

physician will be indifferent to the theories, and will be as loath to encounter the one as the other.

Treatment.—When the bite of a rabid animal has been received, the wound should be scarified, cauterized with a hot iron, or every part of it touched with nitrate of silver. The success of Mr. Youatt has been so great with the nitrate of silver that severer applications would seem to be unnecessary. Permanganate of potassium, having succeeded so well in the bites of venomous snakes, should be tried. There is no specific to prevent the disease, and we are equally ignorant of a remedy to cure it, unless Pasteur's inoculations with the modified virus prove to have the effect which he claims for the method. Of all the remedies hitherto proposed, curare is the only one which seems to possess any power over hydrophobia. Two cases have been reported recently—one in Italy and one in New York—in which a disease, diagnosed as hydrophobia by eminent practitioners, got well under the hypodermatic injections of curare. Chloral, chloroform, gelsemium, nicotine, etc., may be used to alleviate the distress.

PARASITES.

TRICHINÆ AND TRICHINOSIS.

Trichina.—This dangerous parasite is found in two forms, as the *intestinal trichina* which is sexually mature, and as the *muscle trichina*, not fully developed, or sexually immature. The name given by Professor Owen (*Trichina spiralis*) is based on the hair-like appearance of the parasite and the spiral form assumed by it in the muscular tissue. It is a very small, hair-like worm, having a head smaller than the rest of the body, while the caudal extremity is rounded. The females are three or four millimetres long, and contain a sexual apparatus consisting of an ovary, a uterus, and a vagina. Only a part of the sexual apparatus exists in the muscle-trichina, the rest being developed after the parasite has entered the intestinal canal of its host. It is viviparous, and discharges from the vaginal outlet about one hundred embryos a week, and the birth of the embryos begins in about a week after the female enters the intestine. As more females than males are

born, and as successive formation of embryos from the eggs may take place,* the number developed becomes enormous. The male trichina is one half the size of the female, and contains at its caudal extremity the sexual apparatus. The viable embryos discharged from the female are in lively motion. They do not remain in the intestine, but begin a process of migration which only terminates when they have reached their habitat in the voluntary muscles. The manner of reaching their destination is not known—whether by the blood-vessels, by the lymph-channels, or by direct effort boring through the intervening tissues until the muscles are reached. As they have repeatedly been found in the blood and lymph,† and in the connective tissue only adjacent to muscles,‡ and as the rate of migration is so rapid, it seems pretty certain that the distribution is chiefly passive by the blood and lymph-streams. Endowed with a strange instinct, these parasites, when they reach the muscular tissue, stop their wanderings, pierce the muscles, and force their way into the primitive fasciculi, where they coil up. The sarcolemma of the primitive fasciculus now undergoes thickening, a quantity of granular matter surrounds the parasite, and a number of "oval, vesicular-shaped muscle nuclei" § develop on the inner surface of the capsule formed by the thickened sarcolemma. In the process of transplantation of the parasite from the intestinal canal to the muscle, the parasite grows; but it reaches the greatest size in fourteen days after it is established in the muscle. In the intestinal canal the embryos have a very short lease of life (five to eight weeks); but, safely deposited in the muscle, they continue during the life of their host and for a short period after his death. In the muscles, after a time, the trichinae undergo a further change. Lime-salts are deposited in and about the capsule, and ultimately in the parasite itself, when minute bits of lime, just visible to the eye, are seen more or less thickly distributed through the muscular tissue. The distribution of trichina is determined by the migrations of its hosts—the hog, the rat, and man. This parasite has been found in the cat and other animals, and has been artificially reared in rabbits and Guinea-pigs. In the dog, however, it appears to develop no further than intestinal trichina, migration of the embryos not taking place in this animal. As man and the other hosts of the parasite are to be found everywhere, so this parasite is universal. It is especially frequent in this country in the great West, because of the enormous extent of the pork-traffic. The proportion of hogs infected in the West is variously stated, but it is prob-

* Cohnheim, "Zur pathologischen Anatomie der Trichinenkrankheit," Virchow's "Archiv," Band xxxvi, p. 163.

† Virchow, *ibid.*, Band xxxii, s. 332, "Zur Trichinenlehre," contains also a full historical account of progress of discovery.

‡ *Ibid.*, Band xxxiv, s. 469.

