

PART V.

THE IMPORT OF CYSTICERCOSIS IN MEAT
IN RELATIONSHIP TO PUBLIC HEALTH.

It has been considered a moot-point as to whether the Cysticercus cellulosa in pork and its correlative Taenia solium in man, or the Cysticercus bovis and its adult Taenia saginata is the more important parasite, from the perspective of public health. At the present time it would appear that Taenia saginata is far more frequently found in humans than Taenia solium, in most countries where both parasites are encountered. Yet, in many countries, and in South Africa in particular, Cysticercus cellulosa in the pig is the more common larval form.

It has hardly been found practically possible to conduct scientific surveys of the incidence of the two species causing human taeniasis in any country, and, therefore, recent literature is remarkably silent on the question. That either or both parasites occur almost universally may be gleaned from reference to the recent articles by Lièvre (France, 1933); Cameron (Great Britain, 1933), Robertson (Great Britain, 1920); Krueger (1934), Junack (1926-31), Profé (1934) and many others in Germany; van der Slooten (1932), van Oijen (1929), Kerstens (1931), and many others in Holland; Cattaneo (1932) and others in Italy; Krupski (1917), Guillebeau (1917) and others in Switzerland; Dikoff (Bulgaria, 1931); Elvinge (1929) and Nielsen (1934) in Denmark; Grado (Sicily, 1935); Michail (Roumania, 1935); Eguchi and Nishiyama (Japan, 1930); Mills (1923-24), Gear and Pedersen (1934) in China; Rao (India, 1933); Yenikomshian and Berberian (Syria and Lebanon, 1934); Bergeon (French Indo-China, 1928); Le Coultre

(Dutch East Indies, 1928); Price (U.S.A., 1925), Hall (U.S.A. and Central America, 1927); Nauck (Costa Rica, 1931); Palais (Brazil, 1933); Schwartz (1925) and Schwartz and Tubangui (1922) in Phillipine Islands; Penfold, Penfold and Phillips (1936) in Australia; Claverie (French Guinea, 1928); Teppaz (Senegal, 1923); Maplestone (Sierra Leone, 1924); Poisson (Madagascar, 1929 and 1934); Daubney and Carman (Kenya, 1928); Porter (1918), Watkins-Pitchford (1923), Cawston (1934 and 1935) and Mönnig (1934 and 1936) in South Africa.

A detailed survey of the incidence of human taeniasis is not given in every case by the above authors, in respect of the countries to which the various articles refer, but the extent of infection in some countries can be gauged from extracts from many of the articles. According to Lièvre (1933), in France in every hundred cases of tapeworm infection, only one is due to Taenia solium. The frequency of human infection is inversely proportional to the degree of infestation of the intermediate host.

According to Junack (1926) infestation of humans with Taenia saginata in Germany had a big increase during the war period, when many soldiers served in parts where no meat inspection existed, or where the inspection may have been of a perfunctory nature.

Special reference may be made to countries with predominantly non-European populations. Eguchi and Nishiyama (1930) report that Taenia solium is very rarely met with in Japan, with the exception of the Prefecture of Okinawa, where they found twenty-five cases of T. solium. Wu (1936) stated that in all, fifteen cases of Taenia solium have been reported from the following Chinese provinces:- Shantung 1, Hupeh 1, Hunan 1, Yunnan 1, Kwangtung 1, Shansi 1, Szechuan 3, Hopei 5, Chekiang 1.

According to Wu, fifteen cases of Taenia saginata were also reported from the following Chinese provinces:- Hopei 12, Yunnan 1, Anhwei 1, Fukien 1.

Mills (1924) stated that in 2 years he treated 12 patients for Taenia saginata in the Peking Union Medical College, including one American girl of 24. No cases of Taenia solium were observed by Mills. He believed that taeniasis was much more prevalent in China than was supposed. Although very few patients were actually treated in clinics, a vast number was treated by native medicines in bazaars. Liang (1932), quoted by Gear and Pedersen (1934), reported a case of Taenia solium infection, and in the Chinese hospital survey only two cases of T. solium were specifically diagnosed, one from Peiping and one from Nanking, both in Chinese subjects.

Rao (1933) reported a case of T. solium in Madras, India, and made special mention that he believed that T. solium was a more common parasite in India than has been revealed.

That Taenia saginata is quite a common parasite in Syria and Lebanon, is shown in the statistics supplied by Yenikomshian and Berberian (1934). These authors state that "taeniasis is much more common in Beirût and its surroundings than in Aleppo and Damascus. In both Syria and Lebanon, meat is frequently eaten raw as Kibbi neyyi, a national dish, or broiled. In Beirût more beef is eaten than in Aleppo and other parts of Syria, where mutton and goat meat is preferred." In the four main cities of Syria and Lebanon and on the Amik plain the authors found the incidence of T. saginata in faecal examinations to be: Aleppo 2.6%, Damascus 3%, Baalbek 3%, Hamah 0% and Amik plains 5%. In Beirût the incidence was found to be 12%. In that particular area no T. solium was found, since the majority of the inhabitants were

Mohammedans, who did not eat pork. On the coast belt and along the Orontes R[^]iver the incidence of Taenia saginata was 10%.

Penfold, Penfold and Phillips (1936) give a suggestion of the extraordinary incidence of T.saginata infection among Syrians. These authors conducted a survey of the incidence of tapeworm infection in the State of Victoria, Australia, and they found that 90 out of 1,830,000 people in that State had Taenia saginata. Of that number 42 were S[^]yrrian-born Australians. In the entire State of Victoria there were only 377 people who were born in Syria, and 42 were infected, or 11,000 per 100,000. The survey was conducted under the aegis of the Victoria Government, who offered a reward of £5 to carriers for the production of a complete Taenia. In addition a very thorough questionnaire was sent to all physicians and chemists.

According to Bergeon (1928) and le Coultre (1928), both parasites are relatively common among natives in French Indo-China and in Bali, respectively.

Mr J.T.Forbes, M.R.C.V.S. of Singapore writes (19.11.36) that medical^l authorities have reported a very low incidence of taeniasis in Malaya, but Mr. Forbes has "reason to believe that the incidence of infection is considerably higher than is anticipated."

In the Phillipine Islands, according to Schwartz and Tubangui (1922), the incidence of T.saginata was relatively high. About 30 in 4000 stool examinations were positive. The incidence of T.solium was much lower.

Price (1925) believed that the incidence of T.solium was high in Texas, U.S.A., with its large Negro and Mexican population.

Nauck (1931) found that Cysticercus cellulosae in humans, due to the frequency of T.solium among the inhabitants was very readil_v

acquired in Costa Rica.

In order to obtain knowledge of the incidence of infection with various kinds of worms among natives in Sierra Leone Protectorate, Maplestone (1924) examined the stools of 500 natives, inmates of the Freetown gaol. He found that 3.2% were infected with T.saginata.

D[^]aubney and Carman (1928) examined the stools of the inmates of a Government reformatory in the Kenya Highlands and found the incidence of T.saginata to be 50 %. The inmates of this reformatory were boys drawn from all parts of East Africa, and represented almost all tribes.

Capt. H.J.Lowe, M.R.C.V.S., of the D[^]epartment of Veterinary S[^]cience and Animal Husbandry, Mpwapwa, Tanganyika Territory, supplies copies of reports from some Medical Officers concerning the incidence of human tapeworm infestation in different parts of the Territory. (Letter dated 24/10/36):-

D[^]r. R.C.S[^]peirs, Medical Officer, Moshi found 313 infected stools among 552 examinations from prisoners, sanitary porters, school boys and other native children. (April 1933).

Dr. W.Hood-D[^]ye Medical Officer, Iringa found 34.17% of stool examinations positive for T.saginata among the Wahehe tribe, and 14.02% among the Wabena tribe. (August 1933.)

Dr.A.McA.Blackwood, Medical Officer, Dodoma, found among inpatients at his hospital that 34 out of 638 stool examinations were positive for T.saginata, or 5.32% (July 1933.)

