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GMS

G. H. Hurme

In
The Trichina Spiralis
&
Trichinosis.



The following is a list of the works from which
the data for this Thesis have been derived:

"Untersuchungen über Frichins Spinale" von
Dr. Med. Rudolf Leuckart, Professor der Zoologie zu
Gießen.

"Die Frichinen" von Dr. Ragenstecher, Professor
der Zoologie, Heidelberg.

"Die Lehre von den Frichinen" von Rudolf
Vichow.

"Die Frichinenkrankheit" &c von Dr. B.
Kapprecht, Wetzlar.

A number of papers by different authors in
Vichow's Archiv, Wagner's Archiv, Schmidt's Lehrbuch &
were also consulted.

The class of Parasitic Diseases is one of the departments of Medicine in which our knowledge has chiefly been acquired in recent times. By the application of the microscope in their investigation, many diseases, previously of obscure origin, have been found to belong to this group. This has especially happened in the case of Skin-diseases. General parasites of which have been ascertained to depend on the presence of a parasite - vegetable or animal. Again, another division of the same Subject has recently had much light thrown on it by direct experiment. By this method of research the development of ~~the~~ some of the intestinal worms has been explained, and found to present many interesting facts. Especially have the experiments of Nüthenmeister been attended with the most remarkable results in demonstrating the Alternate Generation of the Tapeworms.

But the parasite which at present claims for itself the greatest share of Scientific Attention

well as popular interest is the *Trichina Spiralis*.
And in this instance our knowledge of the pa-
rasite belongs entirely to the last thirty ^{or forty} years. Previous
to that time it was quite unknown, and only
during the last six years has it become the ob-
ject of so great an interest. And in some quan-
tity of so much dread as are now attached to it.
During the years intervening between those two
periods it was known chiefly as an encysted
worm occasionally met with in the human muscles,
and had excited a considerable degree of interest
by the mystery in which its origin and mode of
propagation were involved. To solve this mys-
tery researches had been undertaken at various
times by scientific men in England, France, and
Germany. In this way the subject had been to a
considerable extent wrought out when the well-
known Brecken case occurred and showed that
the *Trichina*, hitherto looked on as harmless,
might be the cause of a painful and fatal disease.

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The case referred to occurred in 1860 and to Prof.
Zenker is due the merit of having first brought this
'new disease' under the notice of the profession in
Germany. The patient was a young woman admitted
into the Dresden Hospital, suffering under what was
diagnosed as Abdominal Typhus. Some of the more
usual symptoms of Typhus, however, were ~~wanting~~ ab-
sent while some of those present were peculiar. Especially
the intensity of the muscular pains was such as to at-
tract attention. The case ended fatally. At the time
it occurred Zenker happened to be investigating
the changes in the muscles of Typhus patients - and in
the post-mortem examination of this case also the muscles
were examined. They were found to be in a state of
great degeneration, and in addition to be crowded
with Trichinae. A further consideration of the case
led Zenker still more to doubt the propriety of
referring it to Typhus, and induced him to sus-
pect a connection between the symptoms and the
myriads of worms found in the muscles. On follow-

out the history of the patient this supposition was found to be fully justified. Not only did he find Trichinae in Swine's flesh of which the girl had eaten, but also learned that several persons, who had eaten of the same flesh, had suffered from more or less similar symptoms though less severely.

I have noticed this case here because it forms the mark of division between the two eras, into which the history of the Trichina is naturally broken up. Between the first notice of the parasite in 1832 and the publication of Zerkow's case in 1860 is the first of these periods. During that time the anatomy of the Trichina and many facts in its development were made out. But as already mentioned its presence in the human muscles was believed to produce no symptoms whatever. During the second period on the other hand it has become the acknowledged cause of a disease of frequent occurrence in Germany though elsewhere almost unknown.

In following out the subject in this Thesis I will adopt the arrangement thus indic-

ated. The researches made during the first period will require notice so far as necessary for showing the manner in which the development of the Trichina has been traced out. The further history of the Parasite during the last six years consists chiefly of a history of the disease produced by it, and does not require special notice, chronologically. The materials for the description of the disease given in the latter half of the Thesis have been mostly derived from the records of Trichinosis during that time.

The first notice of the Trichina was that given by Hilton, a Surgeon of Guy's Hospital, who found them in 1832 in the muscles of a man who had died from Cancer. He saw only the capsules, however, and considered them to be Cysticerci. In 1835 these cysts were more carefully examined by Reget, and found to contain a spirally coiled worm. Almost at the same time this fact was observed by Owen, but the priority of discovery seems in reality to belong to Reget. In Owen's description the worms contained in the cysts re-

carried the name they have since borne - and were
 described by him as simple in structure and
 allied to the lowest forms of organisms. This opinion
 was not shared by the best writer on the *Eichinia*-
Farre. He recognised a more complicated structure,
 in so far as he was able to trace an intestinal
 canal running throughout the length of the worm,
 and distinguished, as an organ, a mass of granules
 near what he described as the posterior, but really
 the anterior extremity. These descriptions of the parasite
 were followed by others in different countries
 in which it was occasionally met with in the
 dissection of the dead body. Among the more detail-
 ed descriptions were those of Lueckha and Bies-
 off, both of whom differed from the opinion held
 by their predecessors as to the nature of the cyst. It had
 been generally looked on as belonging to the tissues
 of the infected animal. But by these observers it
 was regarded as a part of the worm. By the former
 the inner part of the capsule was held to be an egg-

envelope' while the outer arose subsequently from a plaster exudation.

In the meantime the Trichina had been found to occur in the cat: and in the Saw legged in America, in 1849.

