

## PART I.

### I N T R O D U C T I O N.

In discussing the etymology and history of, what we understand in the ordinary English of the meat industry, as "measles" in pork and beef, it is quite insufficient to consider the "bladderworm" stage of the parasite only, without discussing the historical advancement of knowledge regarding the adult worm which succeeds the "bladderworm". The measles, bladderworm or larva, found in the muscles of the pig, for example, and the adult resultant tapeworm of man are so closely related, that one cannot be successfully described or discussed, without investigation of the corresponding stage in the other.

It is obvious, however, that in an article on "Cysticercosis", the bladderworm stage of the common parasite should receive the fuller consideration, although the adult, parent or final stage of the parasite must also receive attention, since we are usually dealing with two stages of a parasite, usually passed in two different hosts, and in order to arrive at a plan of campaign towards eradication of the parasite at either stage, we should understand the histology, pathological anatomy and peculiarities of both. It will be noticed that the word "usually" was expressly been used in the previous statement. The normal intermediate host of one of the two parasites to be discussed is the pig, and the final host, or host of the mature tapeworm is man. Under certain circumstances, however, man may actually be the host at both stages, and thus play the rôle, in the inter-

-mediate stage, of the pig, and be the harbourer of the pig measles. Then again, in addition to the pig and man, the dog and the monkey may also be the intermediate hosts of the pig measles bladderworm. We shall, therefore, not depart from the limits justified by the title of our subject, if we deal with tapeworm larvae of the same species as those of the pig in, for example, man, the dog, and the monkey, since the pig must in every case be considered as the original host of that particular bladderworm, which is followed by an adult tapeworm stage in man, and followed in turn by a second embryonic generation in, say, another pig, which may then be the precursor of various series of adult and embryonic generations alternating between man, the dog, man, the pig, man, the monkey, etc.

#### ET Y M O L O G I C A L    D I S C U S S I O N .

The intermediate, or bladderworm stage of certain tapeworms known as the cysticercus stage. The pathological infection of an animal body with cysticerci is known as cysticercosis.

The name cysticercus is derived from the Greek words Kystis, a bladder, and Kerkos, a tail. (Italic, instead of Greek lettering will be used throughout this work, when names of Greek derivation are defined). The pig measles is known as Cysticercus cellulosae, the bladderworm of the cellular or connective tissue, on account of its usual location in the connective tissues between muscle fibres. The beef measles is known as the Cysticercus bovis, i.e., the bladderworm of the ox, or in some parts of Europe it is called Cysticercus inermis, the unarmed bladderworm.

The adult tapeworms of the above-mentioned cysticerci are the Taenia solium and the Taenia saginata, respectively. The Latin name Taenia is derived from the Greek word Tainia, a ribbon or a fillet. Taenia solium means the solitary tapeworm (French "Ver solitaire"), a name to which Leuckart took strong exception. Taenia saginata means the "stout" or "fat" tapeworm. The two respective species were first named by Rudolphi and by Goeze.

It is difficult to account for the adoption of the English name "measles", except that the bladderworms visible in the musculature of a measly pig somewhat resemble the spotted eruption characteristic of the human disease of that name. The name is most misleading to the layman, who generally associates the parasitic disease of the pig or the ox with the entirely different human disease. Not only the English, but also the French adopted a misnomer for ordinary usage in describing the disease of the pig and the ox. The French name for the disease, Ladrerie, is said to have been derived from the Greek Laidros, deformed or awkward, or from Lazareus or Lazarus, whose name has been corrupted in common speech to "Saint Ladre". Ladrerie was sometimes used in former days as synonymous with "leper" and "leprous", and it is not known by what affiliation this designation of Ladrerie has passed from leprosy to a parasitic affection, from which it is absolutely different. (Neumann).