D[^]r.J.S.Armstrong, Medical Officer, Singida, treated 2456 cases for tapeworm at the Singida Hospital during the five years 1928-32. He calculated that the Singida Hospital served a population of 45,000 -50,000 people. (May 1933).

Dr. D. A. Skan, Medical Officer, Dar-es-Salaam, found 110 stool examinations out of 3015 positive for Taenia infection. (April 1933).

We have already seen that many of the earlier writers mentioned the severe - almost 100% - incidence of T.saginata among the Abyssinians. (Reference Neumann, 1892; Leuckart, 1886). To what extent the infection occurs in that country at the present time is not known, since little or no literature is available on the subject.

Poisson (1930) supplied statistics for the year 1927 of recorded cases of T.solium in Madagascar. He mentioned that the bulk of cases found in Madagascar were residents of the hovas, also among Europeans born in Reunion, and the disease was not unknown among Europeans resident in the Capital, and common among Indians at Farafangana. According to Poisson, 49 cases of T.solium were recorded in Madagascar in 1927, of which number 16 came from Farafangana, and 6 among the tirailleurs of the garrison at Majunga.

It is a great pity that regular surveys of the incidence of taeniasis are not undertaken in our civilized countries. In South Africa, Porter (1918) did a survey of the incidence of helminthic infection among natives in Johannesburg. In the Johannesburg General Hospital she detected the ova of tapeworms in the excretum of 37 out of 375 native patients, and in 1 out of 60 European patients. "All of these patients had been admitted for diseases other than 'worms', and many of them were surgical cases." Twenty-six of the natives harboured T.saginata and eleven T.solium. The European case harboured T.saginata. Porter further recorded 104 post-mortem examinations on native mine labourers. "Tapeworms were discovered in the intestinal canal in 20 instances. (12 T.saginata and 8 T.solium.)"

Watkins-Pitchford (1923) estimated the incidence of tapeworm infection among South African natives to be from 10 to 19 per-cent., "and it is not uncommon amongst Europeans." According to Watkins-Pitchford, between 1917 and 1923, 17 cases of tapeworm (12 *T. saginata* and 5 *T. solium*) were diagnosed in Europeans from microscopic examination of faecal specimens sent to the South African Institute for Medical Research, Johannesburg. "Such returns do not give, of course, any indication of the extent of the prevalence among Europeans. Many people harbour these parasites and are quite unconscious of the fact, because they never inspect their own dejecta. Those cases in which diagnosis is arrived at by microscopic examination of faecal specimens must represent a very small fraction of the total number."

Dr. A. J. Orenstein, Chief Medical Officer, Rand Mines, Ltd., very kindly supplied the following tables which show the incidence of worm infestations among natives employed on the City Deep Mine, Johannesburg. The tables were compiled by Mr. W. O. Fischer, for the years 1928-33, inclusive.

TABLE I.

Incidence of tapeworm in 1086 consecutive autopsies on native mine workers of the City Deep Central Native Hospital.

TRIBE	No. of P.M.'s.	<i>Taenia saginata</i>		<i>Taenia solium</i>	
		No.	%age.	No.	%age.
Shangaan	533	4	1.2	-	-
Mchopi	170	5	2.9	-	-
Nyambaan	116	3	2.6	-	-
Tonga	32	2	6.3	-	-
EAST COAST NATIVES TOTAL 651					
		14	2.2	-	-
Basuto	215	5	2.3	1	0.47
Xosa	93	1	1.1	-	-
Zulu	34	2	5.9	-	-
Bechuana	29	-	-	-	-
Pondo	27	1	3.7	-	-
Fingo	9	-	-	-	-
Hlubi	9	2	22.2	1	11.1
Baca	8	2	25.0	-	-
Moenda	5	-	-	-	-
Swazi	4	3	75.0	-	-
Cape Coloured	2	-	-	-	-
UNION NATIVES TOTAL 435					
		16	3.7	2	0.5
T O T A L 1,086					
		30	2.8	2	0.2

TABLE II.

SHOWING THE INCIDENCE of TAPEWORM ova in the STOOLS of Natives of the City Deep Mine in 1,016 consecutive examinations.

TRIBE	No. of Stools Examined	Ova of <i>Taenia saginata</i>		Ova of <i>Taenia solium</i>	
		No.	%age.	No.	%age.
Shangaan	214	7	3.3	1	0.47
Nyambaan	38	1	2.6	-	-
Mchopi	31	2	6.5	-	-
Tonga	20	-	-	-	-
EAST COAST NATIVES TOTAL 303					
		10	3.3	1	0.47
Basuto	352	16	4.5	2	0.6
Xosa	145	4	2.8	1	0.69
Bechuana	68	1	1.5	-	-
Pondo	44	1	2.3	-	-
Zulu	36	-	-	-	-
Swazi	34	1	2.9	-	-
Baca	9	1	11.1	-	-
Fingo	8	-	-	-	-
Moenda	7	-	-	-	-
Hlubi	5	-	-	-	-
Cape Cold.	4	-	-	-	-
Union Natives TOTAL 713					
		24	3.4	3	0.42
T O T A L 1,016					
		34	3.3	4	0.4

Since the above, according to Dr. Orenstein, Dr. Fischer in 1935 found *Taenia saginata* in 2.2% of 934 Union Natives (excluding Zulus); in 3.9% of 103 Zulus; and in 3.2% in East Coast Natives.

Note: By East Coast Natives in the Pretoria Library Services, 2013 East Africa.

Dr. C.G.Becker (17/2/37) kindly supplied statistics showing the number of positive examinations of the stools at the South African Institute for Medical Research, Johannesburg, for the years 1934 to 1936 (inclusive). The following table illustrates the numbers of cases found (ova and/or segments), and the statistics refer to T.saginata, except where special mention is made of T.solium.

<u>YEAR</u>	<u>EUROPEANS</u>		<u>NON-EUROPEANS</u>		<u>TOTAL STOOLS EXAMD.</u>
	<u>OVA</u>	<u>SEGMENTS</u>	<u>OVA</u>	<u>SEGMENTS</u>	
1934	14	25	21	9	4700
1935	9	19 plus 1 T.sol. (segments)	11	3	3844
1936	11 plus 1 T.sol. (ova & segs.)	13	30	2	3813

Between the period 4/4/36 and 10/1/37, the following cases of Taeniasis were treated at the Pretoria Hospital. (Statistics kindly supplied by Dr.H.J.Hugo, Medical Superintendent.)

EUROPEANS.

<u>Age</u>	<u>Sex</u>	<u>Diagnosis</u>	<u>Date</u>	<u>Remarks.</u>
11	F	T.solium	4.4.36	
6	M	" "	20.8.36	
10	F	" "	7.9.36)	One Family N.B.
3	M	" "	7.9.36)	
8	F	" "	7.9.36)	
4	F	" "	30.9.36	
5	M	" "	23.10.36	

NON-EUROPEANS.

5	F	T.solium	5.1.37	Basuto. Admitted in coma.
14	F	" "	10.1.37	Basuto. Admitted as accident case.

Judging from these statistics and from figures supplied by the medical authorities of two of our neighbouring Native Protectorates, it would appear that the incidence of taeniasis among natives and Europeans is not high in Southern Africa. Dr. J.W. Stirling, Principal Medical Officer, Bechuanaland Protectorate reports (4.11.36) "From reported cases one would conclude that infection in humans of tapeworms is not excessive. Out of 27,662 first attendances of out-patients in 1935, only 43 were for tapeworm infection." Dr. H.W. Dyke, Principal Medical Officer, Basutoland reports (30.10.36): "Out of 133,021 out-patients there were 231 cases of tapeworm. These figures are for a three year period at all Government stations. At Maseru out-patient department for the period 1st January to 30th September 1936, out of 7,800 out-patients, there were 7 cases of tapeworm!"