As yet, and for some time afterwards, the Trichina was known only in the encapsulated state, and no ^{more than} ~~traces of~~ conjectures were made as to its origin and mode of propagation. Most of the Helminthologists, who had given attention to the subject, were inclined to regard it as a distinct, fully developed species, and by some suggestions had been thrown out that propagation might take place by budding or division. Even in 1844, however, the opinion had been advanced by Stenard and V. Siebold that the Trichina might be the young undeveloped form of some round-worm. The cyst V. Siebold believed to be formed by the Trichina, which waited inside it for an opportunity of further development in the intestines of a second animal. As such an opportunity

was not likely to occur in the case of Trichinae whose
 seat was the human muscles, he considered the calc-
 ifying the cysts were apt to undergo, as following the
 death of the worm and as thus the result of the
 'Straying'. These opinions met with little favour
 for some time. Only eight years afterwards,
 when Küchenmeister had established experimen-
 tally the development of Cysticercus into Roundworm,
 did the similar principle begin to be generally
 applied to the Trichina. In 1838 Meissner expressed
 the opinion that the worm of which the Trichina was
 the undeveloped form was a Trichostrongylus.
 Küchenmeister on the other hand, grounding his
 opinion chiefly on the similarity in ^{the} structure of the
 intestinal canal in the two, believed that the
 developed worm was rather a Trichocephalus.
 And as Leidy in noticing the natural occurrence
 of Trichinae in swine had mentioned the current
 belief in America that the human subject could
 derive Trichocephalus disease from the eating of

Livine's flesh. Küchenmeister suggested that this
 might be the variety produced from the Trichina.
 To establish or disprove these theories experiments
 were undertaken in different quarters. Experiments
 by feeding with Trichina-flesh had before this been
 repeatedly made, but had been unattended by re-
 sults of importance. In 1848 Herbert had carried on
 a series of such experiments, and had succeeded in
 producing Trichinae in the muscles of a badger by
 feeding it with the naturally trichinuous flesh of
 a dog. And with the flesh of the badger again
 he infected a second dog. But the Trichina
 Spiralis does not seem to have been accu-
 rately distinguished by Herbert from other worms
 bearing a resemblance to it. He stated that
 he had met with three varieties, and that he
 had found the Trichina in various animals
 in which later observers have not been able
 to detect it. In consequence of these defects the
 experiments of Herbert do not appear to have had

Much value attached to them by contemporaneous or subsequent inquirers.

The experiments now made, with reference to Küchenmeister's views, were conducted chiefly by Leuckhart, Küchenmeister and Ziemer. With the two last, the experiments were attended with little success. Neither were those of Leuckhart ~~at~~ productive of much result, except that in the intestines of a mouse on the 3^d day after feeding the Trichinae were found to have fallen out of their capsules and to have attained double their original size. And from this it could at least be concluded that the Trichina in the muscle was not a fully developed worm.

Two years later, in 1858, the feeding of a young sow with Trichina-flesh by Leuckhart, gave a result which seemed conclusive in favour of Küchenmeister's view. The sow was killed four weeks after feeding and in the intestines a considerable number of Trich. cephal. were found.

These Leucoblasts believed to resemble much more the Diplo than the Crenatus - the form already known to him as occurring in Swine.

In the Summer of 1839, before the publication of this experiment, Virchow had found in the intestines of a dog, which died four days after feeding numbers of small worms. These exactly corresponded to the muscle Trichinae, except that their length was greatly increased, and that they had become sexually developed. Influenced especially by the latter fact, Virchow was inclined to believe the Trichina to be a distinct species of Nematode - an opinion which was naturally somewhat shaken on his becoming acquainted with the result of Leucoblasts experiment. At the same time he did not consider the question as finally settled: he pointed out that there were differences in the anatomy of the Trichina and Trichocephalus which rendered a transformation of the one into the other improbable. Especially there was in the Trichina an absence of the

characteristic external male genital organs of the *Trichocephalus*. And the ova of the former were totally unlike those of the latter. For these reasons, while suggesting the greater a priori probability of the *Trichina* becoming developed into a *Strongyloides*, we considered the question still open to be decided by future investigations.

Leuebrant was the first to renew his experiments in the latter half of January 1860; and the results of these sufficed to remove the fallacy arising from the one already mentioned. In a dog killed four days after ingestion of the trichinious flesh, the worms had become sexually ripe, and the ovary & uterus of the female were filled with ova. But the second experiment was still more decisive. The subject pig, also a dog, was allowed to live seven days after the feeding. In its intestines numbers of *Trichinae* were found, and not only had these attained nearly increased dimensions and become sexually ripe, but in

(1) The muscles of thin skin some weeks afterwards
were found covered with Trichinae. Similar ex-
periments have seldom succeeded in the hands
of other experimenters.

the cavities of the female great Muscles of coiled up embryos were seen to lie. By this experiment the fact was established that the Trichina is viviparous.

Still one important point in the history of the Trichina remained to be cleared up. This had reference to the ~~fact~~ question whether the embryos required to be conveyed into the intestines of a second Animal before their development into muscle-Trichinae could go on. Under the impression that this was necessary Leubrand fed a Sow with the intestines of the dog the subject of the second experiment. "But in the meantime the Dresden case had occurred, and new material was afforded to Virchow and others for further investigation. As the result of these several important facts were made out. Virchow who used Rabbits in his experiments proved that a change to a second Animal is not necessary for the development of the embryos. And claim. That the accuracy of his already expressed opinion

that the eye of the *Trichina* is not placed between the muscle primitive bundles but inside the *Sarcolemma*.

Thus the main facts, which had now been established as to the relations of the *Trichina*, were these. The muscle-*Trichina*, held by the first investigators to be a perfect worm, was shown to be only a stage in development. It was found that on being carried, with the flesh in which it lay, into the intestines of an animal, it underwent further development, became sexually ripe, and produced living embryos. That these embryos, without a change of place being necessary, passed at once out of the intestines and made their way into the muscles, in which after a time they became encapsuled. While its circle of development was thus being traced out the anatomy of the *Trichina* was also greatly cleared up. By several of the earlier observers, especially Luschka, Brislone & Meunier, a tolerably complete

Account of its Structure had been given. And among the later writers, Lenebrant, Virchow, & others have filled in many of the blanks previously existing.