How the Afrikaans word masels, or the immediately pre-Afrikaans South African Dutch word mazelen came into use is a mere

conjecture. One would feel inclined to believe that measles was totally disregarded, or otherwise unobserved by our early Dutch, Huguenot and German South African ancestors. The Afrikaans word masels is distinctly a literal translation of the English designation of the human disease, and one is inclined, further, to theorize that measles was first observed by our English fellow-ancestors after the arrival of the 1820 settlers in South Africa, who, probably had seen measly pigs in Great Britain. In support of this theory one may cite the fact that measles in pigs was well known in Europe even in the Middle Ages, and if our first Dutch, French and German ancestors had recognized the disease in whatever pigs were slaughtered at the Cape in the early

one feels sure that posterity would not have lost the Dutch names finnen and gortigheid, or the German finnen and finnenkrankheit, or the French ladrerie. Instead, in Afrikaans today, we use a literally translated English misnomer.

History has, therefore, unfortunately lost trace of the origin of knowledge of pig and beef measles in South Africa. Whether measles was an indigenous disease among our early native stock, or/and whether our aborigenes were tapeworm carriers, is unknown. It is also unknown whether measles in pigs and cattle was first introduced into South Africa by tapeworm carriers among the early Portuguese visitors, or among the subsequent Dutch, French, German and English settlers, or whether it came from the northern interior of Africa with the Bantu invasion. Nor, of course, is it known whether the infection was brought to

South Africa by means of importation of infected livestock, or whether humans brought and established the "vicious circle". Support is lent to the theory that the Bantu might have brought the disease from the north, by the fact that the Bantu invaders were closely related to the Ethiopians and Nubians, who in turn were closely associated, geographically, with the Egyptians, and the latter at least had placed a ban on the consumption of pork, for various reasons, whereas the Abyssinians were among the first to be described during the last century, as heavily infected with Taenia saginata.

#### H I S T O R I C A L   S U R V E Y.

That pig measles was known and recognized from the very earliest days can be learned from ancient writers. The parasitic nature of the measles, however, or its pathogenicity to man, was not known. It is hinted, however, by some authors, that the injunctions to Moses, which led to the Mosaic Laws were prompted by a knowledge that the meat of pigs, under certain conditions, might be dangerous, rather than "unclean" in the literal sense. Thus in Leviticus xi, 3, we read "Whatsoever parteth the hoof and is clovenfooted, and cheweth the cud, among the beasts, that shall ye eat"; and in the next verse: "And the swine, though he divide the hoof and be clovenfooted yet cheweth not the cud, he is unclean to you". It is debated by some, as to whether Mosaic law meant that the pig was "unclean" physically, or "unclean" due to its possible diseased condition. Vorwahl (1923), has

written against this discussion, and indeed against the Bible's reference to the uncleanness of the pig. He is of opinion that the Israelites followed the views of the Syrians, viz. the pig should be considered a sacred animal.

In Greek literature are found several references to measly pork. Thus Aristophanes, B.C. 424, in his "Comedy of the Knights", mentioned the then existing custom of examining the tongue of the pig, in order to detect the presence of the so-called "glandular tumours".

Later Aristotle (B.C. 384-323) wrote and described what we would today understand to be measly pigs. "Measly pigs are those which have bad meat on the shanks, neck and shoulders", he wrote, "In those parts we find most measles. When only a few measles are found the meat is sweet, but when numerous, the meat becomes watery and unpalatable. As far as we know, we only find measles disease in pigs. Sucking pigs have no measles". It was also he who first attempted a description of the symptoms: "Measles mainly appear under the tongue. Those pigs with measles appear weak in the hind quarters". Aristotle's remarkable description was almost exactly reproduced by Rufus, and later it was mentioned by Pliny, Didymaeus, Plutarch, Aretaeus, Archigenes and Androstheneas.

Von Ostertag refers to Herodotus and Plutarch, who taught us that the Egyptians were forbidden to eat pork for the reason that it produced "an excess of humours and eruptions". The Phoenicians did not eat the meat of cows or swine, but held the flesh of dogs as a delicacy. On the other hand, the

Romans were extremely fond of pork. Vosgien (1911) mentions that Roman vendors of pork had to guarantee the meat against measles.