§ Heller, Ziemssen's "Cyclopædia," article "Migratory Parasites," vol. iii.

ably not an exaggeration to say that from one to twenty per cent. contain trichinæ.*

Trichinosis.—The symptoms produced by trichina, when these parasites reach the body of man, are entitled *trichinosis*. They are not very uniform, but a division into stages, based on the several steps in the life-history of the trichina, will be convenient. These stages are *the intestinal, the migration, and the encapsulation*. When a piece of pork, containing in every cubic inch eighty thousand (Dr. Sutton) trichinæ, is swallowed, these parasites are set free; they then complete their sexual development, and, as each female discharges a hundred embryos, the intestinal canal soon contains thousands. If few in number, there may be but little disturbance of the canal, but usually more or less irritation of the stomach and intestines follows in a short time after the infected meat is swallowed. In a few hours or in a day or two, some uneasiness of the stomach is felt, and in some cases severe attacks of neuralgia of the solar plexus; nausea comes on, and then vomiting occurs. The vomiting may end with the first effort which empties the stomach, or it may continue with much retching and anguish for several days. The mouth feels pasty, and a subjective sense of foul odor is also experienced. Intestinal uneasiness comes on with the irritability of the stomach; colic, more or less distention of the abdomen, and diarrhœa follow. The stools, at first composed of fæces merely, become watery, light in color, and may ultimately assume a nearly rice-water appearance. This symptom is more persistent than the vomiting, may continue, indeed, for several weeks, and is apt to be exhausting. Diarrhœa may alternate with constipation; in some cases there is constipation only. When the digestive disorders have persisted for several days, fever comes on in the usual way, preceded by shivering or a chill. It is probable that the fever is about coincident with the birth of the embryos and the beginning migration. The fever is remittent in type in the sense that typhoid fever is, which it closely resembles. In some cases the type is truly remittent, with a decided morning remission and an evening exacerbation. The pulse is quick, rather small, and early shows a tendency to weakness, the range being from 90 to 140. There is intense thirst, the tongue and lips are dry, and the face is red and swollen (Davaine). During the existence of these symptoms the muscles of the body generally are sore to the touch and are flabby, but this state must not be confounded with that condition of the muscles caused by the migration of the parasites into them (Heller). The *migration period* is especially marked by the invasion of the muscles. The symptoms due to this invasion do not occur

* The reader is advised to consult an excellent paper by Dr. Sutton, of Aurora, Indiana, giving an account of an outbreak of trichinosis, and some general remarks on the proportion of trichinous pork, which he puts at three to sixteen per cent. for southeastern Indiana. (Reprinted from "Transactions of the Indiana State Medical Society.")

earlier than the tenth day, which allows three days for the migration from the intestine. The muscles are affected to varying degrees of severity, doubtless, according to the number of parasites entering them. There may be only a little soreness, but in decided cases, as might be expected, the muscles are hard, swollen, and very tender. The muscles of the extremities, especially the flexors, are penetrated, but those of the trunk also, only to a less extent. In consequence of this, the muscles are the seat of violent rheumatoid pains, and motion increases the distress. Hence the patients lie motionless, with the limbs semiflexed. As the muscles of mastication and deglutition are also invaded, chewing and swallowing become difficult and painful; hearing is impaired because of invasion of the stapedius muscle, and vision may be double or distorted because of the penetration of the ocular muscles. Œdema of the eyelids is one of the first symptoms of this period, and subsequently œdema of the extremities and effusion into the peritoneal cavity appear. For the same reason, doubtless, that the voluntary movements are impaired, the respiration is embarrassed, and dyspnœa is added to the other difficulties, and by the end of the fourth week a general bronchitis, a pleurisy, or a pneumonia may arise to complicate the case.* During the development of these formidable symptoms, the mind may continue undisturbed; in fact, a singular apathy takes possession; in other cases delirium occurs, but this may result from the wakefulness, the *coma vigil*, which is so pronounced a feature of the cerebral condition in many adults. In children there is a condition of somnolence throughout. Various miliary and pustular eruptions appear on the skin, which is extremely sensitive, but the most pronounced symptom connected with this organ is the profuse sweats which appear early and continue throughout the disease. The sweats are not critical, and do not modify the temperature. Bed-sores form to a slight extent, and desquamation of the cuticle occurs during convalescence. Abortion sometimes takes place, but the fœtus is free from trichinæ; and, on the other hand, pregnancy may continue undisturbed. The menses may or may not be interfered with, more usually not. *The course of trichinosis* is greatly influenced by the number of parasites. A small number may cause a mere temporary diarrhœa; a large number may produce a violent gastro-enteritis, sufficient to cause death without the migration into the muscular system (cases by Dr. Sutton). In such cases there will occur the symptoms of gastro-enteritis only, and, after death, intense hyperæmia, swelling of the mucous membrane, and destruction of epithelium will be seen. The range of temperature in these cases is from 98° to 100°, and the type of the fever remittent. When migration of a small number of parasites occurs, the fever will assume the typhoid aspect, the temperature range from 100° to 104°,

