

PART IV.

A.

THE JUDGMENT OF MEASLY CARCASSES.

In many countries in which the incidence of Cysticercus bovis is low, it is customary to condemn a measly carcass, irrespective of whether only a single measle, which may even be degenerated, or many measles may be found in the inspection incisions. In some other countries with a relatively high incidence of beef measles, it has been considered wilful waste to condemn lightly infested carcasses outright. Ways and means of sterilising such lightly infested carcasses have been found, so that after various modes of treatment the infested carcasses have been considered, or even rendered, fit for human consumption. These various methods of sterilisation, and the time required for the treatment of the carcass according to whatever method may be employed, have been based upon the results of tests for the viability of measles subjected to the various processes.

With regard to Cysticercus cellulosae, it has been customary in many countries to condemn measly pig carcasses outright, no matter how light the infestation of the carcasses may be. This somewhat severe judgment, it is supposed, has been based on some of the erroneous opinions of many of the older writers who considered, e.g., that the pig measle was not destroyed by freezing, or correctly so, that the older chilling method of sterilisation had comparatively little effect on the C. cellulosae.

Furthermore, it was considered uneconomical to treat measly pork carcasses for definite (formerly prolonged), periods in freezing chambers. The last named is probably the reason why few abattoirs in South Africa encourage the treatment by freezing of measly pork carcasses.

Judgment of Measly Carcasses in Great Britain.

According to Leighton (1927) amongst the English recommendations are:-

Section V - Instructions as to the action to be taken in the event of evidence of other disease being found in carcasses of bovines, swine etc., (other than tuberculosis).

A, The entire carcass and all the organs shall be condemned if evidence of any of the following conditions is found:-

(Amongst others)

6. Cysticercus bovis (measly beef), if generalized in the meat substance.

7. Cysticercus cellulosae (measly pork), if generalized in the meat substance.

With regard to the judgment of measly carcasses in Scotland, Leighton (1924) quotes:-

"In the event of evidence of Cysticercus bovis (beef measles) being found in a carcass and/or in a head, the carcass and/or the head may be passed for human consumption provided that they are placed in cold storage at a temperature not higher than 20° Fahrenheit, for a period of at least three weeks, or, alternatively, they shall be seized." The Section is, of course, devised to permit of saving such measly carcasses slaughtered at abattoirs where

suitable refrigeration is available, since it is believed that a temperature of 20oF. for three weeks is lethal to the Cysticercus bovis.

Section A. of Part V of the Scotland Meat Regulations (1924) provides that the entire carcass and all the viscera of pigs infected with Cysticercus cellulosae shall be condemned.

The Judgment of Measly Carcasses in Germany.

In the fourth (English) edition of his "Handbook of Meat Inspection", von Ostertag (1913) gives the following official Regulations concerning the method of procedure with measly hogs up till that time.

For the Kingdom of Prussia, the following Ordinance was passed on February 16th, 1876.:-

1. That fat obtained from measly hogs by rendering or cooking may be utilized unconditionally, but that lean meat can only be admitted for sale or for use in one's own household in cases where it is only slightly infested with cysticerci and is thoroughly boiled under police supervision after having been previously cut up. (According to a decision of the Second Criminal Senate of the Imperial Court, March 25th, 1884, (p.106) the rendered fat of measly hogs is to be sold under declaration. - von Ostertag).

2. That no objection whatever, from a sanitary police standpoint, can be raised against the use of suitable parts of measly hogs in the preparation of soap or glue, or against the free utilization of the skin and bristles, and the chemical utilization of the whole body, and that these uses are to be permitted without hesitation."

5. That in all cases in which hogs are found to be badly infested with cysticerci, care must be exercised by the police to secure the certain destruction of the carcass, after this has been utilized as far as possible.

With reference to the utilization of viscera free from cysticerci, a decree of the Ministries of the Interior and Education, June 26th, 1883, permits the fat, liver and intestines of hogs found to be measly to be freely admitted to the market as food for man, provided they have been found, upon examination, to be free from cysticerci. Von Ostertag (1913) gives the following Regulations, in accordance with the opinion of the Royal Superior Medical Committee, May 20th, 1882, which were applicable to Bavaria:-

1. The meat of hogs extensively infested with cysticerci is to be withheld from consumption and from the public market and is to be rendered harmless in a suitable manner. In the case of fat hogs, the separation and removal of the bacon is to be allowed at the request of the owner. No objection can be raised to the technical⁽¹⁾ utilization of such animals.