There can be little doubt that the figures given in the statistics, and also those of the two Native Protectorates are only ~~those~~ indicative of a very small percentage of the actual infections. Reference to the Survey of the Incidence of Cysticercosis in an earlier Part of this work shows a particularly high incidence of C. bovis in Natal, where a large number of cattle of Zulu origin is slaughtered; in Barberton, which district borders on Swaziland; and in the coastal Cape-Eastern abattoirs, East London, Kingwilliamstown, Fort Beaufort and Port Elizabeth, centres which draw a good deal of their stock from the Transkeian Native Territories. The Eastern Orange Free State is a "black" area as regards C. cellulosae. Reference to the "Incidence Map" shows the proximity of the districts of Ficksburg, Senekal, Clocolan and Wepener to the Basutoland border. We have noted that the Principal Veterinary Officer for Basutoland

estimated that the incidence of C.cellulosae in that Territory was about 10% in pigs. South African statistics - the few which are available and not by any means truly indicative - appear to agree with the observations of Lièvre in France, that T.saginata is encountered far more frequently than T.solium, and that the incidence of infection in the human is inversely proportional to the severity of the infection in the intermediate stage. Undoubtedly, if pork were not eaten in a well-cooked state, even by natives, the incidence of T.solium would be much higher everywhere in South Africa, but the omnivorous habits of the pig tend to the ready ingestion of the entire human stool, containing countless thousands of T.solium ova, and heavy infestation of the pig follows. A theory, which I think bears a good deal of fact and may possibly explain the somewhat anomalous disproportion between the relative frequency of infection in the pig and the rarer infection of the human in South Africa, with the adult tapeworm, Taenia solium, is that the risk of the human infection is very much greater through the handling of measly pork than through the ingestion of it. Leuckart bears out this point and mentions that he found infestation with T.solium far more frequently in women than in men, and especially among cooks and kitchenmaids who handled pork, and when found in males, most frequently in butchers. In our Native Reserves the older men and the women most frequently handle pork carcasses. Owing to the sticky nature of pig measles and the greasiness of the lard, viable cysticerci can readily be conveyed by the hands to the mouths of such carcass-dressers. The young men, from whom mine workers are recruited, eat well-cooked measly pork in their Native Reserves, but the handling and preparation of the raw pork is mainly done by their women-folk. On one occasion the writer could have been subject to tapeworm infection, when he found a viable

(Cysticercus cellulosae)

Cysticercus cellulosae on the mouth-piece of his cigarette, after having minutely dissected a measly pig carcass for observation purposes. I do not suggest that the incidence of T.solium in South Africa is as great, or nearly so, as that of T.saginata, but I do believe that in actual fact the incidence of infection is not truly reflected in observations on native mine workers. A high percentage of infection with T.solium should be observed if systematic faecal examinations could be made of representative colonies of natives, including those who most commonly handle measly pork in the Reserves, namely the women. During 1936 I had occasion to apply to Dr. Viviers, District Surgeon, Vereeniging, for some information regarding the origin of a case of cerebral cysticercosis in a native who died in the Bloemfontein Mental Hospital. The patient originated from the Vereeniging District. (See Case History Native Lucas Mpake in a subsequent ~~part~~ portion of this Part.) Dr. Viviers replied inter alia (Letter dated 10 / 12/36): "I know that at least 25% of the natives in this (Vereeniging) district are infected with Taenia solium. In compounds, of which there are many in this area, the incidence of infection is higher." Upon first sight the remarks of Dr. Viviers may appear to be a somewhat exaggerated "guess in the dark", but to those who know the South African native and his habits it will be clear that no gross exaggeration is presented. During 1932, I had occasion to satisfy my curiosity as to the extent of infection of humans with tapeworm in one of the "ative Reserves. On that occasion, along with an Extension Officer attached to the Native Affairs Department, I visited the stad of the Chief of the Moiloa Native Reserve in the Marico District. (N.W. Transvaal.) At a meeting of about 4000 natives, which I addressed on the subject of anthrax control, I was eventually questioned by one of the Headmen

on the reason why so many of their cattle and pigs are condemned for measles, when sent to the Johannesburg and Pretoria abattoirs. After a brief outline of the life-histories of the two parasites, I gave the opinion that many of the natives present must have been infected with tapeworm, and bluntly, in order to appease my curiosity, I asked those infected to show their hands. At first, apparent coyness caused only a few to admit, but after my assurance that there was really nothing to be ashamed of and that I would suggest a simple line of treatment to them, what I estimated to be between 15 and 30 per-cent. of those present caused a mass of hands to be shown. It is, therefore, suggested that but a few of the actual carriers of tapeworm infection present themselves for treatment at various hospitals, such as those institutions for natives in Bechuanaland and Basutoland. As long as no great discomfort and physical pain due to the infection may be experienced by native carriers, these will not come to European physicians for treatment, and some, undoubtedly, are treated by their native "doctors". The native's mentality and his suspicion of European interference with his ailments are amusingly reflected in a letter dated 14/5/33 from Dr. J.S. Armstrong, Medical Officer, Singida, Tanganyika, to Capt. H.J. Lowe, M.R.C.V.S., Veterinary Officer, Mpwapwa:- "Upon receiving your letter I made an attempt to induce out-patients at this hospital to attend for the examination of their stools, but I regret that the only result was that all ran away before the treatment (of their other ailments) was completed."

In areas where proper meat inspection is not undertaken, the risk of infection to humans is great, and the incidence correspondingly high. Cawston (1935) related an astonishing fact. He wrote:

"Seven years ago (therefore about 1928. - N.F.V.) some 30 per-cent. of school children attending the clinic of the Potchefstroom Health Committee were found to be suffering from tapeworm infection, and this was used as evidence of the need for the establishment of an approved abattoir." The Potchefstroom experience should surely have been a warning to smaller communities, especially those close to Native Reserves.

Unfortunately no statistics of the incidence of tapeworm infection in school children in the Union are kept. According to Dr. H. Maugham-Brown, Medical Inspector of Schools, Cape Province (letter dated 28/12/36), the incidence of infection in school children "seems to be higher in the Eastern Province than in the rest, more particularly in the areas which obtain their cattle from grazing areas occupied by natives." The Chief Medical Inspector of Schools, Transvaal, writes (8/1/37):- "During the routine medical inspections the School Medical Officers do not examine all children on the presence of any intestinal parasites, on account of lack of time and facilities. Any statistics that may have been compiled out of facts obtained from medical inspections are very inaccurate and are only obtained from (a) direct information from the child, without being questioned in this direction, and (b) information obtained from the child on account of being questioned in this direction. Our experience, however, is that the incidence of tapeworm in European school children is fairly high in the rural areas of the Transvaal, and especially in the so-called Bushveld Areas (e.g. Marico, Zwartruggens, Rustenburg, Waterberg, Lydenburg, etc.) and this, presumably, is closely connected with the fact that in these areas cattle farming is the main occupation, and that in addition to this the native population

is probably heavily infected with tapeworms. Roughly stated, the incidence of tapeworm in European school children in rural areas of the Transvaal ranges from a fraction of a percentage to as high as 20 to 25%."

On the strength of this collection of evidence, it is clear that the problem of taeniasis infection in rural and native South Africa is most important, and warrants the scientific investigation of the medical profession.

After having considered these various facts, we are still no further in our decision as to whether Taenia solium or Taenia saginata is the more important parasite in the field of public health. If we accept the frequency of occurrence of each individual species, as gleaned from actual observations, which, admittedly, reflect an incomplete survey, then Taenia saginata must be considered of prior importance. If, on the other hand, we must accept available medical evidence as to which species is the more damaging to the host, and is responsible for the more grave sequel^{ae}, then one must surmise that Taenia solium is the more important.

We have already mentioned the fact that Taenia saginata is more frequently the more "solitary" species in the host. (See Parts I and II). It stands to reason, that the ingestion of an insufficiently cooked, heavily infested piece of pork, may cause the development of a great number of Taeniae solium. The chances of gross infestation through the ingestion of measly beef are less, owing to the general lighter infestation of the bovine. An exceptional infestation of a native was mentioned, however, by Watkins-Pitchford (1923), who stated that on one occasion as many as twenty specimens of T. saginata were recovered on autopsy, from the intestines of a single native.

The Effect of Taeniasis Infection on the Human Host.

