

three or four days. An unpleasant consequence which sometimes follows the administration of this drug is xanthopsia or yellow vision.

(b) *Oxyuris Vermicularis* (*Thread-worm*; *Pin-worm*).—This common parasite occupies the rectum and colon. The male measures about four millimetres in length, the female about ten millimetres. They produce great irritation and itching, particularly at night, symptoms which become intensely aggravated by the nocturnal migration of the parasites.

The patients become extremely restless and irritable, the sleep is often disturbed, and there may be loss of appetite and anæmia. Though most common in children the parasite occurs at all ages.

The worm is readily detected in the fæces. Infection probably takes place through the water or possibly through salads, such as lettuces and cresses. A person the subject of the worms passes ova in large numbers in the fæces, and the possibility of reinfection must be scrupulously guarded against.

The treatment is simple, though occasionally there are instances in which all forms of medication are resisted. A case is mentioned of a gentleman, aged forty, who had suffered from childhood and had failed to obtain any benefit from prolonged treatment by many helminthologists. Santonin may be used in small doses, and mild purgatives, particularly rhubarb. Large injections containing carbolic acid, vinegar, quassia, aloes, or turpentine may be employed. In children the use of cold injections of strong salt and water is usually efficacious. They should be repeated for at least ten days. In giving the injection care should be taken to have the hips well elevated so that the fluid can be retained as long as possible. For the intense itching and irritation at night vaseline may be freely used or belladonna ointment.

## II. TRICHINIASIS.

The trichina spiralis in its adult condition lives in the small intestine. The disease is produced by the embryos, which pass from the intestines and reach the voluntary muscles, where they finally become encapsulated—muscle trichinæ. It is in the migration of the embryos that the group of symptoms known as trichiniasis is produced.

*Description of the Parasites.*—(a) Adult or intestinal form. The female measures from three to four millimetres; the male, 1.5 millimetre, and has two little projections from the hinder end.

(b) The embryo or muscle trichina is from 0.6 to one millimetre in length and lies coiled in an ovoid capsule, which is at first translucent, but subsequently opaque and infiltrated with lime salts. The worm presents a pointed head and a somewhat rounded tail.

When flesh containing the trichinæ is eaten by man or by any animal in which the development can take place, the capsules are digested and the trichinæ set free. They pass into the small intestine, and about

the third day attain their full growth and become sexually mature. Virchow's experiments have shown that on the sixth or seventh day the embryos are fully developed. The young produced by each female trichina have been estimated at several hundred. Leukart thinks that various broods are developed in succession, and that as many as a thousand embryos may be produced by a single worm. The time from the ingestion of the flesh containing the muscle trichinæ to the development of the brood of embryos in the intestines is from seven to nine days. As soon as born the embryo trichinæ leave the intestines; wandering through the peritonæum and the connective tissues, probably through the mesentery and retroperitoneal tissues—some hold by means of the blood current—they finally reach the muscles, which constitute "the seat of election." After a preliminary migration in the intermuscular connective tissue they penetrate the primitive muscle fibres, and in about two weeks develop into the full-grown muscle form. In this process an interstitial myositis is excited and gradually an ovoid capsule develops about the parasite. Two, occasionally three or four, worms may be seen within a single capsule. This process of encapsulation has been estimated to take about six weeks. Within the muscles the parasites do not undergo further development. Gradually the capsule becomes thicker, and ultimately lime salts are deposited within it. This change may take place in man within four or five months. In the hog it may be deferred for many years. The calcification renders the cyst visible, and since first seen by Tiedemann, in 1822, and Hilton, in 1832, these small, opaque, oat-shaped bodies have been familiar objects to demonstrators of normal and morbid anatomy. The trichinæ may live within the muscles for an indefinite period. They have been found alive and capable of developing as late as twenty or even twenty-five years after their entrance into the system. In many instances, however, the worms are completely calcified. The trichina occurs in swine, in the rat, occasionally in mice and cats; it has been found also in the fox and a few other animals. The parasite was first found in the hog by the late Joseph Leidy. Experimentally, guinea-pigs and rabbits are readily infected by feeding them with muscle containing the larval form. Dogs are infected with difficulty; cats more readily. Experimentally, animals sometimes die of the disease if large numbers of the parasites have been eaten. In the hog the trichinæ, like the cysticerci, cause few if any symptoms. An animal the muscles of which are swarming with living trichinæ may be well nourished and healthy-looking. An important point also is the fact that in the hog the capsule does not readily become calcified, so that the parasites are not visible as in the human muscles. For a long time the trichina was looked upon as a pathological curiosity, but in 1860 Zenker discovered in a girl in the Dresden Hospital who had symptoms of typhoid fever both the intestinal and the muscle forms of the trichinæ, since which time the disease has been thoroughly studied.