* Davaine, *op. cit.*, p. 760.

the usual muscular soreness to a small extent be felt, but the most pronounced symptoms will be those of inflammation of the gastrointestinal canal. Recovery may ensue in such a case by the encapsulation of the parasites, and a gradual subsidence of the gastro-enteritis. From three to four months will be occupied with such a case from its beginning to the completion of convalescence. In the severest cases all the symptoms given above will appear, and death will take place in three to four weeks, frequently caused by pneumonia. The mortality from trichinosis will range from twenty to fifty per cent., dependent of course on the amount eaten of any given specimen of trichinous pork.

Diagnosis.—Cases of trichinosis are often mistaken for ileo-colitis and for typhoid fever. From the former it may be differentiated by the œdema of the eyelids, the muscular pains, and the profuse sweats. The range of temperature being much the same as that of typhoid, the distinction between the two must rest on the muscular symptoms, the œdema, the pain and hyperæsthesia, the profuse sweats, and the absence of the muttering delirium, the subsultus, and other nervous symptoms. The œdema occurring in this disease, which is general, is separated from cardiac and renal dropsy by the absence of cardiac and renal disease, and by the other symptoms pertaining to trichinosis. In cases of doubt, the harpoon may be used to take out a bit of muscular tissue for examination, but this is a measure of doubtful propriety, because severe gastro-enteritis may ensue without migration. In typical cases the harpoon would hardly be necessary, yet Dr. Sutton, removing a small piece of the gastrocnemius in one of his fatal cases, found it swarming with trichinæ, "estimated at more than one hundred thousand to the square inch," and they were in active motion, "coiling and uncoiling."

Treatment.—Attention should be at once directed to the destruction and removal of trichinæ in the intestinal canal. A variety of remedies have been proposed, but no success seems to have attended any of them, unless glycerine may be excepted. The vomiting and purging, if not excessive, should be promoted by diluents. Glycerine and water, which has the power to cause shriveling and death of the parasite, may then be given—one part of glycerine to two parts of water. Carbolic acid may be administered both with the view to allay the intense irritation and to act on the embryos. We venture to suggest a trial of carbolic acid and tincture of iodine for the same purpose. Corrosive sublimate, arsenic, picric acid, benzine, and other agents have been used to destroy the parasites in the intestines, but without results (Haller). Quinine seemed to exercise a good influence in Sutton's cases, the best, indeed, of any of the agents used. As this remedy has a toxic influence on the low forms of life, it seems desirable to employ it more freely in future cases. If constipation be the condition, purga-

tives should be administered without delay. The treatment to be pursued when the parasites migrate, must be purely symptomatic. The obstinate wakefulness and the pains will require morphine and chloral. Quinine and stimulants will be needed to support the powers of life. Milk, beef-juice, egg-nogg, and other aliment must be carefully administered from the beginning. There is but one point in prophylaxis. Meat containing trichinæ should be thoroughly cooked. As the cases arising from these parasites are caused by the consumption of raw hams and raw sausage recently cured, this practice should be totally discontinued.

CHYLURIA.

Definition.—By the term *chyluria*, it is intended to express a condition of disease, characterized by the presence of chylous matter in the urine. The milky or chylous appearance of the urine is now known to be due to the presence, in the blood and urine, of a parasite—*Filaria sanguinis hominis*—or a filaria having the blood of man for its habitat. This filaria is a nematoid entozoön, and hence this malady is appropriately classified with the parasitic affections. It is often confounded with ordinary hæmaturia, or bloody urine.