In the healthy adult an ordinary single infection with either parasite may not have very severe clinical effects on the patient. Yoshino (1934), who deliberately infected himself for experimental purposes with Taenia solium, found that the presence of a few adults in a patient would cause only slight gastro-intestinal derangement, which was usually more manifest in the early stages of infection. So little physical discomfort is felt by some of the more primitive peoples, e.g. the Abyssinians (Schimper, quoted by Leuckart) to infection with Taenia saginata, that these people maintain "that without this guest they would be unhealthy, and that they would suffer especially from constipation." According to Leuckart, intestinal irritation and nervous derangement in the host is much less frequent in Taenia solium than in Taenia saginata, but on the other hand, the presence of the hooklets on the head of the former sometimes causes injuries to the intestinal mucosa. Attachment of both species occurs in the small intestine. "When in possession of its full vital powers, the worm hangs so firmly that it is necessary to pull and bend it before it will quit its hold. And even after it has done so, it will attach itself again in a moment, if the head succeed in catching hold of a portion of the intestine." (Leuckart).

According to Braun-Seifert (1923), the infection may cause the following derangements in man:-

1. Absorption of Nourishment :- The loss of nourishment on the part of the host is usually compensated by the eating of larger amounts of food, owing to the abnormal appetite the patient develops (Heischunger).
2. Digestive derangements:- Frequently diarrhoea, followed by constipation etc. - frequently flatulus, tympanites, sometimes spasmodic colicky

pains, and sometimes a "pressure" in the abdominal region.

3. Nervous derangements.

4. In weaker individuals anaemia may easily follow.

Sequelae.

Braun-Seifert (1923) refers to Spengler, who performed an operation for appendicitis on a 29 years old woman, and found a live proglottis lodged in the appendix. According to Spengler, this proves that the presence of a foreign body will cause, through friction, the symptoms of appendicitis simplex. Martin, Pollag, Retzlaeff and Westermann found similar causes of appendicitis. (Braun-Seifert). Altenkamp (1935) recorded a case of acute appendicitis, in which the presence of a portion of the strobila of a Taenia was the cause. So also did Pytel (1935) refer to a case in which tapeworm infestation was the cause of appendicitis.

Farzane and Ibragimov (1935) found that ileus of the intestine had been caused by a conglomeration of Taenia solium segments.

Leuckart asserts that it is quite conceivable that the powerful contractions of Taenia saginata have an influence on the condition of the intestine. The projecting borders of the joints thus rub in a file-like manner over the villi and easily produce a congested state, which lasts a longer or shorter time according to the circumstances, and gives rise to many disease symptoms. If the disease continue long, the nutrition suffers. From this there often arises a condition which has a certain resemblance to anaemia, and which especially exhibits the many neurotic symptoms of this disease. "Singing in the ears, hallucinations, giddiness, fainting, pains in the joints, epilepsy, chorea and even mental diseases, have all been observed to be caused by the tapeworm, and not infrequently to disappear on the removal of the latter." (Leuckart).

Burnet (1919) placed on record three cases of chorea, which had their origin in the presence of tapeworm, and were cured when the worm was expelled; he pointed out, however, that a rheumatic tendency might have been a predisposing cause.

Very interesting work on the subject of psychosis due to tapeworm infestation was done in South Africa a few years ago, by Dr. A. S. van Coller, who was formerly on the staff of the Bloemfontein Mental Hospital, and is now Physician Superintendent of the Mental Hospital, Grahamstown. Dr. van Coller very kindly supplied me with a memorandum of his research, and has given me permission to quote his hitherto unpublished findings.

Out of 450 cases, all suffering from psychosis, he found two groups, viz.

"a" Toxic Group (180)
"b" Exhaustion Group (130).

Both these groups he considered were directly due to tapeworm of the intestines. After treatment the "a" group responded almost immediately - that is, they recovered within three months. The "b" group was much slower - here recovery was slow - blood examination revealed a secondary anaemia in practically all cases. It usually took from three to twelve months for a recovery. The anaemia had disappeared by the time recovery was established. So in this group he reckoned the tapeworm had been present for such a term as to produce anaemia. The toxæmia, plus anaemia eventually caused a psychosis. The balance, that is 136 cases turned out to be a mixture of classical types, mostly Dementia Praecox. (The remaining four cases were of Cysticercosis of the brain, of which three died from epileptiform psychosis - see later.)

Dr. van Coller was of opinion that in these classical types (Dementia Praecox, etc.) the tapeworm acted mainly as a precipitating factor, not causal.

Dr. H. Egerton Brown of Pietermaritzburg, and formerly of the Union Mental Hospital Service, informed me (letter dated 25/1/37) that he was convinced that a certain number of cases of acute excitement (mania) among native admissions to the Mental Hospital was due to an absorption of a toxin secreted by the living Taenia, and he made it a routine treatment to try and expel the parasite in all cases of this nature. Dr. Egerton Brown kindly supplied a record of 207 positive cases of tapeworm infestation. Of this number 139 recovered after treatment and were discharged. Sixty-eight cases were relieved, or not improved. Of the recovered cases, diagnoses were Hebephrenia or Simple Dementia Praecox and Toxic cases. The relieved or not improved cases all showed an improvement for some time after treatment. "On retreatment, the same thing happened. Three cases of epilepsy due to tapeworm infection were discharged as recovered after treatment. No fits for many months after treatment, they have not been readmitted."

The findings of Doctors van Coller and Egerton Brown have been quoted to illustrate the occasional dangerous sequelae of tapeworm infection, and have, of course, a special South African interest.

Both species of human Taenia may, occasionally show amazing tenacity of life. "These tapeworms grow to a length of twenty to thirty feet and can live for 12 to 20 years, or even longer." (Mönnig, 1936). Franke (1931) referred to the tenacity of T. saginata. Some cases he knew of had harboured the parasite from 15 to 19 years, and in one case the patient required six vermicides before the tapeworm was eventually expelled. Leuckart quotes Cobbold, who had cases who evacuated proglottides daily for 11 years, and Wawruch, who mentioned several cases which lasted from twenty to twenty-five years,

and in one case he even mentioned thirty-five years. "Of course, it is doubtful whether this is always the effect of the same tapeworm". (Leuckart). Leuckart mentions that occasionally after death of the tapeworm, and instead of resultant expulsion, mummification of Taeniae may occur within the host's intestine. Such mummified specimens were found by Cobbold and by Küchenmeister.

Conditions which were caused by what Shahan (1932) referred to as "migratory taeniae", have occasionally been recorded. A soldier in the Egyptian Army, with a history of occasional attacks of suffocation, died in hospital under Shahan's treatment, from a distressing dyspnoea. On post-mortem examination a tapeworm was found lodged in the larynx and upper part of the trachea. Shahan mentions a case in the literature in which incision of the drum of the ear for severe earache was followed by the passage of a tapeworm from the middle ear and eustachian tube. Cases are known in which the whole or portions of a tapeworm have been vomited. Lavalette (Leuckart) reported the case of a pregnant woman who expelled the proglottides singly through the mouth. Leuckart refers to cases in which proglottides, or even the entire strobilae had passed through fistulae of the bowels into the abdominal cavity. "Especially interesting in this connection is a case mentioned by Herz, in which the tapeworm issued through the navel, without, however, bringing any of the contents of the intestine with it, so that the patient could be dismissed as cured a few days after the exit of the worm". Leuckart also records rare cases in which the tapeworm was expelled through the urethra. "In such cases, even when the ordinary signs

of vesico-rectal fistula are wanting, it is evident that the worm can only have reached the urinary apparatus from the intestine. In one of three cases mentioned by Davaine, the tapeworm remained a year in the bladder, and expelled single proglottides at intervals of about eight days, until it was killed by an injected anthelmintic and then expelled at once. We need hardly add that expulsion of proglottides through the urethra is accompanied by violent and painful disorders, and that the above mentioned cases interfere in many ways with the health of the host."