During the third century A.D., Androstheneis compared pig measles with tubercles. Aretaeus compared measly pigs with people suffering from elephantiasis!

Perhaps one of the first references to a connection between tapeworms and the ingestion of pork was suggested by Anthimus (511-534 A.D.), who wrote to Theodoric, King of the Franks, that he suspected that human beings developed tapeworms by eating raw fat pork. (Le Coultre, 1928). His suspicion was certainly not unjustifiable, although he did not know the relationship between the cysticercus and the tapeworm.

During the 8th Century, Pope Boniface pointed out the necessity of cooking or smoking pork thoroughly, before consumption.

The Mohammedans were also forbidden the use of pork by their Prophet, on the grounds that the pig was unclean.

Later in the Christian era we find that in Germany and in France, definite regulations regarding the inspection of pigs were framed. Von Ostertag gives very interesting historical quotations regarding meat inspection in the Middle Ages in Germany, with special reference to the treatment of measly pork. The following quotations from von Ostertag are to the point.

In the year 1261, Count Raoul IV of Neuchatel decreed that "meat showing eruptions should not be sold as good meat, and under the roof of a meat market, pork containing eruptions, or meat killed by wolves or dogs, should not be sold".

The Augsburg Charter of 1276 laid down the following most interesting regulation: "If a butcher kills a measly hog, he shall sell it to no one without a statement of this fact. All the parts of such animal shall be sold in the same booth, and if it is sold whole, it shall be only after declaration".

In Bamberg in 1306, the City Laws forbade the sale of measly meat, and in Würzburg in 1343, punishment was enacted for "all persons who offer for sale measly and mangy meat". In 1346 the inhabitants of the village of Wolfmannshausen agreed "to bring at an appointed time all their hogs to the Monastery of Frowenrode, where they shall be appraised and inspected by viewing the tongues. Those, which from the appearance of the tongues, shall be considered clean and worth the estimated price, shall be retained by the Monastery".

Similar Charters are cited for Zwickau (1348), in which the sale of measly meat was forbidden in the booths, and for Hamburg, and also for Lübeck and Stade in 1375, where it was laid down that measly meat was required to be sold in a special booth on a white cloth. In 1376 the butchers of Regensburg were punished for selling measly pigs.

In Aachen, during 1385-1386, special pig inspectors or



"Finnenkückers" were appointed, whose instructions were to examine all pigs offered for slaughter sale, and to "brand all unclean pigs with a distinctive cut". These pig inspectors assumed office under an oath to carry out their duties fairly and scrupulously, irrespective of the social standing, race and domicile of the vendor.

In Passau in 1394, meat inspectors were appointed, whose instructions were "to throw measly pork into the Danube, and the vendor was compelled to return the price of the hog to the buyer".

Landshut in 1401, went a step further, and passed an Ordinance prescribing that butchers should not sell "Jew meat, or measly meat anywhere else than between the tables, and that neither Jew meat, nor measly meat should be offered as good meat".

In Wimpfen in 1404, a Charter laid down that measly meat was to be sold in a "measly booth", three steps removed from the ordinary meat booths. In 1414 the butchers of Ulm asked the council to adopt the following regulations, namely regulation of the traffic in measly pork, bulls' meat and Jew meat. Whoever offered such meat for sale was not allowed to sell any other meat at the same time. "If a butcher pickled measly pork immediately after slaughter, and the twelve sworn masters of the market were satisfied of that fact, the butcher was allowed to sell other meat"

Steffen von Bergendorff was made to take the oath to keep the peace in 1434, after having been imprisoned in the City of Regensburg, because he attempted to sell hogs in which the bladder-worms had secretly been punctured, so that the inspector could not recognize them.

The town of Marbach in Alsace appointed sworn meat inspectors in 1437. Their duties, among others were to determine whether measly meat had been worked out into sausages.

In the year 1582, the Palatinate State Laws decreed that the meat of measly hogs, if not badly infested, should be offered for sale outside the shambles or butcher shops, at a place to be determined upon by the authorities. "In case, however, the measly meat in question is found to be quite unclean, it shall be absolutely rejected and shall not be sold, nor used".