Causes.—Chyluria is a disease of tropical and sub-tropical regions, but cases have been observed in England, and they are not infrequent in the southern parts of this country. The West Indies is a favorite locality for the appearance of this parasite; and Brazil—as might be expected—has furnished many cases of chylous urine.

The parasite, to the presence of which, in the blood and urine, the disease seems to be due, is a nematoid entozoön having the diameter of a red blood-globule (=0.007 mm.) and a length of $\frac{1}{5}$ " (=0.34 mm.) (Lewis). The filaria is inclosed in an extremely delicate and transparent membranous sheath, and is, when living, employed in movements, now coiled, now fully extended. The relation of the parasite to the production of chylous urine is not clear, but the constancy of the association is undoubted, and various theories have been put forward to explain the presence of the lymph-fluid in the blood. By Robin and Bernard it is maintained that the state of the urine is due to the admission into the blood of the chyle, by means of the agency of the parasite. Dr. Carter holds that a direct communication is established between the lymph-canals and blood-vessels, but he does not explain how the parasite effects this admixture. Dr. Roberts also proposes an explanation, by which the chyle gets into the blood through an opening made by ulceration into hypertrophied lymph-canals. None of these theories reconciles all the facts, hence they can not be regarded as adequate. The constant presence of the filaria seems now to be well established; but the exact relation of the parasite to the chylous

urine remains to be demonstrated. Besides the filaria, as a cause of hæmaturia, a fluke was discovered in 1851 by Dr. Bilharz, as producing the same condition.

Pathological Anatomy.—No disease of the kidneys has been discovered, and, indeed, no change in any organ or tissue has been made out, that properly pertains to the condition of chyluria. There are, however, in all parts of the vascular system—found in the blood, venous and arterial—numerous specimens of the filaria. This parasite is also contained in the lymph-fluid discharged at any point, and in the chylous urine. It follows, therefore, that the changes in the blood induced by the parasite are the sole pathological conditions of chyluria. As this state may exist for many years, various intercurrent diseases can arise, but then the morbid conditions are independent of the chylous state of the urine.

Symptoms.—It is now well known that there is no constancy in the symptomatic expression of chyluria. Nevertheless, it is the intention of the author to present as clear an outline, as may be, of the symptoms properly pertaining to this state.

There may be no symptoms to indicate the onset of the disease, until the characteristic chylous urine makes its appearance; but in a majority of cases there occurs some uneasiness in the back, extending through the loins, along the course of the ureters, and in the perinæum. Coincidentally with this symptom there are much debility and depression of mind. Hypertrophied lymph-vessels may yield, and lymph-fluid escape, in the axilla, groin, scrotum, and elsewhere. Occasionally elephantiasis lymphangiectodes is associated with chyluria; or, indeed, true elephantiasis may occur simultaneously. The most characteristic symptom, however, is the presence of chylous fluid in the urine. When this admixture takes place, the urine has a milky or whey-like appearance and odor, and, after standing for some time, coagulates, forming a jelly-like mass. If blood is present, as sometimes happens, the coagulated mass has a reddish hue, or the blood, in shreds of coagula, is seen at the bottom of the vessel holding it. Sometimes the contained blood coagulates in the bladder, and, obstructing the urethra, suddenly stops the flow of urine.

The presence of chyle in the urine may be determined by two tests: by the use of ether to dissolve out the fatty matter, and by heat to precipitate the albumen. When the urine is shaken up with ether, the fat is dissolved out, and hence the milky appearance ceases; when boiled and nitric acid added, the albumen present coagulates. It is important to note that the quantity of chylous fluid present in the urine is not always the same: indeed, under some circumstances it may be absent. In different examples of the same disease, and in the same case at different times, the quantity of emulsified fat may vary greatly. There may be as much as 1.39 of fat in the urine at one

time, and in the same subject, a few hours subsequently, none may be detected. The fat and albumen are not always present in the same relative proportion. After active exercise, the albumen exists in greater quantity, and, after meals, the fatty matter. The latter may be nearly entirely absent in the early morning before any food has been taken, and must vary in quantity with the proportion of fatty matter in the food. Any analysis of the urine must, therefore, be considered with reference to the period at which the examination was made. In general, it may be said that chylous urine does not correspond in composition to any of the fluids of the body, but compares more nearly to chyle than any other.