To summarize, we might mention that:-

- 1) Simple infestations with either Taenia have not, as a rule, any serious damaging effects on the human hosts, but
- 2) Anaemia, with resultant debility, may follow.
- 3) Frequently both tapeworms may show amazing tenacity of life, and may remain alive and actively eject mature proglottides for many years.
- 4) Both species may be responsible for very serious sequelae, among which have been recorded:-
 - (a) Digestive derangements and pathological conditions of the intestinal tract - ileus of the bowel, appendicitis, intestinal fistulae. which may cause migration of the parasite to the uro-genital tract.
 - (b) Nervous and mental derangements - e.g. chorea, psychosis with dementia praecox, epilepsy due to Taenia infection.
 - (c) "Migratory taeniae" may lodge in the respiratory tract (usually in the upper part of the trachea and the larynx), and in rare cases segments may be found in the acoustic and olfactory regions, e.g. in the eustachian tubes.

The Infestation of the Human Subject with Cysticerci.

Of perhaps greater importance from a clinical point of view than infection with the adult Taeniae, is the infestation of the human subject with Cysticercus cellulosae and Cysticercus bovis, which, according to Broughton -Alcock, Stephenson and Worster-Drought (1928) has been known since 1558. According to consensus of opinion, the former parasite is far more frequently met with in the human subject, and many authorities doubt whether actual cases of bovine cysticercosis have been encountered in man. Leuckart accepts, with a great deal of reservation, the probability of human infection with cysticercosis bovis. Mönning refers to the possibility of such infection, but qualifies this with the reminder that the C. cellulosae is by far the more frequent parasite. (1934). Von Ostertag (1934) states that C. bovis "has never been definitely found in man." It is, therefore, almost certain that by far the large bulk of cases of human cysticercosis (to be clearly distinguished from human echinococcosis, or so-called hydatid disease) is due to infection with C. cellulosae.

In every case of human cysticercosis, the victim of infection has undoubtedly been directly or indirectly in contact with a Taenia carrier. Such infection may result from the following:-

1. Auto-infection: According to case histories, and also to the opinions of many authorities, it is less frequent that cases of human cysticercosis have been met with, in which on post-mortem or other examination evidence of Taenia infection was found. When such cases occur, auto-infection may result from:-

1. Anti-peristalsis, in which reverse movements of the intestinal contents lodge in the stomach, and in such movements carry ripe proglottides of the Taenia solium with them. The ova are liberated, and human

infection follows on similar lines to that of the pig (See Part III).

ii. Conveyance of ova on the fingers, or under the finger-nails into the mouth, by a Taenia carrier. In such cases the tapeworm carrier, most commonly of T. solium, will infect himself with C. cellulosa.

Vosgien (1910-11) mentions that out of 579 cases of human cysticercosis observed by Auscher, 62 were infected with Taenia solium.

2. Infestation due to ingestion of Taenia ova voided by a carrier and contamination of food-stuffs:

This mode of infection is probably responsible for the great bulk of cases of human cysticercosis. ~~Chin~~ Chin (1933) was of opinion that the ingestion of insufficiently cooked vegetables was the greatest source of infection in China. A similar opinion was given by Vosgien (1910-11). Colonel F.P. Mackie (1934), in a discussion on MacArthur's paper on "Cysticercosis as seen in the British Army", comments on the fact that in India only the lowest caste inhabitants eat or touch pork, and it is probably they, in preparing and handling soldiers' food directly, or in eating houses in bazaars, who, as Taenia carriers, were responsible for the infection of the number of cases cited by MacArthur.

The use of human excrement as fertilizer for vegetable gardens is a grave source of infestation of cysticercosis to the human subject. Such vegetables as lettuce, parsley, celery and water-cress, the leaves or stems of which are generally eaten in a raw state, are positively dangerous if human excrement has in any way come in contact with them. It is highly probable that the majority of cases of human cysticercosis found in South Africa, especially in Europeans, originate through accidental infection through the ingestion of ova in the food. "We run a grave risk of infection in South Africa through our close contact and association with our native population. Garth (1923) stressed the potential danger in a household of a T. solium carrier, whose contact with the rest of the family

could cause the ingestion of Taenia ova by them.

It is a remarkable fact that most of the case histories in British literature have reference to infection in India and elsewhere in the Orient, and nearly all refer to subjects who served in the Army or Navy. (Reference articles by MacArthur (1934), Dixon and Smithers (1935), Dudley (1934), Dick (1936), Holmes (1934), Lindeman and Lyburn (1935), Marsh (1934), Ferry (1936), Broughton-Alcock, Stephenson and Worster-Drought (1928), Priest (1926) and Roth (1926).

The incidence of Taeniasis solium is not known in India and China, but, according to MacArthur and others, it can only occur among the very lowest caste in India, and, as has been mentioned, according to Mills (1923 and 1924), Gear and Pedersen (1934) and Feng (1934), the recorded incidence of T. solium is very low in China. In our survey of the incidence of infection in pigs, it was also recorded that, from abattoir observations, the incidence of porcine C. cellulosa was almost negligible in that country. In South Africa, in many parts, the incidence of porcine cysticercosis is very high. Although we have no data to prove our surmise, except the opinions of some medical observers, it is, nevertheless, almost undeniable that Taenia solium must be a very frequent parasite among our native population. It is they, who generally handle our food, and we are thus seriously exposed to a far more dangerous infection than we would ordinarily acquire through the eating of viable measly pork or beef.

It has been suggested by some writers (Vosgien, 1910-11) that heredity may also be a factor of transmission of infection. This factor we mentioned in dealing with infestation of the pig and the bovine. Volovatz (1902), according to Vosgien, "in his highly documentary thesis draws attention to the fact that cysticerci have been found in

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 placentae; this might explain the origin of this entozoon in new-born infants."

Breat-fed, suckling infants, however, must run the smallest risk of infection, since their only diet is their mothers' milk. Heller (1874), according to Vosgien, mentions, however, a case of a 6 months old child who had a cysticercus in the mesentery. Vosgien also quotes Virchow (1877) who found this larva in a 9 months old child; Karewski (1877), who found cysticerci in a breast-fed child whose mother carried Taenia solium.

It would appear that in the majority of cases of human cysticercosis, the onset of infection occurs between the ages of 20 to 40 years. It is, thus, usually a disease of adults. According to Vosgien, out of a total of 478 cases observed, 206 occurred between those ages. Dudley (1934) described a case of epilepsy in a sailor, and based his diagnosis of C. cellulosa as being the cause of the disability on: Age of onset, 40 years; place of origin, China; infestation with an adult Taenia solium plus X-Ray appearance of calcified cysts.

Locations of Cysticerci in Man.

The brain is commonly held to be the most frequent site for Cysticercus cellulosa in man, but this may merely be because cerebral symptoms, when they show themselves, are more marked than muscular symptoms (Chizzola, 1933). Similarly, MacArthur (1934) explains that ocular and orbital cysticercosis causes outward signs which can hardly be unobserved, whereas intramuscularly they may exist for years without the patient or his associates observing them. None of a large number of calcified cysts in the arms and legs of a case described by Chizzola, and demonstrated radiographically, was palpable. This rather suggests that cysticerci are usually situated intramuscularly, rather than

subcutaneously.

McCrae (1931) quotes Stiles, who compiled statistics of the locations of infection as follows:-

In 155 cases, the brain was involved in 117 cases; the muscles in 32; the heart in 9; the subcutaneous tissues in 5 and the liver in 2.

Vosgien found the predilection sites in man to be:-

Eyes and adjoining structures	46%.
Brain and Nervous System	40.9%
Skin and Cellular Tissues	6.32%
Muscles	3.7%
Other organs	3.2%.

Cysticercosis of the Muscles, Skin and Intracellular Tissues and Other Organs : A Review of a few Recent Case Histories.

Priest (1926) mentions a case in which five years after enlistment in the Army a private became sick, showing abdominal pains and vomiting. His liver was found to be enlarged. He then developed pain and swelling in the calf muscles, which on examination were found to be nodular. A few months later he had a "fit". He showed a chain of nodules on the forehead and muscles. There was no evidence of the patient having harboured a tapeworm, so that he must have become infected through ingestion of extraneous segments or ova.