Anatomy. The *Trichina Spiralis* is placed by Helminthologists among the Rematodes Strongyl
oides, in which Suborder it forms a distinct family. It is characterised by a complete digestive system and distinct sexes. We have seen also that it is peculiar in the manner of its propagation - that a change of habitat is necessary but that all the stages may be found in the same animal at the same time. It is a microscopic worm, but the size of the muscle and intestinal Trichinae differs greatly.

In describing more minutely the anatomy and development of the *Trichina*, I will follow the order in which it goes through its stages in an infected animal, from the ingestion of the diseased flesh to the completion of the encasement of the young worms in the muscles.

(1) It is not implied by this that the *Trichinae* must
^{have} *Eucapnoid* in order to propagate themselves.
Infectum can equally well take place with the
Eucapnoid *Trichinae* provided they exceed the
Size mentioned at p. 24.

Intestinal Trichinae. When the flesh of one animal containing Trichinae is taken into the stomach of another, the first step is the liberation of the worms from their capsules. ⁽¹⁾ This occurs in the ordinary process of digestion, the capsules being dissolved by the juices of the stomach, while the Trichinae resist them. In a few hours after the eating of the flesh the Trichinae may be found in the upper part of the small intestines. There they immediately begin to grow. In the muscles they may have reached a size varying from .6 millimetre ⁽²⁾ to 1. mm ⁽³⁾. In the intestines in four or five days the males will have grown to 1.2 mm ⁽⁴⁾ the females to 1.6 mm ⁽⁵⁾. have become sexually ripe and the one of the latter already fructified. Beyond this size they grow considerably during the time they remain in the intestines. The male worms usually reach a length of 1.5 mm ⁽⁶⁾ and are always much smaller than the female, which are sometimes met with having a length of 3 mm ⁽⁷⁾. When freed from the intest-

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 $\frac{50}{50}$ —

cial mucous, individual specimens are with difficulty seen by the naked eye as delicate white threads. Under the microscope they are seen to be round worms, with a sharp anterior and blunt posterior extremity. If taken from the intestinal canal of an animal recently dead - or if the glass on which they lie be heated, movements of a peculiar nature can be noticed. They consist in a movement from side to side of the sharp head end, and a hammering and widening of the loops which the worm sometimes forms. Usually in the intestines the *Fichinae* are not coiled up, but lie stretched out.

The anatomy of the *Fichinae* is difficult to trace out from the way in which one organ overlaps, or altogether conceals another from view. Its external integuments are described as consisting of an outer Chitina envelope, and a muscular layer with an internal lining of delicate epithelial cells. In the muscular layer two bands, one on either side, are seen to run from near the head.

Backwards to the dorsal posterior extremity where each meets its fellow of the opposite side. These bands consist of a clear structureless substance, in which cells are arranged with such regularity, in two alternate rows, as to give the intermediate line the appearance of a canal. Hence Luschka held these bands to be vessels, but they are now generally regarded as muscular.

At the anterior and posterior extremities are situated the Mouth and Anus. And there the Chitinous envelope is continuous with the interior of the alimentary canal, in the same sense that the skin in higher animals is continuous with the mucous membrane of the mouth. Following the alimentary canal from the mouth backwards it is easily recognized in the first part of its course. Very soon however as it becomes somewhat wider it also becomes surrounded by cells which more or less encase it. These accumulate, and the canal then passes into an envelope formed of large cell-locks. As each of these occupies nearly the whole breadth of the body cavity and is set edge to edge with its

Neighbors, they give to that Segment of the worm
 in which they occur a peculiar aspect. Like appear-
 ance. These cells are about fifty in number, ar-
 ranged in single file, and possess each one or more
 nuclei with dark granules. Different functions
 have at various times been attributed to them. By
 Insectaria they were described as forming the anus,
 but by some more recent writers on the Trichina they
 are looked upon as secreting cells, whose product
 passes by haemolymph into the alimentary canal,
 to be employed in the process of digestion. The two
 anterior sections of the canal already described
 - that between the mouth and the cell-envelope and
 that surrounded by the cells - are distinguished
 as the mouth and Esophagus. As the canal issues
 from under covering of the last cell-body it is
 widened into a funnel-shaped cavity - the Stom-
ach. Between the base of this dilated portion, which
 is towards the anterior extremity, and the last
 cell, is placed on either side a small blind
 sac the purpose of which is not known.

(1) - The body of the *Prickia* when at rest usually forms an arch.
The convex side, which in the female is that side on which the
genital opening is situated, is distinguished in both sexes
as Ventral.

At the posterior part of the stomach the cavity rapidly narrows & the canal is continued backward as the small intestine to the apex. This description of the alimentary canal refers to both male and female. In both the arrangement is the same except as regards the connection between the intestine and the male genital cavities, which will have to be mentioned in describing the latter. In the female no such connection exists.

The Nervous System is represented in the Tribinia by a mass of ganglionic cells situated near the posterior head & bristly. This mass surrounds the alimentary canal and from its process can be traced for a short distance, branching out in a ray-like manner.

