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TRICHINOSIS: A DANGER IN THE USE OF RAW PORK FOR FOOD.

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Trichinosis is a disease occurring in man and other animals as a result of eating flesh containing the living larvæ of a parasite, *Trichinella spiralis*, commonly known as trichinæ.

These larvæ have been found encysted in the muscles of many different kinds of mammals, most frequently those of omnivorous or carnivorous habits. The occurrence of trichinæ in herbivorous mammals, or in those which do not normally eat meat, is very rare, and results only when, abandoning their usual food habits, or accidentally, these animals eat meat which happens to be infested with the parasite, or when as a matter of experiment they are purposely fed such meat. From the standpoint of public health, the only animals which are of importance in this country as sources of infection and propagators of the disease are hogs and rats. Man becomes infected through eating trichinous pork, hogs become trichinous by eating the trichinous flesh of other hogs or of rats, and rats acquire the parasite by eating the flesh of trichinous hogs or by eating other rats which happen to be infested. The country slaughterhouses where hogs are commonly kept and fed on the offal of slaughtered animals and where rats usually abound are one of the most important factors, if not the most important, in the propagation of infection.

LIFE HISTORY AND DESCRIPTION OF TRICHINELLA SPIRALIS.

Three stages may be distinguished in the life history of the parasite—the adult, the embryo, and the encysted larva.

In the adult stage the parasites are small, slender worms, gradually increasing in thickness toward the posterior end, and scarcely visible to the naked eye. This stage of the parasite lives in the intestine and develops from larvæ swallowed in infested meat. The cysts

surrounding the larvæ are destroyed by the action of the gastric juices, and the larvæ, passing from the stomach into the intestine, grow to maturity in about two days, and, according to their sex, become adult males or females. The male (fig. 1) is the smaller of the two, measuring only about 1.5 mm. in length (about $\frac{1}{16}$ of an inch), the female (fig. 2) measuring 3 to 4 mm. in length (about $\frac{1}{8}$ to $\frac{1}{4}$ of an inch).

Apart from differences in their internal anatomy, the two sexes may be distinguished by the presence of a pair of conical protuberances at the posterior end of the male, which are lacking in the female. Copulation occurs between the two sexes, and the fertilized eggs in the female develop into embryos (fig. 2, *emb.*), which finally escape from the uterus through an opening (fig. 2, *gp.*) on the ventral surface located some distance in front of the middle of the body. At birth the embryos are elongated and wormlike, measuring 90 to 100 μ long by 6 μ in thickness near the middle (about $\frac{1}{200}$ by $\frac{1}{4000}$ of an inch).

The embryos begin to escape from the bodies of the females into the intestine of the host about six days after infestation, and the production of embryos may continue for a month or more but abates considerably after the first few days. The adult worms usually disappear from the intestine in five or six weeks, or even sooner if the patient is affected with diarrhea. The total number of embryos which each female is able to produce has been estimated at 10,000 to 15,000.

As soon as born the embryos begin to migrate, penetrating the intestinal wall and entering the connective tissue, lymphatics, and blood vessels. They are apparently aided in their migrations by the blood current and are carried to various portions of the body, finally entering the muscles (figs. 3, 4, and 5). This period of migration lasts from six to ten days. Having reached its final resting place in a muscle the embryo grows considerably, reaching a length of 0.8 to 1 mm. (about $\frac{1}{30}$ to $\frac{1}{25}$ of an inch) and a thickness of 40 μ (about $\frac{1}{250}$ of an inch). Meanwhile as it grows the embryo coils itself into a spiral and becomes surrounded by a membranous cyst, produced by changes in the interfascicular connective tissue of the muscle, brought about in consequence of the irritating influence of the worm.

In form the trichina cyst (fig. 5) is usually ovoid or lemonshaped, with its long axis directed parallel with the muscle fibers. The average size is about 400 μ by 250 μ (about $\frac{1}{80}$ by $\frac{1}{100}$ of an inch). After a time fat globules are deposited on the outside of the cyst in little masses at each pole. In seven or eight months after infestation the cysts begin to degenerate, commonly becoming calcified, and the vitality of the worms is finally destroyed.