Radiology has been instrumental in the discovery of quite a number of cases of cysticercosis in man, especially when calcified cysts have been located in the limbs. Capua (1932), having detected calcified C. cellulosa in the musculature radioscopically, suggested that this method of diagnosis should be employed in all suspicious cases.

Roth (1926) describes a case of cysticercosis in a man 44 years of age, a hairdresser. He complained of pains in the left knee-

joint, of five years' duration. For ten years the patient had suffered from epileptiform "fits". He served in India from 1908 till 1911. Radiograms of the left knee were taken, which disclosed some 80 calcified cysts. It was then decided to take radiograms of the rest of the body, and these showed calcifications in the extremities down to the ankles and wrists. The pectoral muscles showed numerous cysts. Three bodies were seen to be lying in the pia mater of the brain. Similar cases were described by Gavazini (1934) and Casuccio (1933). Streignart (1933) demonstrated calcified cysticerci in the muscles of a peasant's leg which was X-rayed for fracture. Disseminated calcified cysticerci were found in a case by Kremser (1934), also by Grado (1935), and were demonstrated by X-Ray. Brailsford (1926) demonstrated cysticerci in the thigh of a patient radioscopically. Chin (1935) described thirteen cases in Peking, which showed "nodules" or "tumours" under the skin, and were found to be due to C. cellulosa.

According to MacArthur (1934) cysts may be detected in the muscles or subcutaneous tissues of any part of the body - the head and the face, including the eyelids and lips, trunk and limbs, but rarely in the hands and feet. They are found more commonly in the upper half of the body, not because the parasites are more numerous here, but because of the better cover afforded by the larger masses of muscle in the lower half. Among other unusual locations of C. cellulosa is the mammary gland. Such a case was described by Stumpf (1915).

In 26 cases of cysticercosis in the viscera and "other organs" mentioned by Vosgien, Cysticerci were found in the heart in 10 cases; glands in 6 cases; digestive organs in 3 cases; lungs in 2 cases; and in the mouth in 1 case.

Cysticercosis of the Eyeball and its Annexes.

Vosgien (1910-11) mentions 372 cases of ocular (or related) cysticercosis out of 807 observations. Of these cases :

The retina was affected	120	times.
The vitreous " "	112	" "
Subconjunctiva " "	84	" "
Anterior Chamber " "	26	" "
The orbit " "	19	" "
The iris " "	7	" "
The crystalline " "	2	" "
The cornea " "	2	" "

Vosgien quotes Hirschberg (1892), who "made a remarkable observation, that the Cysticercus apparently has a different predilection in various territories." "It is difficult to explain," states Hirschberg, "but the predilection of the Cysticercus in France is for the conjunctiva, in England for the posterior chamber, and in Northern Germany for the various parts in front of the eyeball." One wonders, however, whether coincidence may not have been the more important factor which caused Hirschberg to have made this peculiar observation. Since von Graefe (1866) demonstrated the presence of the Cysticercus in the vitreous humour, many cases have been placed on record, and it is a condition which is easily recognized.

According to Burdon-Cooper (1921), three different species of tapeworm larvae occur in the eye, namely that of Taenia solium, that of Taenia echinococcus and the Bothriocephaloid tapeworms, but the first named is by far the most common.

It has been found possible to remove Cysticerci successfully in eye affections. Two such cases were described by Gomes (1919). In the one case the Cysticercus was located in the anterior chamber, and was removed without difficulty; the other was removed from the vitreous chamber by incising the sclerotic, the procedure being guided by

ophthalmoscopic examination.

Pavia and Durando (1933) described a case of C. cellulosa which developed behind the retina of the right eye in a woman, 31 years old. The changes in the vision of the patient, as the cyst grew, were traced by the authors.

Among some interesting cases recorded of Cysticercus of the vitreous, mention may be made of a case described by Schweinitz and Wiener (1919). In this case the left eye was involved and was blind five months before the patient came under examination - blurred vision being noted ten months previously. There were no gross changes in the iris, but a few punctate deposits on Descemet's membrane and a few spots on the anterior capsule of the lens. The vitreous was cloudy with a few fixed vitreous opacities. There was a grey reflex in the upper and inner quadrant, "and a large globular mass in the central field of the vitreous, well in advance of the maculose region; the outline of this was regular, the border translucent and from the lower edge protruded a tubular extension, transversely wrinkled, which terminated beyond a constricted neck in a head showing two bright dots - the position of the hooklets. Peristaltic movements and movements of the head were very active at times." The diagnosis of Cysticercus of the vitreous was readily made. The general examination of the patient revealed little except that the stools contained ova but no segments of the worm. Operation was undertaken and the cyst removed, when it ruptured promptly.

Kress (1924) gives a most graphic and interesting description of the development of a Cysticercus in the vitreous, which occurred in a woman of 26. In the author's own words it is summarized somewhat as follows. There was at the onset, what seemed to be a detachment of the

retina, which, under dilatation at a later date proved to be a bluish-white cyst, which was of a perfect spherical shape and moved slowly in the vitreous, with movements of the patient's head. This bluish-white cyst had, practically at all times, an orange or orange-red halo at its periphery, shading off somewhat as do the colours of the spectrum. Later the greyish-white head and neck of the parasite put in an appearance, at about "5 o'clock meridian", and this neck could change its shape and become thicker through contraction, and it could bend itself and twist on itself, and at times invaginate or probably contract within the cyst until practically nothing but a slit was seen at its former site. The activity of the head and neck movements and of the suckorial and snout or rostellum areas, as well as the undulating movement of the vesicle proper, could be seen ophthalmoscopically. The eye had to be excised. Casanovas (1933) described a case of atrophy of the bulb of the eyeball, as a result of intra-ocular cysticercosis. Chica (1925) reported a very similar case to that described by Kress. He reminded us that this was the third case he had seen in Bucharest.

According to Feng (1934), less than 20 cases of ocular cysticercosis have been reported from China. Rao (1935) recalls that Wright of the Madras Ophthalmic Hospital has found that 3% to 6% of cases in that hospital had ocular cysticercosis. In consideration of this relatively high incidence of ocular cysticercosis, it must reasonably be presumed that the incidence of T. solium must also be relatively high in parts of India.

Cerebral Cysticercosis.

Cysticerci cellulosa may be present in the human brain, and also in other organs and the musculature for many years before clinical disorders become manifest. Although, in a case described by Billello, (1934), more than 1000 cysticerci were present in the cortex of the brain and the fourth ventricle, hardly any symptoms were present before death, and cysticercosis was not suspected. Occasionally records occur of admission to hospital for headache and unidentified fever, or for myalgia or rheumatic pains, "but these latter are usually of a degree so indefinite as not to impress the patient's memory." (MacArthur, 1934).

In the brain, the Cysticercus becomes enclosed by a wall of sclerosed neuroglia, corresponding to the fibrous capsule found in extracranial tissues. Small round cells and a few plasma cells are present between the delimiting neuroglia and the surrounding normal brain tissue. "Unless the parasites have invaded the brain in overwhelming numbers, or have lodged in some particularly responsive centre, they cause little nervous disturbance while in their relatively quiescent stage, otherwise it seems impossible that anyone could survive for years - as we know to be a fact - with 200 cysticerci present in the brain." (MacArthur, 1934). Surrounding the dead and disintegrating Cysticercus, the tissues undergo active degeneration. (MacArthur, 1934; Heilmann, 1932). MacArthur believes that Cysticerci while alive usually ^{enjoy} a relative tolerance on the part of the host, but after their death they act as foreign irritants and bring about the degenerative changes. The degenerating tissues may be visible around the Cysticercus as a discoloured ring, according to MacArthur, perhaps 3 mm. or thereabouts in depth, shading off into the normal brain tissue.