Genital Organs. In the male the external genital organs consist solely in a pair of so called sexual lobes. They are quite terminal on the posterior extremity, and are placed one on either side of the anal opening. They are curved with the convexity looking backwards and forwards (ventrally⁽¹⁾) and the

points downwards and backwards. but their
 direction is capable of being altered. The purpose of
 these hooks is supposed to be to grasp the female, during
 the shedding of the sperm-cells. Internally in the
 male is found a single testis, which is pouch shaped.
 with the blind end placed posteriorly. From this it
 passes forwards to near the blind sac, mentioned
 in connection with the alimentary canal, and
 then bends on itself and narrows to be continued
 backwards as the seminal duct. Frequently
 the duct as it passes backwards presents a dil-
 ation forming a kind of seminal vesicle, and
 again narrows, before it joins the intestinal canal
 at a short distance from the anus, to form the
Cloaca. At this part are found the only connections
 between the integuments of the worm and the
 canals in the shape of a meshwork of bands run-
 ning between the inner surface of the envelopes &
 the cloaca. Among these bands are two, one on
 either side, which are more strongly developed
 and have been distinguished as the Retractor Cloacae.

The use assigned to them is the drawing back of the cloaca which is protruded during the sexual act.

The testicle is filled with a mass of glaniny cells which contain smaller cells with clear nuclei. The first are to be regarded as mother-cells, and the latter are the proper sperm cells, which are found in the Vas deferens and Seminal vesicle.

In the female the genital organs consist of an Ovary, uterus, and Vagina or duct which communicates externally by an opening near the Anterior End of the worm. These three parts Ovary, Uterus, and Vagina, pass into each other and are arranged in order from behind forwards. The blind end of the pouch constituting the Ovary lies nearer the extremity of the body than the corresponding part in the male. It extends forwards to near the stomach portion of the intestinal canal, and there is inserted by a constricted neck into the somewhat broadened end of the uterus. The latter is then continued forwards, gradually narrowing into the terminations of a duct - and at a varying distance from the

Anterior extremity, is situated at the opening by which the embryos pass out of the genital cavities.

The Ova are round, and contain a germinal vesicle and spot, with clear yolk-mass. They are produced in great numbers so that usually in a *Trichina* examined some time after fructification the whole body cavity seems filled with them, and nothing else can be seen as far as the part where the uterus narrows outwardly.

Development from the ovum takes place by the usual process of cleavage of the yolk-mass. And by the time the embryo has reached the narrower part of the uterus, it is fully formed and has burst the envelopes. Thus in a *Trichina* which has been 9-12 days in the intestine of an infected animal, ova are found in the posterior segment of the cavities while in the anterior part of the uterus are numerous rollers of embryos. As these embryos pass into the vagina they become stretched out in the long axis of the canal, and escape singly from the cavities of the mother.

The time required for the complete development of the embryos within the body of the mother varies with several conditions but may be stated generally to be about 7-9 days. The rapidity of development is greatly influenced by the age of the ingested muscular trichinae. When these have been long encysted they become much sooner sexually ripe, and consequently fully developed embryos will be much sooner found.

11 $\frac{11}{50}$ $\frac{11}{50}$ ga Muscles - trichinae again which fall short of a cent. in certain size ($5'' \cdot 6''$ $\frac{13}{100}$ mm) do not undergo development at all and therefore flesh containing only trichinae under this standard is not harmful.

How long the parent trichinae may continue in the intestinal canal and produce embryos has not been absolutely determined. In one of Nag. Cusack's experiments on rabbits male and female trichinae were found more than eight weeks after the feeding. As a general rule they may be found for two or three weeks at least. They then pass out of the intestine with the feces or becoming disintegrated in the bowel altogether disappear.

Embryos. The number of ova and embryos in an
 impregnated trichina at one time is exceedingly great.
 And as probably each female is impregnated more
 than once, the number of embryos produced from one
 mother is perhaps not overestimated at two or three
 thousand. When they leave the body of the female
 the young trichinae are from .08⁽¹⁾ - .12⁽²⁾ Mm in length.
 They do not remain long in the intestinal canal
 so that in examining the mucus and fluid from the
 bowel, they are seldom to be found. They seem to pass
 almost immediately through the intestinal walls and
 begin to distribute themselves throughout the vol-
 untary muscles. The mode of their migration is
 believed to be directly through the tissue, ~~of the body~~
 and also probably to a small extent by means
 of the blood stream. The occurrence of the latter
 mode has been chiefly advocated by Fiedler,
 who grounds his opinion on the facts, that he
 has found young trichinae in blood clots in the
 eight chambers of the heart, and that in the
 muscles even of the extremities quite undeveloped

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Hume Trichina



In W. Humes Thesis

we have a very good resume
of most of the facts already
known regarding the Trichina
spiralis and the formidable
disease of Trichinosis to
which it gives origin.

He has consulted
the greater number of the

German Authors who have written on the subject, and he has for the most part carefully condensed their observations, in his Thesis.

The most defective part of the Thesis is that in which he treats of the anatomy of Trichina. In this he does not carry us up

to the present state of knowledge,
and Mr. Hume does not appear
to have studied Rudolf
Senzkrant's last important
treatise on Taiichina,
or that by Hensen in
~~the book~~ Max Schultze's
Archiv for April, —
treatises with which if
Mr. Hume intends to pursue
this subject I should recom-
mend him to become
acquainted.

Worms are met with in the immediate neighborhood of others much older and larger. These younger trichinae he thinks must have been carried direct to the place in which they were found by means of the blood. It seems certain however that most pass into the muscles direct through the tissues. When the current of the circulation is frequent means of conveyance, one would expect to find the worms sometimes acting as plugs and being the cause of embolic processes. Few observers also besides Liddle have succeeded in finding trichinae in blood-clots.

As soon as the emigration has begun young trichinae may usually be found in the Cavities - the peritoneum, pericardium and pleura. These generally show no increase in size beyond that of the youngest embryos, and we may conclude that they remain in the cavities only a very short time. At the same time they ~~are~~ begin to be distributed throughout the muscles, and their number increases according to the

Lucidity of the infection. They also grow rapidly so that in about 14 days after their passage into the muscles they have acquired a length of .5- .6 Mm. At first they are stretched in the long axis of the primitive bundle in which they lie. But by the time they have grown to the size mentioned, they become coiled up and the process of encapsuling begins.