Man is infected by eating the flesh of trichinous hogs. The incidence of the disease in swine varies much in different countries. In Germany, where a thorough and systematic microscopic examination of all swine flesh is made, the proportion of trichinous hogs is about 1 in 1,852. At the Berlin abattoir, where the microscopic examination is conducted by a staff of over eighty men and women, two portions are taken from the abdominal muscles, from the diaphragm, and from the intercostal muscles, and one piece from the muscles of the larynx and tongue. A special compressor is used to flatten the fragments of the muscle, and the examination is made with a magnifying power of from seventy to one hundred diameters. During the three years ending in 1885 there were 603 trichinous hogs detected, a ratio of 1 to 1,292. Statistics are not available in England. In the United States systematic inspection is unknown, and the statistics are by no means extensive enough. "Taking all the examinations of American pork thus far made, both at home and abroad, and we have a total of 298,782, in which trichinae were found 6,280 times, being 2.1 per cent, or 1 to 48" (Salmon, 1884).

In 1883, in conjunction with A. W. Clement, I examined 1,000 hogs at the Montreal abattoir, and found only 4 infected. There is no reason to believe that the hog of this country is less liable to trichina than the German animal.

*Modes of Infection.*—The danger of infection depends entirely upon the mode of preparation of the flesh. Thorough cooking, so that all parts of the meat reach the boiling point, destroys the parasites; but in large joints the central portions are often not raised to this temperature. The frequency of the disease in different countries depends largely upon the habits of the people in the preparation of pork. In North Germany, where raw ham and *wurst* are freely eaten, the greatest number of cases have occurred. In South Germany, France, and England cases are rare. In this country the greatest number of persons attacked have been Germans. Salting and smoking the flesh are not always sufficient, and the Havre experiments showed that animals are readily infected when fed with portions of the pickled or the smoked meat as prepared in this country. Carl Fränkel, however, states that the experiments on this point have been negative, and that it is very doubtful if any cases of trichiniasis in Germany have been caused by American pork.

*Frequency of Infection.*—The dissecting-room and post-mortem statistics show that from one half to two per cent of all bodies contain trichinae. Of 1,000 consecutive autopsies of which I have notes the trichinae were present in 6 instances. I have, in addition, seen them in two dissecting-room cases and in two bodies at the Philadelphia Hospital.

The disease often occurs in epidemics, a large number of persons being infected from a single source. Among the best known of these outbreaks are the Hedersleben, in which there were 337 persons affected, and the Emersleben, in which there were 250 persons attacked. The extensive

outbreaks of this sort have been, with few exceptions, in North Germany. Alfred Mann, after a careful search, at my request, of the literature in the Surgeon-General's library, finds records of 456 cases in this country. The two largest groups of cases were at Astoria, Ore., reported by Kinney, 15 cases and one death; and at St. Paul, Minn., reported by Persons and Andrews, 15 cases and three deaths.

*Symptoms.*—The ingestion of trichinous flesh is not necessarily followed by the disease. When a limited number are eaten only a few embryos pass to the muscles and may cause no symptoms. Well-characterized cases present a gastro-intestinal period and a period of general infection.

In the course of a few days after eating the infected meat there are signs of gastro-intestinal disturbance—pain in the abdomen, loss of appetite, vomiting, and sometimes diarrhoea. The preliminary symptoms, however, are by no means constant, and in some of the large epidemics cases have been observed in which they have been absent. In other cases the gastro-intestinal features have been marked from the outset, and the attack has resembled cholera nostras. Pains in different parts of the body, general debility, and weakness have been noted in some of the epidemics.

The invasion symptoms develop between the seventh and the tenth day, sometimes not until the end of the second week. There is fever, except in very mild cases. Chills are not common. The thermometer may register 102° or 104°, and the fever is usually remittent or intermittent. The migration of the parasites in the muscles excites a more or less intense myositis, which is characterized by pain on pressure and movement, and by swelling and tension of the muscles. The limbs are placed in the positions in which the muscles are in least tension. The involvement of the muscles of mastication and of the larynx may cause difficulty in chewing and swallowing. In severe cases the involvement of the diaphragm and intercostal muscles may lead to intense dyspnoea, which sometimes proves fatal. Œdema, a feature of great importance, may be early in the face. Later it develops in the extremities when the swelling and stiffness of the muscles are at their height. Profuse sweats, tingling and itching of the skin, and in some instances urticaria, have been described. The general nutrition is much disturbed and the patient becomes emaciated and often anæmic, particularly in the protracted cases. The patellar tendon reflex may be absent. The patients are usually conscious, except in cases of very intense infection, in which the delirium, dry tongue, and tremors give a picture similar to typhoid fever. In addition to the dyspnoea, present in the severer cases, there may be bronchitis, and in the fatal cases pneumonia or pleurisy. In some epidemics polyuria has been a common symptom. Albuminuria is frequent.

The intensity and duration of the symptoms depend entirely upon the grade of infection. In the mild cases recovery is complete in from ten to fourteen days. In the severe forms convalescence is not established for six or eight weeks, and it may be months before the patient recovers the



muscular strength. One case in the Hedersleben epidemic was weak eight years after the attack.