The Slaughter Ordinances in Rostock forbade the sale of measly hogs in 1699.

The detailed directions to meat inspectors in Bruchsal<sup>"</sup> about the year 1784, forbade the sale and consumption of animals suffering from certain diseases, among which cysticercus disease was expressly mentioned.

It will now be interesting to record that in France, in the Middle Ages, and up till the time of the French Revolution, similar Ordinances to those enacted in Germany were enforced.

In the thesis of Vosgien (1910-11), are found a number of quotations. In France, about the year 1375, specific pig inspectors were appointed. The inspectors, or langueyeurs had to ascertain whether pigs were measly or not, by an inspection of the pigs' tongues. A langueyeur could not be a butcher and an inspector at the same time. Hugues Aubriot, 1375, ordained that "No one dare act as langueyeur until he has been proved competent by the master butchers". The duties of the langueyeur were fully described in the Edict of Charles VI in 1403.

The Ordinance of Robert d'Estouteville, Guard to the Prévôt de Paris, dated 1475, established : "No one may buy or sell, or make sausages from exhausted pigs, or measly pigs".

The langueyeurs were quite important personages, and held very high office. Later, they were actually appointed by the King.

According to Gach, it was decreed in France, as long ago as 1476, that measly pork could be salted for forty days, and then sold in the halls. Vosgien, however, records that in 1601 the Parliament of Paris decreed that measly pork, after having been salted for 40 days, could be sold in a specific place to be named by the Prévôt de Paris, and had to be marked by a drapeau blanc, (white flag).

Vosgien also relates the punishment which was meted out to an offender. On May 28th, 1716, the Chamber of Justice of Paris condemned one Antoine Dubout to the following punishment, because

he had issued measly meat to the soldiers:- "He was to be exhibited in a public place, nu en chemise, la corde au cou, with a burning wax candle in each hand, and with a placard on his chest and back, bearing the inscription of the nature of his offence". In addition Dubout was fined 50,000 livres, was banished from the City, and was deprived of all his rights as a butcher.

From about the middle of the 18th Century systems of meat inspection became less thorough in France and in Germany. In practising their professions correctly, qualified veterinarians had shown the public that the meat of animals suffering from certain diseases was harmless, but, unfortunately, local authorities appeared to misconstrue that teaching, and confusion resulted, to the extent that it was assumed that the meat of all diseased animals, including measly meat, was harmless. That unfortunate state of affairs continued in both Germany and France until 1852, when <sup>"</sup>Kuchenmeister startled helminthologists, veterinarians, medical men and hygienists, by proving that the Cysticercus cellulosae was the embryonic stage of the human Taenia solium.

#### HISTORICAL REVIEW OF EARLY LITERATURE AND RESEARCHES ON CYSTICERCUS -TAENIA.

Although, as has been mentioned, measles was known to the ancients, up till the year 1685 cysticerci were regarded as glandular tumours. During that year Hartmann discovered the parasitic nature of cysticerci. He described the Cysticercus tenuicollis as parasitic, and followed his researches further. In 1688 he

recognized the animal nature of the Cysticercus cellulosae.

Ten years later, Malpighi, having worked independently of Hartmann, confirmed the latter's work, and further described the head process of the cysticercus very closely. "In verminous pork, called Lazarioli, live numerous colonies of worms, which are the cause that the sale of such animals is forbidden by public edict", wrote Malpighi, and continued: "These worms are in abundance in the cellular interstices of the muscle fibres of the thighs. They appear in the shape of small oblong tumours, as little sacs filled with transparent fluid, in which floats a white globular body. Should the envelope break, when pressed slightly, the worm squirts out of the vesicle, and one sees its horns coming out like those of snails. The rings fold over themselves, and the animal rolls into a ball. At the top is a little head, and on the rolled up worm there is what looks like a little umbilicus at the extremity of the vesicle".