Meantime the irritation of their presence has caused changes in the muscular fibre. For some distance in its course on either side of the ^{infection} it presents a homogeneous appearance from loss of the cross striping - or its whole substance is broken up into a granular mass. Around the affected fibre is accumulated a mass of cells derived from the interfibrillar connective tissue, and the muscular nuclei themselves are greatly increased in size and number. The nuclei have also become much elongated, and contain often two nucleoli. Sometimes all these three changes may be illustrated in and around a single fibre. By degrees the degenerated contents of the fibre which was at

first swollen disappear and allow the sarcoclemma to fall together on either side while around the coiled up worm it still bulges out. The accumulation of cells which when at its height readily conceals the worm then diminishes and in its place is found a close capillary network, first described by Luschka. Whether muscular fibres are reproduced from the nuclei seems doubtful. Colberg has described their connection into elongated ribbon shaped ~~tubes~~ cells, on which he saw indications of transverse striping, but others have not been able to satisfy themselves of the accuracy of this observation.

While these changes are going on around, the sarcoclemma forming the capsule of the trichina becomes thickened. Part of this thickening probably consists of a deposit in the interior from the granular matter enclosed in the cyst. This granular matter results from the degeneration of the muscular fibre and while some of it may be deposited in this way, a certain amount remains

And may serve as nutriment for the Echinia during its vita minima in the muscle. A portion of the necessary nutriment must also pass into the interior of the cyst from without.

The formation of the capsule is completed about the second month from the date of infection. When fully formed the continuity of the outer envelope with the sarcolemma can ~~be~~ no longer be traced. In form the cyst is lozenge-shaped and its poles are, ^{often} considerably elongated. This is the shape of the capsule as a whole, but as the internal thickening has taken place in greater quantity at the processes the sharply defined cavity, which contains the worm, is round or oval. The further changes which occur around, or in the cyst, are the accumulation of large fat globules at the poles, and the calcifying of the cyst itself. Almost immediately on the full completion of the capsule, the capillary net. work begins to disappear, and at the same time fat is deposited. This deposit ^{often} becomes very great, and when time is given it is found collected

in large bead-like masses by preference in the situation mentioned but also around the whole body of the capsule. A much longer time is necessary for the process of calcification to begin. Its average time of commencement has not been accurately determined. But in rabbits which have been allowed to live a year after infection no trace was to be seen. While again in one fed by Rogers Stecher and killed about the 80th day, a molecular deposit had evidently taken place. This deposit seems always to begin at the processes, and then gradually extends over the whole cyst. Usually the process goes no further, and does not involve the body of the worm. When this does happen and the trichina becomes calcified along with the cyst, the death of the former must in all probability have first occurred. The duration of the life of the trichina within the cyst is not as yet known. Cases are on record in which the infection could be accurately fixed as having occurred eight and thirteen years before death, and yet specimens

With the trichinosis muscle in these cases, gave a strong infection in the animals employed. How far the limit must be extended beyond the longest of these periods we cannot say. But there are no grounds for concluding that the limit has already been reached.

Anatomy of the Muscle-Trichinae. At the time of encapulating the trichina has not reached the full size and development it is capable of within the muscles. But as even in the embryonic condition the brain and alimentary canal are formed the further development affects mainly the sexual organs. In the male, the sexual gland which is at first similar in both sexes shoots forwards and turns on itself in the region of the stomach. The ^{narrow} elongated process thus formed ~~the~~ elongates towards the posterior extremity and becomes connected with the intestinal canal. Thus the internal sexual organs of the male trichina are formed in the muscle. And the further development which takes place when it becomes an intestinal worm consists in

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the production of Sperm-cells and the growth of the hooks.

In the female the formation of the sexual organs does not advance so far. The gland represents merely the ovary, and extending from its extremity to the blind sac, Kaganstocker describes a row of six or seven cells which he considers to be ova. At the end of the ovary itself is accumulated, only after the trichina has been sometime encapsuled, the mass of granules described by Farre. This indicates the limit between the ovary and uterus and, along with the row of ova, occupies in fact the place of the latter, in the fully formed condition. The uterus therefore does not properly exist in the muscle trichina - and there is no trace of the vagina or external opening.

Origin of the Trichina. One of the problems connected with the trichina that has offered the greatest difficulties to its solution is the source from which the larvae are infected. This is the problem yet unsolved. The progress that has hitherto been made in this direction has lain rather in

disproving false explanations than in establishing
 the true. From the time ~~of~~ Herbst believed that he
 had found the *Trichina spiralis* in several birds
 and in great numbers in the mole, it has been
 stated to occur in various animals from which
 the infection has been supposed to spread. Among
 these the mole and the common earth worm have
 attracted the greatest attention and blame. All
 the animals put forward at different times are
 certainly found to contain worms, often spirally
 coiled, and having all a certain resemblance
 to the true *Trichina spiralis*. But in every instance
 closer observation has shown essential differences,
 while the test of experiment in the case of the mole
 and earth-worm have sufficiently proved that
 it is not from them that swine become trichinose.
 Again the source has been sought for in the vegetal
 kingdom and certain spiral, encapsuled,
 worms occurring on the beet-root in some parts
 of Germany have been suspected. But apart
 from their being encapsuled in the free state

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While the true Trichina becomes so only in the muscle, there are sufficient anatomical grounds for separating them. And recently the history of these beet-root worms has been more exactly made out by Stein in Wedderlehen, and found to differ essentially from that of the Trichina.