2. In cases where the cysticerci occur only sparingly in the meat, it may, according to⁽²⁾ the opinion of a scientific meat inspector, and after it has been properly cooked under police supervision, be turned over to the owner for use in his own household.

(1) and (2) The wording is precisely as that of von Ostertag.

(1) It is not clear what is meant by "technical utilization", but it is presumed that von Ostertag interprets the Regulation to mean that the meat of measly hogs may be used as fertilizer, meat meal and for other technical purposes, but not for human consumption.

(2) The wording of this Regulation is not quite clear, but, here again, it is presumed that von Ostertag infers that if in the opinion of a qualified meat inspector (presumably a veterinarian) the carcass is not too grossly infested, the owner may receive it for his own use, but not for sale.

The owner is to be properly instructed concerning the danger to human health from measly meat and is to be made cognizant of the police regulations concerning the control of such matters.

3. The public sale of meat, slightly infested, is to be permitted in freibanks under declaration of the danger from the meat only after it has been properly cooked under police supervision.

In the Kingdom of Saxony, the meat of hogs slightly infested with cysticerci is to be admitted to the market in a cooked or pickled condition, as unmarketable. The fat may be treated by rendering instead of boiling or pickling. The liver, spleen, kidneys, stomach and intestines of measly hogs may be utilized in a raw condition as non-marketable, provided they are found to be free from cysticerci by veterinary inspection.

In his work of 1934, Von Ostertag gives the following directions for the treatment of pork or meat of other animals (canines) infected with Cysticercus cellulosae:-

1. In the dog, the whole carcass is unfit for food.
2. In a mild infestation in swine, the flesh is fit for food when cooked, steamed or pickled, but not when chilled or frozen!
3. The fat of infested swine is fit for use.
4. The cooking and steaming of cysticercous pork is sufficient when the innermost parts are grayish-white and there is no red meat juice.

For measly cattle, in his "Handbook of Meat Inspection", 1913, von Ostertag states that in the Kingdom of Prussia the method of procedure with the meat of measly cattle was regulated up till

1913 by a ministerial decree of November 18th, 1897, which read as follows:-

"Since the conditions for the destruction of the beef measles worm have been more accurately determined by detailed investigations, than in the case of the pig measles worm, we have compiled 'the principles for the sanitary police procedure with measly cattle and calves.' While we hereby repeal all previous regulations and order that until further notice, procedure in this case shall be governed according to the principles hereby formulated. We call attention at the same time to the following statements:-

Meat is to be considered well boiled, when a uniform gray colour is observed on a fresh cross section.

The content of salt solution is to be accurately determined or controlled in the preparation of brine, or by means of the alkalimeter.

The pieces to be utilized in pickling shall not be heavier than $2\frac{1}{2}$ Kgm.

Pickled meat is to be kept under police control during the prescribed period.

For the determination of the temperature in cold storage rooms in operation in public abattoirs, tested maximum and minimum thermometers are to be used, and reliable self-registering hygrometers for the determination of the moisture.

The temperature and moisture content of the room are to be taken during the forenoon and evening of each day and to be registered in tabular form.

When properly equipped, cold storage rooms in operation in

public abattoirs can be considered as 'suitable'. The district veterinarian, in co-operation with the local police authorities, shall decide in each individual case whether the conditions for the proper treatment of the meat by cooking or hanging are present. The meat of cattle which are only slightly infested with cysticerci may be hung in quarters in special apartments under police control; that of calves in a similar condition, without quartering. In a given apartment, only the meat of one or several measly animals slaughtered on different days should be placed in the same apartment, only when the pieces of meat are so stamped that all possible confusion is avoided.

Although it has been demonstrated by previous investigations that decomposition of meat does not take place in cold storage rooms with the required temperatures and moisture content, it should, nevertheless, be determined by a veterinarian after the lapse of 21 days and before the meat is discharged, whether the meat has kept well and is not tainted.

By means of the provision that the meat of animals slightly infested with cysticerci and which has been rendered suitable for human consumption, shall be sold only to the consumer or for domestic use, it is intended to prevent commercial middlemen, butchers, sausage makers and hotel keepers from obtaining possession of such meat. If considered necessary, the resale of this meat is to be forbidden under the penalty of law."

