the larvae are distributed throughout the body by the blood and penetrate the muscles, the affected individual may have severe muscular pain, and the muscles may become swollen, hard, and tense. Moving the eyes and the tongue and chewing, breathing, swallowing, and other muscular movements become painful. These symptoms may become more pronounced as the larvae continue to grow within the muscle fibers and become enclosed in cysts. New symptoms may appear, and the fever, which set in earlier in the course of the disease, often becomes more pronounced. Recovery from a severe attack is slow. Sometimes the affected individual may die 5 or 6 weeks after eating the infected meat.

Routine inspection of hogs will not lead to the discovery of those that harbor trichinae. In some European countries, especially in countries where people commonly eat raw pork, microscopic inspection of pork for trichinae is part of the meat-inspection procedure. Such inspection, however, cannot guarantee the detection of all infected hog carcasses. If the hog is lightly infected, the examination under the microscope of even numerous small samples of meat may fail to show any trichinae. The meat might be dangerous if large amounts of it are eaten raw or are not cooked or cured enough.

About 66 of every 10,000 hogs in the Corn Belt contain trichinae. They are so lightly infected, however, that it is doubtful that anyone would acquire a sufficient number of trichinae to get trichinosis unless he ate large amounts of raw or inadequately cooked pork. The incidence of trichinae of farm-raised hogs between 1933 and 1939 was nearly 1 percent. Early in this century it was about 1.5 percent—evidence of progress in reducing the extent of the infection in farm-raised hogs.

In garbage-fed hogs from various parts of the country, however, the incidence of trichinae in 1933-1939 was nearly 6 percent. In Massachusetts it was a little more than 10 percent. In 1949-1952, pigs from garbage-feeding establishments in Boston, New York, and Philadelphia showed an incidence of slightly more than 11 percent.

In 1954 and 1955, following the enactment by most States of legislation requiring the cooking of garbage to be fed to swine in order to prevent the spread of the disease vesicular exanthema, there were indications of a marked decline in infection with trichinae of hogs fed cooked garbage. It was still too early, however, to say whether the decline would continue and whether other possible sources of infection, such as rats and mice, also would be affected by cooking garbage. Human trichinosis has been of considerable concern to physicians and
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public health workers in this country for many decades. The disease is not among the major maladies of man, but it is of considerable importance from the standpoint of human health. Trichinosis is a serious, painful, and sometimes a fatal disease of man. It is easily preventable by following the simple advice never to eat raw or incompletely cooked pork—but the fact remains trichinosis continues to occur from time to time.

From 1842, when the first case of human trichinosis was diagnosed in the United States, up to 1915, when all the known cases of the disease were summarized, the total number of recorded cases in this country was about 1,500. A search of all the reported cases in 1935 showed that the number was about 5,500. The average number of cases reported by the United States Public Health Service between 1937 and 1951 was about 350 a year. Medical authorities have assumed that not all cases of trichinosis have been correctly diagnosed and reported. Trichinosis has been confused in the past with typhoid fever, undulant fever, and other diseases.

The greatest number of trichinosis cases has been found on the Atlantic and Pacific seaboards, where the practice of feeding garbage to swine has become a sizable enterprise.

Besides cases diagnosed as such by physicians, people sometimes have had undiagnosed infections which apparently produced no symptoms during life. Since 1931, when such undiagnosed infections were reported as a result of studies made in Rochester, N. Y., on 700 persons who had died from various causes other than trichinosis, similar studies have been made in thousands of autopsies. An average of 1 of 6 persons whose muscles were examined after death by special methods showed evidence of having become infected with these worms sometime during life. Practically nothing, however, in their medical histories showed that they had ever had trichinosis.