Thus one by one of these supposed habitats of the Trichina has been excluded, and the list of animals in which there is good ~~reason~~ evidence of its natural occurrence contains only the cat, mouse, cat, and most important the Swine. Probably also the Hedge hog is to be added. The presence of Trichinae in mice and rats perhaps indicates one quarter from which Swine can be infected. From them cats also can become trichinious and in this way the circle widened. There is also a probability that the trichinae are propagated in another manner. Under certain circumstances unpropagated trichinae pass out of the intestines, whether of the human subject or otherwise, and there may be taken up in the excrement by Swine. Viechow has also

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draw attention to the frequency with which portions of flesh pass through the intestinal canal undigested, and to the possibility of such being means of infection, when they contain trichinae.

The microscopic examinations of Swine flesh, which have been instituted in different towns in Germany to afford protection to the public, have shown that the proportion of Swine affected with trichinae is very variable. In Brunswick, among 3,000 Swine examined only 2 were found trichinous. In Blankenburg again, where there has been more than one epidemic of trichinosis, 4 were found affected among 100. And in another town in a very short time 3 were found to contain trichinae.

The first case in which the Trichinae were recognised as the cause of disease ~~has~~ that described by Prof. Ziemer of Breslau - has been already shortly noticed. Although the first recognised it was certainly not the first case of Trichinosis. It is not the disease but the knowledge of it that is of so recent a date as 1880. ~~That~~ That this is the case is proved by the Trichina having been so often found previously in the human muscles. Cases also which at the time passed as examples of other diseases are now known with considerable certainty to have been instances of Trichina-infection. The symptoms described in the Venues of many cases of Saurage-poisoning bear so great a resemblance to those of Trichinosis that they must be considered as referable to that disease. Cases of Trichinosis have also at the time of their occurrence been looked on as Influenza or Epidemic Gastro-enteritis. Towns have at different times been visited with such Epidemics and a correct understanding of the cases

in several instances has been obtained, some years afterwards, when individuals who suffered in the Epidemic became the subject of Post Mortem Examination. One or two cases also, which, by the similarity of their symptoms with those of some forms of poisoning, excited judicial inquiry, are to be referred to the same origin. An instance of this was met with in the Memoirs of Prof. Langenbeck, in Berlin, in 1843. The patient was a man from whose back a cancerous mass was removed, and in the portions of muscle attached to it, Trichinae were found. The event which this circumstance was held to explain was the following. In 1845 the patient along with five colleagues met in a provincial town of Saxony for the purpose of examining a School. They breakfasted together at the house of a merchant, and shortly afterwards, they were seized with such symptoms as to cause a suspicion of poisoning to fall on their host. Four out of those who had partaken of the breakfast died. But neither in the Archives nor in any of the Articles of Food was

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the Suspected poison found, and the matter remained a mystery till it was cleared up in the manner described.

At a still earlier date 1835 - a case occurred in Bristol, the details of which given by Dr. W. Wood, at least do not contradict the supposition that it may have been one of Trichinosis. The case was that of a young man who died in what was diagnosed as an attack of acute Rheumatism. But in the Muscles Wood found Trichinae, or at least worms exactly corresponding to those described a short time before by Owen. But he found only the ~~few~~ worms. "His manipulation," he said, "was not fine enough for the dissection of the cysts." Probably because there were no cysts. And as the fact that the case was regarded as one of Rheumatism rather favours the idea than otherwise, it is perhaps unnecessary to differ from the German writers, who have nearly all quoted it as probably one of Trichinosis.

Hitherto, so far as known, no cases have been met with in France, nor, with the above doubtful exception, in England. It would be too much,

"A large proportion of the cases have occurred in Northern Germany especially Saxony. In Russia the disease is not infrequent. and during the past winter cases presented themselves from time to time in Berlin. The last severe epidemic, mentioned a little further on occurred in a Russian town.

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however, to say that none have occurred. In both countries the Irish are met with occasionally in the dead body, and no one can now believe that the infection took place without accompanying symptoms. But as the disease can be so readily communicated with others even where there are ample opportunities of preserving it, it can be no matter of surprise if this happens where such opportunities do not exist.

Since 1860 ~~in~~ Germany, on the other hand, and especially some parts of it, has never been free from Irishism. Its frequency is attributable to the extent to which Swine flesh is used and still more to the insufficient way in which it is generally cooked. Besides numbers of isolated cases, the disease has broken out in different towns and districts at various times in an endemic form. The severity of the disease has varied greatly in different instances. Some Endemics have been attended with only a very small mortality or an entire absence of fatal cases, in others again the rate of mortality has been exceedingly high.

As instances may be mentioned the Eudemie^{40.}
in Hettstadt in which out of 158 affected 27
died: that at Calbe an der Saale in which 8 cases
were fatal out of 38. And the most recent Eudemie
which prevailed in the end of last year and the
beginning of the present in Uedersleben, a small
Prussian town of 2000 inhabitants, in which
320 persons were affected and about 100 died.

The individual cases of Trichiniasis ex-
hibit naturally the same differences in severity as
are shown in the Eudemies just referred to. These
variations are dependent on the amount of trichinae
eaten, the extent to which it contains trichinae,
and the mode of its preparation. Besides these
modifying circumstances there are also others
connected with the patient. The time of life,
state of health and similar conditions naturally
enable them to pass more lightly through the disease
or otherwise. Hence in those cases in which the
conditions are favorable the appearance of
marked symptoms is delayed often for a considerable

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crable time. And in such also the disease usually runs a comparatively mild course. In seven cases again the symptoms as a rule come on soon after the meal - are urgent throughout, and end ~~at last~~ in a protracted recovery or not seldom fatally. These two classes of cases will be best considered separately, taking the more severe first, as giving the complete picture of the disease.