Of 72 fatal cases in the Hedersleben epidemic the greatest mortality occurred in the fourth and fifth and sixth weeks; namely, 52 cases. Two died in the second week with severe choleraic symptoms.

The mortality has ranged in different outbreaks from one or two per cent to thirty per cent. In the Hedersleben epidemic 101 persons died. Among the 456 cases reported in this country there were 122 deaths.

The *anatomical changes* are chiefly in the voluntary muscles. In the early stages they look normal, but in the fourth or fifth week grayish-white areas appear in which the muscle fibres are extensively degenerated and in the neighborhood of the trichinae there is an acute interstitial myositis. Cohnheim has described a fatty degeneration of the liver and enlargement of the mesenteric glands. At the time of death in the fourth or fifth week or later the adult trichinae are still found in the intestines.

The *prognosis* depends much upon the quantity of infected meat which has been eaten and the number of trichinae which mature in the intestines. In children the outlook is more favorable. Early diarrhoea and moderately intense gastro-intestinal symptoms are, as a rule, more favorable than constipation.

**Diagnosis.**—This is perfectly clear when a large number of persons are infected at once and the parasites have been found in the ham or sausages. The worms may be discovered in the stools. The stools should be spread on a glass plate or black background and examined with a low-power lens, when the trichinae are seen as small, glistening, silvery threads. In doubtful cases the diagnosis may be made by the removal of a small fragment of muscle. A special harpoon has been devised for this purpose by means of which a small portion of the biceps or of the pectoral muscle may be readily removed. Under cocaine anaesthesia an incision may be made and a small fragment removed. The disease may be mistaken for acute rheumatism, particularly as the pains are so severe on movement, but there is no special swelling of the joints. The tenderness is in the muscles both on pressure and on movement. The intensity of the gastro-intestinal symptoms in some cases has led to the diagnosis of cholera. Many of the former epidemics were doubtless described as typhoid fever, which the severer cases, owing to the prolonged fever, the sweats, the delirium, dry tongue, and gastro-intestinal symptoms, somewhat resemble. The pains in the muscles, swelling, oedema, and shortness of breath are the most important diagnostic points. Under acute myositis reference has already been made to the cases which closely resemble trichiniasis. The epidemic in 1879 on board the training ship Cornwall presented symptoms similar to those of trichiniasis. One patient died. Two months after burial the body was examined, and living and dead nematode worms were found which, as Bastian showed, were not the trichina, but a rhabditis.

They were probably not parasitic, but entered the body of the cadet after burial.

**Prophylaxis.**—It is not definitely known how swine become diseased. It has been thought that they are infected from rats about slaughter-houses, but it is just as reasonable to believe that the rats are infected by eating portions of the trichinous flesh of swine. The swine should, as far as possible, be grain-fed, and not, as is so common, allowed to eat offal. The most satisfactory prophylaxis is the complete cooking of pork and sausages, and to this custom in England, France, South Germany, and particularly in this country, immunity is largely due.

**Treatment.**—If it has been discovered within twenty-four or thirty-six hours that a large number of persons have eaten infected meat, the indications are to thoroughly evacuate the gastro-intestinal canal. Purgatives of rhubarb and senna may be given, or an occasional dose of calomel. Glycerin has been recommended in large doses in order that by passing into the intestines it may by its hygroscopic properties destroy the worm. Male-fern, kamala, santonin, and thymol have all been recommended in this stage. There is no doubt that diarrhoea in the first week or ten days of the infection is distinctly favorable. The indications in the stage of invasion are to relieve the pains, to secure sleep, and to support the patient's strength. There are no medicines which have any influence upon the embryos in their migration through the muscles.

### III. ANCHYLOSTOMIASIS.

The *dochmius* or *strongylus duodenalis*, also known as the *sclerostomum* or *anchylostomum duodenale* is the only strongyle harmful to man. It belongs to the same family as the *strongylus armatus*, which causes the verminous aneurism in the horse. The parasites live in the upper portion of the small intestine, chiefly in the jejunum. They are easily seen, the male having a length of from six to ten millimetres, and the female from ten to eighteen millimetres. The mouth is provided with a series of tooth-like hooks, by means of which the parasite attaches itself to the mucous membrane. The male has a prominent expansion or bursa at the tail end. The existence of the parasite has long been known, but it was not thought to be pathogenic until Griesinger demonstrated its association with the Egyptian chlorosis. It has also been shown to be the cause of the anaemia to which miners and brick-makers are subject. Throughout Europe the disease has been widely spread by the employment of Italian and Polish laborers. In certain Italian provinces it is extremely prevalent and serious. It occurs in India and in Brazil, and has been described in Jamaica (Strachan). Dolley states that the parasite was described many years ago by physicians in the Southern States, but no recent observations upon the disease have been made in this country.

**Symptoms.**—The parasites withdraw blood by suction, and the