The composition of the blood is, also, altered in chyluria. The proportion of fatty matter in normal blood is as 1 to 116 of albuminoids, but in chyluria the fat exceeds the albumen. Although there are discrepant opinions, the general truth is in the direction stated. Besides the change in the quantity of fat, the blood is not altered, except in regard to the presence of the hæmatozoön—the *Filaria sanguinis hominis*. The same parasite is found in the urine also.

Course, Duration, and Termination.—The course of chyluria is essentially chronic, and no fixed duration can be assigned to any case. The disease lasts from one year to fifty years. Now and then a case terminates fatally, in a most unexpected manner. The sufferers from this malady appear debilitated, and experience a marked degree of mental depression. The explanation of these symptoms may be found in the presence of blood or chyle in the urine. In some cases, without any apparent reasons, the urine assumes a milky appearance, and afterward the general symptoms of depression come on. Indeed, the aspects of the malady are Protean, and a proper discrimination is possible only by recognizing the filaria in the blood and urine. Even before the symptoms appear, sometimes filariæ can be detected. The prognosis can not be regarded as favorable in any case, since, when a cure has been apparently effected, the disease unexpectedly recurs, and this may happen many times.

Treatment.—No curative remedy has thus far been proposed. Gallic acid, in full doses—a drachm or two daily—has proved useful in some cases. Probably carbolic acid and tincture of iodine, alone or in combination, will be found to act beneficially. Large doses of iodide of potassium have proved beneficial in a few cases. Full doses of quinine may have an effect on the growth and development of the parasite. The influence of change of associations, of occupation, of climate, has not been sufficient to warrant the recommendation of such hygienic means. As the chronicity of the cases will permit, the various parasiticides may be tried in turn.

DISEASE-PRODUCING MICROSCOPIC ORGANISMS.

Forms and Characteristics.—There are various parasites which appear to have a causative relation to certain morbid processes. Some of them have been studied in relation to the diseases produced by them; others remain for separate consideration.

VEGETABLE PARASITES.—Parasites infesting the human body belong to the *vegetable* and *animal* kingdoms. The former—or vegetable parasites—are contained in two classes: the Protophyte or Schizophyta; the Zygosporæ. Of the former, the order Schizomycetes contains the most numerous and important of the vegetable parasites, viz., Micrococcus, Bacterium, Bacillus, Vibrio, Spirillum, etc.

To the second order belong the Saccharomycetes: Torulæ and the Sarcina Ventriculi.

MICROCOCOCI.—This word signifies a *small berry*, and is applied to a spherical body, highly refractive, of very minute size, never exceeding and often less than $\frac{1}{25000}$ of an inch in diameter. They are seen as isolated dots in active motion, dividing transversely by fission, or form in rows or chains of six, eight, or more, or when united by an intercellular fluid into masses are called *zoöglæa*. They are composed of protoplasm, highly refractile, taking up coloring-matters with facility, but resisting the action of acids and destructive agents generally. They develop most perfectly in fluids containing carbon and nitrogen compounds and a small quantity of free oxygen, but air does not seem very necessary to their growth, since they develop without it under other favorable conditions.

There are various kinds of micrococci. Only those having pathological relations need to be alluded to here. It is quite certain that micrococci are found in connection with various pathological fluids and processes, but it must be admitted, we think, that their exact relation to these conditions can not always be made out. It seems to be well established, however, that if micrococci are entirely excluded, putrefactive decomposition can not occur in animal substances. It was long ago ascertained by Pasteur that every kind of fermentation (putrefactive included) is correlative of the growth and multiplication of some organism. Infective pus owes any virulence it may possess to the presence of these organisms, since it has been shown that fresh pus free from these bodies has no infective property. But there are not wanting facts on the other side, especially the filtration experiments, which seem to prove that the infective property is contained in a substance produced by micrococci in course of their development, and not to their mere presence. The relation of these bodies to some infectious diseases has been shown, according to the best observers. Thus the coccus of pneumonia, now called *pneumococcus* of Friedländer and Fränkel, although not entirely agreed on, must be considered as

highly probable; also the coccus of gonorrhœa—*gonococcus*—of diphtheria by Eberth, and a bacillus by Klebs and Löffler, of syphilis by Neisser and Lustgarten, and many other maladies of the character called infective.