Symptoms. Some hours after the ingestion of the trichinons flesh the patient begins to feel unwell. He complains of heart burn, bad taste in the mouth, abdominal pains, and the other symptoms of a severe attack of indigestion. His sleep is disturbed. Next day or perhaps the following is marked by the sudden accession of vomiting and diarrhoea. These are usually severe and exceedingly obstinate. After a time the vomiting subsides, but the diarrhoea continues & in this state suffering from severe colic pains and great weakness, the patient

Reaches the end of the first week. A new series of symptoms then sets in. Those already mentioned, indicating a state of Gastro-intestinal irritation, are characteristic of the first week. They are produced by the presence of the Trichinae in the intestine and to a certain extent, perhaps, by the irritation caused by the passage of the embryos through the intestinal walls. The series of symptoms which sets in with the second week is the result of the distribution of these embryos throughout the muscles. About the eighth or ninth day, the patient complains of a feeling of oppression in the forehead, and very soon the eyelids are noticed to be red, swollen, and swollen. The oedema is accompanied by no redness here, and in men often goes no further than the eyelids. But in women and children, in whom the tissues are more lax, it very generally spreads over a greater part of the face. Along with this swelling of the lids the conjunctiva frequently becomes much injected - while the functions of the eye itself suffer. The pupil becomes dilated and sluggish,

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the eye in a great measure loses its accommodating power. And the patient shuts the light.

While these symptoms have been developing, a state of Fever has declared itself. The pulse rises to 84-120. the temperature to 100° F. The thirst is very distressing, and the skin, which has hitherto been dry, becomes bathed with profuse sweats of an unpleasant odour.

Early in the second week also, the still more characteristic symptoms, connected with the muscles, show themselves. Proceeding from the trunk outwards, the different groups of muscles become tense, swollen and painful. They are painful both on movement and touch, and the swelling does not exhibit pitting after pressure. The degree of pain by which the muscles are the seat is intense, and as a consequence the patient lies helpless with the limbs usually half bent.

Neither do the symptoms of the first week as a rule disappear on the accession of those of

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the second. The diarrhoea generally continues for
a varying time, the tongue is clay, loaded, often
swollen, and the breath is of a foul odour. At the
same time the urine is scanty and turbid.

About the end of the second week, the facial
oedema disappears, but the other symptoms continue
during the third week to become aggravated. The
affection of the muscles speaks, and different functions
are disturbed from the implication of the muscles
concerned in their performance. Thus when the
pharyngeal and lingual muscles are affected
severely, the patient suffers from difficulty of
deglutition - when the laryngeal his voice becomes
hoarse. And sometimes also there is dulness of
hearing, possibly from oedema of the pharynx
closing the Eustachian tubes. In some cases the
patient is threatened with asphyxia when the
swelling in the region of the neck becomes great.

The fever in severe cases continues to increase
during the third week. The sweat are profuse
and are followed by the prostration of Miliaria.

The commencement of the fourth week is usually the critical time. The fever has then reached its acme, and the prostration of the patient becomes very marked. When the case goes on to a fatal issue the condition of the patient becomes more typhoid. The pulse is very rapid - delirium sets in, and death speedily follows. In a certain proportion of the fatal cases, death results not from exhaustion, or the typhoid nature of the fever, but from Pneumonia. This in the majority of cases affects the left side, and comes on suddenly in the beginning of the fourth week. It is lobular in its origin and almost invariably fatal.

When the case is about to terminate in recovery the fever abates towards the end of the fourth week. A copious diuresis sets in while the sweats become gradually less profuse and lose their unpleasant odour. In like manner the other symptoms disappearly degrees, leaving the patient emaciated and extremely weak. An oedematous swelling which had already shown itself around

the Ankles and wrists Sprawl upwards as the other symptoms are got rid of. This also vanishes as the patient gains strength, and in a few weeks more the recovery is completed. The falling out of the hair and some impairment of vision are frequently the last to disappear of the consequences of the disease.

Besides the embolic Pneumonia, which has been mentioned as of such fatal issue, cases of Trichinosis are sometimes complicated with pleurisy and Bronchitis. These are of an ordinary character and though they retard the recovery are seldom or never fatal.

Slighter Cases exhibit such variety in their accession and course, that it is impossible to describe any one as a general type. The first appearance of symptoms may be stated at from seven to twenty-one days after the ingestion of the trichina-flesh. The first stage of the more severe cases, that of gastro-intestinal irritation is almost entirely absent. Frequently enough there is more or less disturbance

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of digestion, but instead of the diarrhoea which is
a prominent symptom of the first weeks in more
severe cases, the patient often suffers from consti-
pation. The oedema of the face is very frequently the
first symptom to make its appearance, or perhaps
the disease sets in with violent irritation of the
heart. The further course of the case is marked by the
presence of a greater or less number of the symptoms
mentioned as occurring in the more severe cases.

Among these the affections of the muscles and eye-
the weakness and prostration of the patient, are
the most prominent. The duration of such cases
varies as much as their symptoms. Complete recovery
may take place in two weeks or they may run
a much more protracted course.

Children have always been observed to suffer
much less severely than adults, and to pass the
greater part of their illness in sleep.
Their comparative exemption is no doubt due to
their ~~more~~ higher vital powers and the obstructive
influence of their more vigorous digestion on the

Life of the Fetus in the Female on the other hand
Suffer more severely than men. And besides the
greater severity of the usual symptoms, irregularities
of the uterine functions frequently occur. Menstruation
comes on too early - often in the beginning of the
second month. And at a later period pregnant
women are very liable to abort.

Post-mortem Appearances. Those connected with
the intestinal canal are not always marked.
The majority of deaths occur in the fourth week
when the intestinal irritation has either passed
its height; or altogether subsided. Sometimes how-
ever more or less injection of the mucous membrane
is seen or even the more decided evidences of
inflammation. In one case described by Krupp
follicular ulcers were seen.