Cysticerci may be present in the brain or in the body muscles for many years before cerebral symptoms become evident. MacArthur refers to cases ranging from six to eleven years, and, according to MacArthur, when brain symptoms develop, they are subject to periods of exacerbation, followed by intervals of relative or absolute quietude, and the character of the symptoms may vary so markedly that an individual patient seen at intervals by different observers has been diagnosed as delusional insanity, disseminated sclerosis and cerebral tumour. Such cases of cerebral cysticercosis simulating clinical aspects of brain tumours, were also described by von Lehoczky. (1933). Antonow (1932) stated that young Cysticerci, living at the time of the host's death, are enclosed in a thin capsule composed of an outer layer of granulation tissue, containing giant cells. Around older cysticerci, which have died, the capsule is thick and has in addition an inner connective tissue layer, giant cells being here and not in the granulation layer. As a final stage Antonow described a single thick layer of hyaline connective tissue. MacArthur has found that degeneration of human Cysticerci cellulosa has occurred somewhat in the reverse order from that described in the literature in respect of pig measles. Instead of degeneration commencing and progressing from the vesicle, he has noticed in some newly degenerated excised cysts that calcification commences in the scolex, and the bladder, with its fluid contents, has remained unchanged. The calcified scolex may lie "quite free" in this. According to MacArthur the cyst wall collapses after this, causing escape or absorption of the fluid, and leaving merely the solid calcified scolex. According to MacArthur calcification of cerebral Cysticerci takes many years to occur. He refers to

the case of one soldier who was operated on eleven years after the onset of "fits". Several cysts removed from the cerebral cortex showed no signs of calcareous change, although the cysts in the muscles had been calcified for three years and some for five years.

The location of the parasites in human cerebral cysticercosis may be very variable. According to Heilmann (1932), Cysticerci may be free in the ventricles, blocking Magendie's foramen or the Sylvian aqueduct. In one case Heilmann found Monro's foramen occluded.

Of the nervous manifestations, by far the most common is epilepsy. The attacks may resemble those of petit mal, or may be Jacksonian in type, with, or without, loss of consciousness. MacArthur has proved that Cysticercus cellulosae in the brain is a frequent cause of epilepsy in British soldiers who have served in India. Within about eighteen months, just prior to 1934, MacArthur met with sixty such cases at the Millbank Military Hospital. Dixon and Smithers (1935) mention that of 258 suspicious cases examined at the Queen Alexandra Military Hospital, 79 have been proved to be due to cysticercosis, and 40 were doubtful. Broughton-Alcock, Stephenson and Worster-Drought (1928) described a case of a young soldier who had died, aged 28, after having served in India. For several years after he enlisted, the patient suffered from epilepsy. On post-mortem about 100 cysts were found in the half-brain.

Dick (1936) describes a case of a man 50 years of age, who had served in India 12 to 14 years ago. Between 1923 and 1933 he was engaged in a shipyard. In 1933, he began to suffer from epileptiform seizures and was later admitted to an epileptic colony, where he remained until he died after about a year. He was subject to fits of depression, occasionally with confusion, and at one time he had an outburst of religious mania. In 1935, he began to suffer from cerebral vomiting,

which increased in frequency and a severe and persistent headache developed over the occipital region. After death, autopsy showed numerous cysts in various parts of the brain.

Ramond (1933) described a rather unusual case in which a 35 years old woman showed symptoms of what appeared to be Jacksonian epilepsy, the cause of which remained obscure for some time. Eventually the cause was traced to a multiple infection with Cysticercus cellulosae. Flossbach (1932) mentions a case in a 43 years old woman, who had tapeworm in 1912. Twenty years later she had epileptiform convulsions due to cerebral cysticercosis. Lindeman and Lyburn (1935) had two cases of epilepsy in the British Army, due to cysticercosis, and they suggested several others. Similar cases in the British Indian Army were recorded by Holmes (1934) and by Perry (1936).

MacArthur mentions that the epileptiform seizures may at first be slight and incomplete, but after a year or so major seizures in rapid sequence may succeed. Frequently the "fits" may commence a long time after the presence of cysts are detected.

Other nervous derangements which may manifest themselves in cases of cerebral cysticercosis are acute encephalitis causing rapid death, melancholia, acute mania, delusional insanity and dementia praecox. A case of basilar and spinal meningitis due to C. cellulosae in a 61 years old patient, who had been under observation for some months, was described by Guillain, Bertrand and Thurel (1933). Diagnosis was confirmed by post-mortem examination. A similar case was reported by Liesch and Patrassi (1934).

MacArthur suggests that in the established disease, when the embryos have been "walled off" there is no diagnostic help to be gained from

blood counts, but when the embryos are still active in the body, no doubt an eosinophilia results. Presumably for the same reason, the complement-fixation and skin tests- which are group reactions- have not the high degree of success of the corresponding tests in schistosomiasis, filariasis and hydatid ~~disease~~. disease.

Rizzo (1932) diagnosed a case of human cerebral cysticercosis during life, largely upon the finding of an eosinophilia in the cerebro-spinal fluid, accompanied by a negative Wassermann reaction - the case did not harbour the adult T. solium and infection was confined to the central nervous system.

Fairley, according to MacArthur (1933), obtained a positive complement fixation in 5 cases out of 9 tested.

"Careful enquiries into the value of an eosinophilia, as suggesting the presence of Cysticerci has shown that the blood-count is not an entirely reliable guide. During the acute stage of infection with either Taenia or Schistosoma, most persons develop an evident eosinophilia. The complement-fixation test has proved of value in certain cases, but even this needs to be confirmed by other tests." (Cawston, 1935). In infections with the adult tapeworm, however, Kawanishi (1932) found marked leucocytosis in four persons intentionally infected with T. solium per os. Eosinophilia was only 15%. Neutrophiles showed an increase and lymphocytes a decrease.

As regards treatment, luminal and the bromides are sometimes helpful in controlling fits, but no medicinal treatment has as yet had any curative effect. MacArthur is of opinion that any drug which might be found to be lethal to live Cysticerci may be equally damaging to the tissues of the host. On account of the usual large numbers of cysts in the brain, surgical treatment cannot be resorted to.

Some Records of Human Cysticercosis in South Africa.

It will be noticed from the subjoined number of case histories supplied by various Mental Hospitals, that quite a number of cases of human cysticercosis have been encountered in South Africa. Nevertheless, literature is singularly silent on the subject of cysticercosis in humans in South Africa, and very little has been published in South African and Overseas journals by our medical observers.

Cawston (1935) refers to a case of the late Dr. Barry, in which the brain of an adult native who had died after being struck on the head, had revealed numerous Cysticerci. Apparently no ante-mortem symptoms were observed by those who had come in contact with the native.

Pirie and Kay (1920) showed a case of generalized cysticercosis in a native. There was a great number of cysticerci in the muscles, both of the trunk and the limbs, also in the diaphragm. There were moderate numbers of cysticerci in the brain, the heart and over the pleurae. There was no history of any illness in this native.

Strachan (1926) described the brain of a native male aged 56 years. This native was picked up in the street in a delirious condition, with a temperature of 101°F. On post-mortem examination his brain was found to be riddled with Cysticerci cellulosa. Strachan mentioned that he had found four cases in two years, and described a second case of a native with C. cellulosa in the heart, without brain lesions.

Fischer (1929) recorded, in his paper on "Autopsies on Native Mine Workers", cases of Cysticercus cellulosa accidentally found in the brains of three patients, who died of other diseases. In two cases a number of cysts the size of a pea was found on the surface of the frontal convolution; they could easily be squeezed out, without leaving any visible damage to the brain substance. In the third case a single

Cysticercus was situated in the left lateral ventricle.

Hospital Records.

Pretoria Mental Hospital.

The data of the undermentioned case histories were very kindly supplied by Dr. I. A. Vermooten, Assistant Physician Superintendent. Dr. Vermooten was able to find the records of only five cases between the years 1908 and 1934.

1. Male Native. Age 33; Admitted 4.3.16.

Diagnosis: Epilepsy.

Had epileptic fits since admission - put into bed after a succession of fits and remained in a semi-comatose state for seven days. Died 15.9.19. Autopsy: Cysticerci scattered throughout the brain substance. Cysts in floor of the ventricles. Cause of Death: Lobar pneumonia, aggravated by Cysticerci found in the brain.

2. Female European, M.B. Age 71; Admitted 10.7.18.

Diagnosis: Senile Dementia with Epilepsy.