The animal nature of the bladderworms was not universally accepted, and confirmation of the findings of Hartmann was further effected by Fabricius and by Goeze.

In discussing the history and development of knowledge of cysticercosis-taeniasis, Leuckart repeatedly alluded to the bitter feud which, during the middle of last century, existed between himself and his equally famous co-worker <sup>"</sup>Kuchenmeister. To Leuckart's credit, however, he gives all honour to <sup>"</sup>Kuchenmeister as the scientist who established the connection between the hook-bearing Taenia solium and the Cysticercus cellulosae of the pig. <sup>"</sup>Kuchenmeister observed the fact that the "structure of the head

and hooks corresponded so perfectly in the two forms, that the most careful investigation could establish no differences between them". (Leuckart).

In 1841, Steenstrup considered that the cysticerci could be regarded as the first step in the development of helminths, but to which they were related, he could not determine. Van Beneden followed by von Siebold, in 1850 dispelled Steenstrup's doubts. It must be pointed out, however, that prior to 1850, von Siebold maintained that cysticerci were tapeworms with hydropically degenerate bodies, which was due to the fact that they had developed in an abnormal host, and were not necessarily intermediate stages.

In 1854 van Beneden successfully infected a pig with bladderworms, four and a half months after he had fed the animal on Taenia solium. In spite of van Beneden's test, some doubt existed as to the origin of the bladderworms, and whether they had actually resulted from the eggs of the tapeworm which had been administered by van Beneden. In 1855 Haubner fed single proglottides (segments) of Taenia solium, followed by larger pieces, at various times to three pigs. He killed the pigs, and dissected them at various periods after initial feeding, and thus established the growth of the infection with Cysticercus cellulosae. At about the same time, Leuckart performed a similar series of experiments on five pigs, with the same results. Later Mosler and Gerlach confirmed by further experiments the findings of van Beneden, Haubner and Leuckart.

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Kuchenmeister's Experiment.

This experiment caused a complete revolution in the science of meat inspection, and it is proposed to quote, in almost full detail, Neumann's description of Kuchenmeister's research.

Kuchenmeister published the results of his experiments in 1855.

For three consecutive days prior to her execution, a condemned woman prisoner was given seventy-five cysticerci in her food, by Kuchenmeister, who had made the necessary arrangements with the prison authorities. At the autopsy, made 48 hours after death, Kuchenmeister found 10 young taeniae, 4 mm. to 8mm. long, "some of which already carried several hooks". (Neumann p. 681).

Kuchenmeister repeated the experiment on another prisoner condemned to death. This subject was given 20 measles on two occasions - one four months and the other two and a half months - before execution. At the autopsy he found 19 taeniae, eleven of which had already mature proglottides. Kuchenmeister's experiments were repeated and the results confirmed the following year by Leuckart, who gave four fully developed Cysticerci cellulosa in milk to a young tubercular subject, who voluntarily offered himself as a subject. Two months later, Leuckart found proglottides in the excrement of his subject.

With reference to historical literature on the Cysticercus bovis and its adult counterpart, the Taenia saginata, there is very little written before the 18th Century. Leuckart, however, is of opinion that the Ancient Greeks carried and encountered the Taenia

saginata more frequently than the Taenia solium. He cites as evidence for his theory the fact that the former is a more common disease in Mediterranean countries and the East, than the latter disease-causing parasite; and cites too the writings of Hippocrates, "the tapeworm subject voids in portions the ripe joints of the worm", a phenomenon, which Leuckart points out, is much more usual and striking in the case of Taenia saginata than of Taenia solium. If Leuckart's conclusions are correct, then we must believe that beef measles must, also, have been fairly common in Ancient Greek times, although they were never observed. An important factor in regard to the occurrence of Cysticercus bovis is that the cysts are generally isolated and more frequently than not, are found singly or a mere few, in a carcass. That factor, possibly, was the reason why they were not noticed by the Ancients, or otherwise, in comparison with the usual heavy nature of the infestation of pigs, they were not considered worth while troubling about.