Federal meat inspection does not guarantee that fresh pork passed as safe for human consumption is free of trichinae for the reason that there is no known practical system of inspection by which this can be done. The inspection requirements afford the consumer of ready-to-eat pork products ample protection against trichinosis, however. Among the foods that would be sources of human trichinosis without this protection are cooked hams, various classes of processed hams, frankfurters, salami, and other types of smoked sausages, as well as other pork-containing products designed to be eaten by the consumer without additional cooking. The safeguards that make those products safe include special refrigeration, special heating, or special curing. The processing, which is prescribed separately for each type of ready-to-eat product, is based on rigid, extensive experiments. Thorough cooking of fresh pork is the most effective safeguard that can be recommended to prevent trichinosis.

Other roundworms of domestic animals are transmissible to man. Two are of special importance. One is a hookworm that can cause a severe skin irritation. The other is the large intestinal roundworm, which as an immature worm has migratory habits that are injurious to its host.

Certain hookworm larvae can cause a skin disease known as creeping eruption by penetrating the human skin. The principal offenders are the larvae of the hookworm known as Ancylostoma braziliense, a parasite of the intestine of dogs and cats.

Infection of man usually occurs on beaches where the hookworm larvae, present on sand or soil, can make direct contact with the skin. Having penetrated it, the larvae move slowly for weeks or months under the skin, form tortuous tunnels therein, irritate the tissues, and cause intense itching. If one scratches the place, the skin may become infected.

Creeping eruption is quite common in persons who visit beaches in the
South and other persons whose work brings them into contact with sand or soil containing the hookworm larvae. The larvae develop from eggs deposited on the soil or sand with the droppings of infected dogs or cats.

The intestinal roundworm, *Ascaris lumbricoides*, is a parasite of man. It is structurally and in other ways indistinguishable from a closely related species that occurs in pigs. The two parasites cannot be told apart, but each type apparently prefers its own host in which to grow to maturity. While growing up, however, the pig roundworm can also live in man, at least for a time. It invades the liver, lungs, and other organs.

Its microscopic eggs are deposited with the manure of infected pigs. The eggs develop to the infective stage in about 2 weeks. When they are swallowed by susceptible pigs or accidentally by man, the eggs hatch in the alimentary canal, and the larvae are carried by the blood to the liver, lungs, and other organs. Only those that reach the lungs can get back to the intestine—by moving up the windpipe, reaching the back of the mouth, and being swallowed a second time.

A child or an adult could swallow pig ascarid eggs by contaminating the hands with soil in which the eggs are present or by eating food or swallowing water so contaminated. Even though the parasites may not mature in the human intestine, they can do much damage while wandering as larvae through the internal organs, especially if many of them do so at the same time.

Escape from parasites altogether is a goal that civilized man is attaining gradually.

Primitive man probably was beset by numerous insects and related creatures that pierced his skin to draw his blood and injected into it disabling and death-dealing microscopic parasites. He was tortured, moreover, by hookworms and other vicious marauders that anchored themselves to the lining of the small intestine. Migrating roundworms, including larvae which hardly leave an organ of the body untouched, also were part of the parasite burden he bore. He nourished huge tapeworms, which he acquired during feasts after a successful hunt. To this day internal parasites are threats to health in countries in Africa, Asia, and South America.

The devitalizing effects of internal parasites deprived primitive man of much of the energy he needed in his struggle with the forces of Nature. In fact, man's struggle against parasites undoubtedly was, and in some countries still is, an important aspect of his struggle for existence.

As knowledge concerning parasites and how to circumvent their attacks accumulated, especially since the middle of the 19th century, civilized man has been gradually freeing himself of this threat to health. In the United States and other advanced countries, the march of parasites has been interrupted to a large extent by sanitary walls that are being erected to impede their progress. Sanitary plumbing, meat inspection, improvements in livestock sanitation on the farm, improved standards of living, and progress in personal hygiene are among the barriers that are cutting the lifeline between parasites and their human hosts.

Much still remains to be done to sustain the barriers already constructed and to erect new ones. However strong our sanitary walls may be, they can crumble, especially in times of stress, unless they are steadily supported. We must not relax our efforts, therefore, but continue the unrelenting pressure against animal parasites transmissible to man—wherever they maintain a foothold.

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