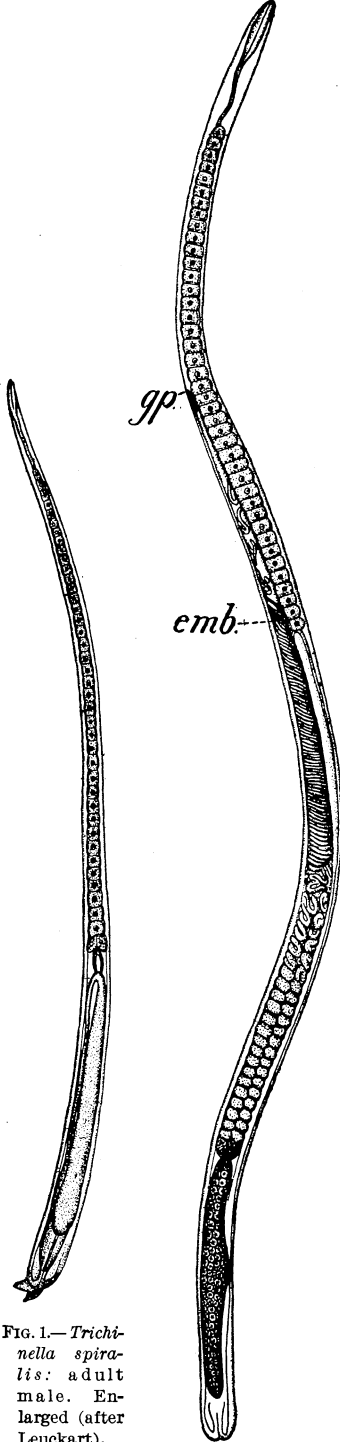


FIG. 1.—*Trichinella spiralis*: adult male. Enlarged (after Leuckart).

FIG. 2.—*Trichinella spiralis*: adult female showing embryos, *emb.*, in uterus; *gp.*, genital opening through which the embryos are discharged. Enlarged (after Leuckart).

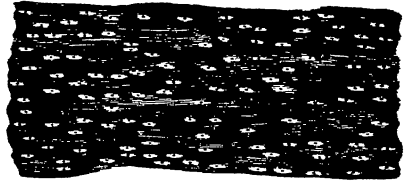


FIG. 3.—Piece of pork showing larvæ of *Trichinella spiralis* encysted amid the muscle fibers. Slightly enlarged (after Ostertag).

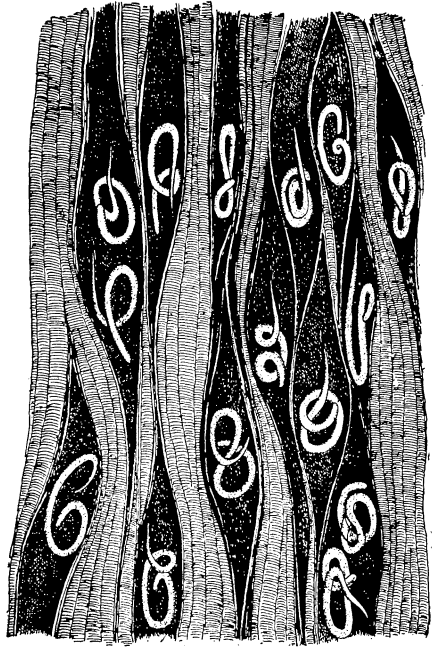


FIG. 4.—Larvæ of *Trichinella spiralis* in muscle, not yet encysted. Enlarged (after Leuckart).

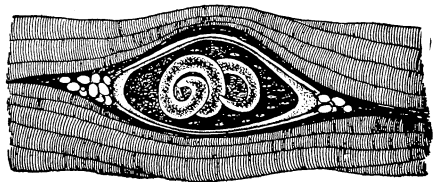


FIG. 5.—Larva of *Trichinella spiralis* encysted in a piece of muscle. Enlarged (after Leuckart).

This process of degeneration is completed usually within about two years, although cases are on record in which calcification of the cysts was still very slight as long as eleven years after infestation, and the worms were still alive.

The number of encysted larvæ which may be present in even a small piece of muscle in cases of severe infestation is very large. As many as 1,200 have been counted in a piece of muscle weighing 1 gram, which would make about 500,000 in a pound. If a person were to eat a pound of pork thus heavily infested, and if all of the larvæ developed to maturity in his intestine, and if each female produced the estimated number of 10,000 embryos, there would be set free in the intestine 2,500,000,000 to 3,000,000,000 embryos. Of course, in an actual case not all of the larvæ would develop, and not every female would produce as many embryos as assumed in the estimate, nor would all the embryos succeed in penetrating the intestinal wall and migrating into the muscles. The computation, however, gives an idea of the great intensity which infestation may reach. The number of cysts present in the bodies of persons who have died with the disease has been estimated in various cases at from 5,000,000 to 100,000,000.

SYMPTOMS OF TRICHINOSIS.

The severity of the symptoms of trichinosis depends upon the number of living larval worms taken into the body. Three periods in the course of the disease are commonly distinguished.

The first period begins in from two days to a week, sometimes not for nearly two weeks after infestation. The symptoms appearing in this stage are those of gastro-intestinal irritation, due to the development of the worms in the intestine and the liberation of the embryos, and consist of lack of appetite, nausea, abdominal pains, diarrhea, and fever. These symptoms are not constant, and are often absent.