On similar grounds, Leuckart holds the opinion that the Arabian physicians mainly investigated Taenia saginata. The Arabians considered the various segments as separate entities formed into a chain, and that the chain constituted what is now known as tapeworm. These views were supported by Vallisnieri and also by Coulet at the beginning of the 18th Century, and by Linné, whose description constituted a comparison between a tapeworm and a plant of many shoots.

With regard to the older descriptions of tapeworms, we learn



from Aetius and Paulus Aeginata, that they considered the tapeworm as a metamorphic product of the intestinal mucous membrane. -

"Lumbricus latus transmutatio, ut ita dicam, est membranae intesti-  
nis intrinsecus agnatae in corpus quoddam animatum." (Leuckart).

#### Ancient Chinese Medical Views:-

Gear and Pedersen (1934) give an interesting reference to the work of Chu and Chiang (1931), who translated twelve old writings, which illustrated the type of knowledge and opinion held by Chinese medicine concerning helminths. These twelve works extend over a period from Tsang Kung Lieh Chuan 180 B.C. to Pien Chiao Hsin Shu in 1767 A.D., and as Hoeppli in an introduction to the study points out, there are several remarkable similarities in the different texts. According to Gear and Pedersen, the same theories with slight variation persist through the twelve works, and are sufficiently illustrated in an extract quoted by those authors, from the translation given of the Ch'ao Shih Ping Yuan of 605 A.D.

"The 'Tsun Pai Ch'ung' is also one of the nine worms. It is about one inch long, white in colour and flat in shape. The attack is due to the weakness of one's viscera. It is said that the infection is due to drinking of "white" wine and eating of raw beef and raw grains. It is also said that eating of raw fish followed by a drink of cold milk likewise produces the infection. It weakens one's general physical condition and produces pain and weakness of the kidney and feet. If the worm grows to one foot in length it causes the death of the host."

Gear and Pedersen quote Hoeppli, who says:- "It is very remarkable, however, that several times the "Ts'un Pai Ch'ung" which, in our opinion, is a tapeworm, is said to be produced by eating raw meat, a belief which is quite evidently not purely speculative, but rather the result of observation."

Actual beef measles, had, however, been seen for many years, but they were considered as tumours. In 1684, Redi in Italy and Hartmann and Wepfer in Germany recognized the animal nature of the larvae from their movements and organisation. (von Ostertag). In 1767 Linnaeus and in 1781 Pallas saw parts of Taenia saginata, but in 1782 Goeze described the parasite.

Perhaps Knox, who served in South Africa as an Army Surgeon, might be considered as one of the first writers who connected an outbreak of tapeworms among humans with the ingestion of beef. Edmonds (1922) refers to Knox's report of an outbreak of tapeworms among soldiers who had participated in the Kaffir War in 1819. Knox ascribed the cause of the infection as due to the fact that "the soldiers had eaten the meat of oxen which had been driven too fast, and were exhausted." Leuckart states that he examined some specimens of the Cape tapeworm, which were sent to him, and he was satisfied that they were Taenia saginata. Leuckart makes special reference to "Knox's outbreak", and strongly hints that this outbreak and its association with the ingestion of beef and certain other factors were instrumental in causing the experiments he conducted in 1861, which definitely established the relationship between Taenia saginata and Cysticercus bovis. The various factors which Leuckart considered were the reports of ancient and modern travellers, and particularly of Duvaime in 1860, that from earliest times, almost without exception, the Abyssinians who ate no pork were heavily infested with tapeworms; that Jews and Mohammedans, who likewise ate

no pork, were frequently infested with tapeworms; and lastly, Weisse's report from St. Petersburg in 1857, that he had often fed raw beef to delicate children, and that tapeworms had frequently been developed in his patients. Leuckart, also, very fairly, mentioned that Hüber and Schmidt had already noted the probability that the ox could be the intermediate host of Taenia saginata. The latter had mentioned to Leuckart that with some certainty he had traced the existence of Taenia saginata to the ingestion of a meat salad made from raw beef.