BACTERIA.—These are rod-shaped, about the $\frac{1}{10000}$ of an inch in length, plain or jointed. They occur in putrescent or fermenting fluids, and vary a good deal in size and shape according to the media in which they are found. In decomposing fluids they are smaller, and in fermenting solutions larger, than the medium size. In the former they are known as *Vibriones*, or in larger and longer rods, as *Leptothrix*; and in the latter they are the well-known *Torulæ*. Some bacteria seem to be entirely without morbid quality, and others, that may not be distinguished from them, contain an intense virus, or, if they do not contain it, have the power to produce it. These pathological bacteria have been discovered in various diseases, as whooping-cough, erysipelas, puerperal fever, and many others. It must be said, however, that only *probability* can be made use of to describe the present state of opinion on the subject.

BACILLUS.—The term *bacillus* signifies a *staff*, and is now applied to a filiform bacteria. Bacilli have been found of late in great numbers in certain infectious diseases, notably in splenic fever and malignant pustule. The discovery by Koch of the *bacillus tuberculosis* has taken the first rank as a scientific fact in these times. There is now but little said in opposition to this explanation of the infective property of tubercle, and it has already borne fruit in the treatment of consumption by means to arrest the growth of this parasitic form.

The *bacillus malarie* of Laveran has been confirmed by late researches, notably those of Professor Osler, of Johns Hopkins University. To this must be added also the *comma bacillus* of Koch, who maintains it as the specific cause of cholera. The discussion on this topic has been warm, not to say acrimonious, but on the whole the position of Koch is supported by an increasing majority of skilled observers.

SPIRILLUM.—This term is applied to the spiral form of bacteria. Cohn, who has made the most careful study of these organisms, and is the highest authority on them, divides these spiral bacteria into three forms: 1. *Vibrio*, which consists of short spiral filaments, very flexible; 2. *Spirillum*, also filaments, but rigid; 3. *Spirochæte*, long, spiral, flexible filaments. The last-mentioned form was described by Obermeier as existing in the blood of relapsing fever during the paroxysms, and his description has been abundantly confirmed. It is sometimes called *Spirochæte plicatilis*, as it is an identical form with that described by Ehrenberg under this name.

ANIMAL PARASITES.—Many of the animal parasites have been considered in relation to the diseases caused by them. There are, how-

ever, some remaining for examination, which are partly of a practical, partly of a scientific interest. Under the name *chyluria*, mention is made of the *Filaria sanguinis hominis*, a parasite discovered by Dr. T. R. Lewis. An endemic hæmaturia occurs at the Cape of Good Hope and other parts of the African Continent, which is caused by a fluke, called after its discoverer, Dr. Bilharz, of Cairo, the *Bilharzia hæmatobia*. This parasite is found in the veins of the portal system and in the bladder, and causes hæmaturia.

Certain trematode parasites, commonly known as *flukes*, are sometimes found in the human body, notably in the liver. About twenty cases of *distoma hepaticum* have been recorded, several by Professor Joseph Leidy, M. D., of Philadelphia, and they may therefore be encountered in this country. Besides their usual abode in the liver-ducts and gall-bladder, they have been found under the skin behind the ear, under the scalp, and in the sole of the foot.

Of greater practical importance to the physicians of this country, especially of the Southern States, is the *chigoe*, or popularly the *jigger* or *sand-flea*. The popular notion is so far true that this parasite really belongs to the flea tribe, and is named *Pulex penetrans*. It inhabits by preference a dry, sandy soil, and is exceedingly prolific. It deserves to have the adjective *penetrans* appended to *pulex*. They bore into the skin of the feet, especially under the nails and between the toes, where the softer integument permits more ready penetration. The impregnated female, thus deposited under the skin, swells to considerable size, and excites a violent local inflammation, suppuration, and sloughing. The larvæ also, deposited in open wounds and ulcers, excite unhealthy and destructive inflammation. The bones finally become diseased, and toes may slough off, or an extremity may be lost by a necessary amputation.

It follows, from these considerations, that when a jigger penetrates the skin it should be removed with the utmost care, so that no portion of it, or any of its larvæ, be permitted to remain behind. If the parasite is not successfully removed, its destruction by carbolic acid, or sulphurous-acid lotions, should be attempted.

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