The symptoms of the second period—that corresponding to the migration of the embryos—develop between the seventh and tenth days, sometimes later. There is more or less fever, and the muscles become tense and swollen and are painful on movement or pressure. There may be pain and difficulty in chewing, swallowing, and breathing on account of the involvement of the muscles concerned in these functions.

In the third stage, following the encystment of the worms in the muscles, the patient becomes emaciated and anemic, watery swellings appear, especially in the face, the skin may itch and tingle, and eruptions sometimes appear.

The duration of the symptoms as well as their intensity depends upon the degree of infestation.

Trichinosis is often mistaken for typhoid fever on account of the similarity of the symptoms, and the muscular pains are sometimes taken for rheumatism.

In light cases recovery occurs in about two weeks; in severe attacks it does not begin for six weeks, and several months may elapse before the patient entirely recovers. In fatal cases death rarely occurs earlier than the second week or later than the seventh, usually between the fourth and sixth weeks, when the muscular symptoms are at their height.

The symptoms of trichinosis in hogs are similar to those in the human patient, ordinarily much less pronounced, and recovery usually follows. During the migrations of the worms into the muscles the animal moves with difficulty, the limbs are stiff, and the hind quarters sometimes seem to be paralyzed. There is soreness of the muscles, more or less diarrhea, and sometimes skin eruptions, so that hog cholera may be suspected by the layman. As a rule, however, the symptoms are so slight that the disease in hogs passes entirely unnoticed.

TREATMENT OF TRICHINOSIS.

If the disease is recognized early, the patient may be treated with purgatives and vermifuges to expel the worms from the intestines. There is no treatment which will affect the embryos after their migrations are begun.

FREQUENCY OF TRICHINOSIS.

The frequency of the disease in man depends upon the frequency of infection in hogs used for food, and upon the extent to which insufficiently cooked or raw, imperfectly cured pork is eaten. Nearly a thousand cases have been placed on record or are definitely known to have occurred in this country, and a large percentage of those patients whose nationality has been ascertained were Germans. In certain States of the German Empire the custom of eating raw pork is a common one, and out of 6,329 cases which occurred in that country during the years 1881 to 1898 (as collected by Stiles ^a), 5,456 cases occurred in States where raw pork is an established article of diet.

The frequency of trichinosis in hogs in this country, as indicated by the microscopic examination of pork for export, formerly carried on by this Bureau (not because it was considered of value as a sanitary measure, but for the purpose of meeting the requirements of foreign trade), averages from 1 to 2 per cent. In some localities the percentage is much higher than this, in others it is less, and there is more or less variation from year to year.

^a Bureau of Animal Industry, Bulletin No. 30.

PREVENTION OF TRICHINOSIS.

In spite of the prevalence of trichinosis among hogs in this country there need be no fear of infection in man if the proper precautions are taken. The danger of infection may be entirely avoided, and only avoided, if pork is not eaten until after it has been thoroughly cooked or thoroughly cured. By either of these means any trichinæ which may be present are killed and rendered harmless. Trichinous meat thus treated is perfectly fit for food and just as wholesome as non-infested meat, except in rare instances when the infestation is so severe as to cause extensive pathologic changes.

Microscopic inspection of pork (examining certain portions of the carcasses of slaughtered hogs with the microscope and condemning carcasses in which trichinæ are found), on account of the danger of overlooking the parasites in many cases when they may be present, has not proved to be an effective means of preventing trichinosis in countries where it has been employed. Although the chances of infection are greatly reduced through the condemnation of many trichinous hogs which would otherwise be placed on the market, microscopic inspection in another way favors the occurrence of trichinosis by creating a false feeling of security in the minds of the public, many persons believing themselves perfectly safe in eating raw pork if it has been inspected and passed as free from trichinæ. The experience of Germany, where a very elaborate system is in operation, with a force of inspectors variously estimated at 25,000 to 100,000, fully demonstrates the fact that microscopic inspection is not successful as a means of barring trichinous pork from market. Out of the 6,329 cases of trichinosis occurring in Germany between 1881 and 1898, 2,042 cases (over 32 per cent) have been traced by Stiles to meat which had been inspected and passed as free from trichinæ.

In numerous instances trichinous pork has been microscopically examined as many as twenty or thirty times before the parasites were found, and as it is utterly impracticable to make so many examinations, the unreliability of inspection for trichinæ should be obvious to all. Since its uselessness as a sanitary measure is evident, microscopic inspection is not included in the system of meat inspection followed in this country. Consumers should understand that the Government mark "U. S. Inspected and Passed" does not guarantee that the meat has been inspected for trichinæ. In all cases, therefore, whether pork has been inspected or not, it should be thoroughly cooked or thoroughly cured before it is used for food.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *March 23, 1907.*