#### LEUCKART'S EXPERIMENT.

Describing his experiment, Leuckart states that in November 1861, he gave about a yard of some 80 ripe segments of Taenia saginata to a calf four weeks old, and about 8 days later he repeated the feeding with a smaller dose. He mentions that the animal he experimented on seemed to be so slightly affected by the experiment, that he was about to extract a muscle, when, 25 and 17 days after the first and second feedings, respectively, he found the calf dead. On post-mortem examination he found all the muscles, and especially those of the breast and neck, and the psoas, had been penetrated by cysts, which measured about 2 to 4 mm. by 1.5 to 3 mm. in size. He found those cysts numerous everywhere, "and in many places they lay so thickly together, that their total number must have been many thousands, yet, it seemed at first as if the death of the animal under experiment could hardly have been caused by them.", writes Leuckart. "It was, however, indeed the cysticerci which had killed the calf. Further examination showed that the

distribution of the parasites was in no way confined to the peripheral muscles of the body", he concludes.

Among other localities Leuckart found "crowds of cysts followed the course of the swollen lymphatic vessels and glands into the inguinal region." "Some of the glands were not only reddened, but were full of extravasated blood, which permeated throughout their entire mass.", continues Leuckart ; and he concludes, "I had almost no scruple in referring the death of the animal to the pathological state of inflammation of the lymphatics. The latter may also be traced to the state of inflammation which resulted from the immigration and development of such a number of parasites."

Leuckart's colleagues Seitz and Mosler agreed with his views and "so have all my successors concluded", writes Leuckart, "except <sup>"</sup>Kuchenmeister ." Leuckart bitterly quotes the writing of <sup>"</sup>Kuchenmeister: "Leuckart's first experiment, taken by itself teaches us nothing, except that, after abundant feeding with the proglottides of Taenia mediocannelata (<sup>"</sup>Kuchenmeister's nomen for T. saginata), the animal remained long, apparently unhurt, till suddenly, 25 days after feeding, it died and exhibited a military tuberculosis caused by the Cestode brood. Without the subsequent experiments, I cannot regard the first as of special value in regard to Taenia mediocannelata."

On December 27th, that year, Leuckart repeated the experiment on a second calf, but remembering the severe results of his first experiment, and the resultant death of the calf, he used smaller doses of segments, and repeated these at five to six

days intervals, until the calf received about 50 segments. Twenty days after the first infection, many pathological phenomena appeared, for example, loss of appetite, fatigue, ruffling of the hair and fever, but those clinical signs subsided, till finally perfect health returned. Forty-eight days after the first, and thirty days after the last feeding, Leuckart extracted the sterno-hyoid muscle of the left side. In this muscle he found about a dozen cysts. The cysts were of various size, representing various stages of development. In examining those embryos, Leuckart made the striking discovery that although the bladderworms were the "descendants and young forms of a hookless tapeworm, they were furnished with a distinct, though small rostellum, and with the rudiments of hooks." Later, Leuckart watched the development of the cysticerci by extracting other muscles at various periods. He thus proved, conclusively, that one of man's principal food animals, the ox, was the intermediate host of the human tapeworm Taenia saginata. All but one pair of the following list of subsequent investigators obtained positive results from confirmatory experiments:-

Germany:- Mosler (1864); Roll (1865); Gerlach (1869); Zurn (1871); Zenker (1872); Probstmayr (1879).

France :- St. Cyr (1873); Masse and Pourquier (1877).

Belgium:- van Beneden Junior (1879).

Italy:- Perroncito (1877).

England:- Simonds and Cobbold (1866) - negative results.

Commenting on the report of Gerlach, Leuckart states, inter alia, "Gerlach killed his experimental calf 5 months after

feeding, and found that it was penetrated through and through with bladderworms."

Conversely, shortly afterwards, Oliver and Ferronci<sup>to</sup> infected themselves and their respective assistants with Taenia saginata, after having ingested Cysticercus bovis bladderworms.