The muscles in all cases proving fatal about
the fourth week will be found beset with
Tubercles. It is exclusively the striped voluntary
muscles in which they are found. Only in one
or two instances have they been met with in

(1) I am not aware that Hornegranate root has been used in actual practice, but experim cuts with it give little reason to hope that it would prove of service. Is one of two rabbits which I fed with Ricinus plant in the pathological Institute of Berlin. I gave during ten days a considerable dose of a strong decoction of the root every day. The other rabbit was not treated in any way.

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the heart. While in the fibres of the involuntary
muscles they have never been known to occur.

Thrombi are very frequently found in the
veins - the result of the stasis of the blood
and of the impeded circulation from want of
muscular action. Along with these also in cases
which have been complicated with Pneumonia,
the emboli will be found in the affected lung,
with the resulting breaking down of the lung
tissue.

Treatment of Trichinosis. What is necessary
on this part of the subject may be ~~discussed~~ discussed
in few words. A remedy which shall act by
killing the Trichinae either in the intestines or in
the muscles has not yet been found. Various sub.
stances have at different times been recommended
and found to fail. Among these may be
mentioned Benzoin, ~~Acetic~~ Nitric Acid, Picric Acid,
of Sassa, and all the Anthelmintics including
Santonin and Pomegranate root. But none
has proved of any service. The treatment

On the 12th day after the feeding both were killed.
No worms could be discovered in the muscle of
either. But the number of worms filled with embryos
and one was just as great in the intestines of the
one that had been treated with the Konyanato root
as in the other which had not. The forces of the former
^{were} ~~had been~~ carefully examined during the time the
experiment lasted. But on ~~no~~ ~~one~~ ~~occasion~~ was a single
worm found - not even after free purgation had
been induced by a dose of Calomel.

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pursued is therefore in great measure such as is
Suggested by the symptoms. Kuffrecht in the Hettstadt
endemic believed that good effect followed the
use of Temple stones of Calomet - and that even when
Chiarrocha was already present it tended to abate
rather than become aggravated under this remedy.
In like manner purgatives generally are advised,
though how they act beneficially is not quite clear.
Frickiaes so seldom pass out of the intestines early
in the disease even in severe purging, that the
hope can hardly be indulged of removing
them by these means.

The most advisable treatment throughout the
course of the disease is found to be that of a
supporting nature. Wine and Ana lephet
generally are used with the best effect. So
as to carry the patient over the time of danger
and allow the Frickiaes to become encapsuled.
The only cure the case admits of is then attained.
And indeed notwithstanding the hosts of Frickiaes
remaining in the muscles little permanent in-
jury

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Seems to be done to the patient. The former strength and bulk of body are recovered and almost no trace of the disease left.

Prophylaxis. In the case of Trichinosis prevention is not only better it is fortunately, also more practicable than cure. To ward off the danger one of two conditions must be fulfilled: either the injurious nature of the flesh must be discovered in time to prevent it being used as food - or such precautions must be adopted in the cooking as to render it harmless even when containing trichinae.

The first of these conditions might, to some extent, be rendered easier, if the trichinae occurred as distinct symptoms in the Swine as in the human subject. But this is not generally the case. Sometimes it would seem that the animal does show signs of illness when infected with trichinae and in some experiments a kind of paralysis of the hinder extremities has been observed. But quite as frequently no symp-

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towns are noticed at all. And as yet the natural
recurrence of infection in the town has never been
diagnosed.

Another method of preventing trichinosis flesh
getting into the hands of the public is at present
being tried. This consists in the microscopic exam-
ination of all the Swine carcasses presented for
sale, which have been instituted in different towns.
The results of one or two of these examinations
have been already quoted. That they afford
an efficient protection when carefully carried
out can scarcely be doubted. But they are
attended with many difficulties and can be
by no means so easily or quickly accomplished
as has been sometimes represented. The irregu-
lar way in which the trichinae are often distributed
in the muscles makes it not improbable, that
their presence may sometimes be overlooked,
when portions from only one or two parts of the
carcass are examined. And it is only in towns
that the protection afforded by such microscopic

Sanitations can be enjoyed.

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But the second way in which the danger is to be avoided - that which consists in exposing the Swines flesh to just a degree of heat as shall render it safe even when trichinosis - seems to be as certain as it is universally applicable. Wüchtemeister has shown that trichinosis muscle which has been subjected to the temperature at which Albumen coagulates ⁽¹⁾ ($49^{\circ}55^{\circ}\text{R}$) produces no infection. But Wüchtemeister has also shown that Swines flesh prepared in the different forms in which it is commonly used in Germany has been exposed to a temperature always several degrees below this, the point that during the process of 'smoking' a temperature of only ⁽²⁾ 30°R . was reached while ~~in~~ in the large masses in which the flesh is cooked before being made into some forms of sausage the interior of the mass was not only many degrees below the exterior but also below the required degree of heat. Hence these experiments have indicated that

$\frac{1}{142^{\circ}}$ —
 -155°Fah.

~~page 5~~
 1499°Fah.

only the immediate cause of the frequent occurrence of Trichinosis in Germany, but also the means by which this may be prevented. And as the danger increases with the degree of rawness of the flesh the not-uncommon custom of eating it altogether raw is especially warned against. When the flesh is ingested in this form the infection which follows is not only certain but more severe and the case of proportionate risk. This is illustrated in the history of the Cholera when Epidemic in which a large number of those who died had eaten the flesh raw.

The review of the means for its avoidance naturally concludes the sketch of this interesting disease. Only for a few years has it been recognized and there are good grounds for the expectation that it will not long claim the amount of attention which it has lately demanded. Every thing favours the efforts to combat it. Its cause is known and the general thought which that

Cause acts. Under these circumstances the chances
 of Success are very much greater than attend
 the struggle against a disease which has the
 additional terror of an unknown enemy.
 It depends in great measure on the carefulness
 with which the means are used, whether the
 Trichina is really to become as harmless as for-
 merly it was supposed to be.

George A. Hume.