She was demented and chattered incoherently. Suffered from fits. 29.7.20: Has had 15 very severe fits during the last two days, and is now only semi-conscious - muscles continue twitching - condition critical.

3.8.20: Continues to have seizures - only semi-conscious.

6.8.20: Died. Autopsy: Head - Calvaria shows very prominent ridges laterally over the temples. Skull is soft and in parts extremely thin, e.g. parietal eminences and just behind the coronal suture. Base of skull normal. Dura Mater: Thickening present. Adhesions marked. Lining shows some congestion. Sub-dural space - contains a large amount of C.S.F. Pia-arachnoid - Well marked opacity and milkiness. Encephalon - As there are numerous cysts in the brain, no dissection has been made and the brain has been put in its entirety into 10% formalin to harden. Head only examined. Cause of death: Cysticercus of the brain.

3. Female European, A.P., admitted 20.12.19. Age 75.

Diagnosis: Senile Dementia.

She was demented and very restless. According to the case sheets on 26th May, 1920 she had a severe seizure, lasting nearly five hours.

10.6.20: Patient has been having frequent seizures during the past few days and is gradually becoming weaker.

10.7.20: Died. Autopsy: Head: Calvaria much thickened. Almost $\frac{1}{2}$ inch in frontal and occipital regions. Dura mater - Thickening very marked. Lining injected. Adhesions - yes, to bone. Subdural space - Contains a large amount of C.S.F. Quite abnormal. Pia arachnoid - opaque and thickened. Separates fairly easily from brain. Vessels of Brain - Injected and more evident than usual. Small patch of atheroma in basilar artery. Encephalon - Weight 1200 grms. Weight of right hemisphere 485 grms. Weight of left hemisphere 495 grms.

Over the surface of both hemispheres and under the pia-arachnoid there are numerous cysts containing a turbid fluid and varying in size from about $\frac{1}{8}$ inch to $\frac{1}{2}$ inch in diameter. The cysts are over the left frontal region where there is quite a depression made on the surface of the brain. They are also numerous on the right parietal region. Cause of Death: Cysticercus of the brain.

4. Male Native. J.M. Age 65. Admitted 8.10.21.
 Diagnosis: Senile Dementia.
 He is demented, unable to give an account of himself; speech indistinct; very deaf.
 15.12.21: He went into status epilepticus and had six fits.
 Autopsy: Cysticercus in large numbers all over the brain.
 Ventricles, Cerebellum and Fourth Ventricle - Cysticerci present.

Cause of death: Cysticerci of the Brain.

5. Male Native. Age 35. Admitted 31.10.25.
 Diagnosis: Cysticercus of brain and symptomatic epilepsy.
 He was dull, rarely spoke. Knew his name, but could give very little further information about himself. Paraplegia of right arm and leg. Had innumerable fits of a Jacksonian type. Hemiplegia

gia aggravated after fits. Few small cysts in pectoralis major of left arm. Shortly before death he was dull and demented.

Quite unable to do anything for himself. Died 26.7.30.

Autopsy: Both hemispheres of cerebrum covered with cysts; many of the cysts lie loosely on the brain surface. Several small cysts scattered throughout pectoralis major and biceps muscles.

Cause of death: Cysticercus cellulosa.

Dr Vermooten concludes: "I have no doubt that if a post-mortem had been done on all cases where the cause of death was ascribed to epilepsy, more cases of Cysticercus would have been discovered.

Dr. H.C. Watson, Physician Superintendent of the Bloemfontein Mental Hospital informs me (letter dated 4.2.37), that between the years 1909 and 1914 he saw at least half-a-dozen cases of cerebral cysticercosis in the Pretoria Mental Hospital.

Dr. F.D. Crosthwaite, Physician Superintendent of the Mental Hospital, Potchefstroom, and formerly of the Medical Staff of the Pretoria Mental Hospital very kindly supplied the following data regarding Cysticerci in the brain in natives. Dr. Crosthwaite states (letter dated 15.1.37) that what they were investigating was

the incidence amongst natives, who were epileptic, of parasitic cysts in the brain, and of the frequency amongst these natives of the cysts as a cause of epilepsy - the figures supplied, refer exclusively to natives certified as mentally disordered (epilepsy with psychosis) in the Mental Hospital, Pretoria.

Period: 1911 - 1918 . - Number of Autopsies 288.

Of these 288 autopsies, 10 revealed the presence of cysts, situated as follows: 9 in brain; 1 in the heart; Of these 10, 7 were males, 3 were women.

Of the 7 males, 4 had epilepsy, 2 were dementia praecox (hebephrenia), 1 had syphilitic brain disease with cysticerci in the heart.

Of the three females, all were dementia praecox.

During the same period, 1911-1918, there were 334 deaths. Of these 334 deaths, 44 were epileptics. Of the 44 epileptics, 34 were autopsied, 29 being males and 5 females. No cysts were found in the women's brains, but 4 of the men's brains had Cysticerci. Counting the cases autopsied only, i.e. 34, Cysticerci were found as the exciting cause of the epilepsy in 11.706 % of the cases.

Potchefstroom Mental Institute.

Dr Crosthwaite states (15.1.37) that during his five years at Potchefstroom, two things have struck him; the very low death rate, and the impossibility, almost, of getting permission to perform autopsies. They have over 100 Europeans who are epileptics, but epilepsy amongst the feeble-minded (low grades, imbeciles and idiots) is of very common occurrence, and is due, when it occurs, to the imperfect development of the nervous system, and its general inadequacy and instability, or to the presence of gross anatomical lesions.

Bloemfontein Mental Hospital.

Case History: Native Lucas Mpake . - Kindly supplied by Dr. G.de la Bat, who attended the patient.

Native Male from Vereeniging. Age 55 years. Admitted 6.6.36, died 16.6.36.

Cause of Death: "Cysticerci of Taenia solium in brain."
Mental State on Admission: Restless and unnaturally talkative. Second day after admission he developed clonic spasms involving musculature generally. He gradually became more dazed and confused. Twitchings became more marked on the right side, especially the facial muscles. Eyes became fixed and staring. Post-mortem showed numerous cysts scattered over the brain. None observed in the skin. Eyes were not examined.

Pretoria General Hospital.

Dr. H.J.Hugo, Medical Superintendent, Pretoria Hospital records a case of Cysticercus cellulosae in a European male, 33 years of age, who was admitted to the General Hospital suffering from concussion, due to a fall under epileptic seizure. The Cysticerci were diagnosed by X-Ray examination. This case was admitted on 31.10.36.

CONCLUSION.

Dr. Cawston of Durban is at least one authority who strongly suggests that writers on this particular subject should stress the importance ~~now~~ that regulations should provide for the compulsory autopsy on every deceased epileptic in South Africa. The fact that Dr. Crosthwaite found that in his limited observations Cysticerci were the exciting cause of 11.7% of epileptic cases, suggests that a fairly high incidence of human cysticercosis exists in South Africa. Dr. Crosthwaite's observations were confined to native cases, and, although the incidence of this fatal condition must be higher among natives, there can be a grave suspicion that numerous European epileptics may also be affected with cysticercosis.

All Europeans resident in countries in which the incidence of Cysticercus cellulosae is high in pigs, are in danger of contracting C. cellulosae through the interim adult T. solium stage in their own, or somebody else's person, by direct or indirect contact with that person. The known incidence of C. cellulosae in pigs and T. solium is said to be low in India, and in that country only the very lowest caste handle or touch pork, and yet relatively large numbers of Britishers serving in that country have contracted, what might be termed a pitiable disease, through contact with but a percentage of the Indian native population. Attention may be drawn, however, to notes which appeared in the Indian Veterinary Journal 3 p. 52 (1926-27) in which it was estimated that the incidence of C. cellulosae was 50% in Madras and Coimbatore in pigs.

One should not appear to be an unwarrantable alarmist, in comparing conditions in South Africa, with its very much larger source of infection, namely a high incidence of porcine cysticercosis, a correspondingly suspected high incidence of T. solium among natives, and the fact that in approximately 100% of South African households the preparation and cooking of food is performed mainly by natives, a large percentage of whom may be presumed to be potential T. solium carriers.