Von Ostertag then proceeds to quote the Principles governing the Sanitary Police Procedure with measly cattle and calves:-

According to the number of cysticerci found in the routine incisions, distinction is made between:

- (a) Animals with at most ten living cysticerci: slightly infested animals.
- (b) Animals with more than ten living cysticerci: heavily infested animals.

For free utilization as human food are admitted:-

1. Rendered fat, unconditionally.
2. The liver, spleen, kidneys, stomach and intestines of animals slightly infested with cysticerci, in so far as these organs are found upon veterinary inspection, to be free from cysticerci.
3. Animals slightly infested with cysticerci in which the cysticerci which are found, are according to veterinary opinion, in a condition of complete calcification.

It is permitted to sell meat of animals slightly infested with cysticerci, after its dangerous properties have been removed under veterinary supervision, for domestic use, or for sale in special booths, freibanks, etc., in pieces not larger than $2\frac{1}{2}$ Kgm, and for sale only to the consumers and under statement of its meatly nature.

The necessary treatment required is:-

- (1) Thorough boiling, or,
- (2) Pickling for twenty-one days in 25 per cent. brine solution, or,
- (3) Preservation for twenty-one days in suitable cold storage rooms in which a temperature of 3°C . to at most 7°C . prevails, and a moisture content of 70 to at most 75 per cent.

The carcasses of animals badly infested with cysticerci are to be utilized for technical purposes, or otherwise rendered innocuous under police supervision.

For the Kingdom of Saxony, von Ostertag (1913) states that the meat of measly cattle, according to Section 5 of the New Regulations, Appendix 6 to Section 16 of the Regulations for carrying out the Saxon Meat Inspection Law (principles underlying the judgment of meat), is to be thoroughly boiled, pickled or refrigerated.

In the Grand Duchy of Baden, the following principles prevailed, prior to 1913 (von Ostertag, 1913):-

1. Meat is to be considered as unfit for food, when the cysticerci are present in such numbers that they are seen on the majority of the cut surfaces in the body musculature.
2. The meat of animals slightly infested with cysticerci - that is, animals in which only isolated cysticerci occur, except in the muscles of mastication - is to be considered as fit for food, but not marketable, after a previous boiling, pickling or refrigeration for three weeks under police supervision. The temperature in cold storage must not exceed 5°C. If the cysticerci are shown to be dead, this procedure is not necessary.
3. The meat of animals in which only isolated cysticerci occur in the muscles of mastication is marketable, but in such cases the head is to be treated according to No. 2.

Von Ostertag (1934) gives the following summary of the revised German Regulations for the treatment of beef infested with C. bovis:-

1. Severe infection:- Living or dead cysticerci found in the majority

of the seats of predilection and other muscles after incisions in more than one place; or a watery or discoloured condition of the flesh, without reference to the degree of cysticerous infection.

Judgment: The whole carcass is unfit for human consumption, with the following exceptions - fat, liver, spleen, kidneys, stomach, intestines, brain, spinal cord and udders, provided they are free from cysticerci after careful inspection, otherwise they are unfit, except the fat.

2. Mild Infection:- All cases in which living cysticerci are found, excluding cases of severe infection, and cases with watery or discoloured flesh.

Judgment: The whole carcass is fit for human consumption when the flesh has been pickled or kept in a cooling or freezing room for 21 days, and the cysticerci thereby rendered innocuous. Fat, liver, spleen, kidneys, stomach, intestines, brain, spinal cord and udders are fit, provided they are found free from cysticerci; otherwise they are to be treated as other parts of the body.

According to von Ostertag (1934), the following official directions are in force in Germany at present, for the preservation of beef with slight cysticercus infection, for twenty-one days in a cooling room or in a freezing chamber:-

- A. 1. The meat must be cooled to air temperature and its surface well dried in air before it is placed in the cooling room.
2. The infected meat must be kept separate, under lock and key, from other meat.
3. The day of introduction into the cooling room must be clearly marked on each portion of meat.

4. The separate parts or quarters of the animals must be hung so as to be exposed to air on all sides. The abdominal integument must be extended so that it does not lie upon other parts of the flesh,
5. The temperature in the cooling room must be kept at 0°C . to plus 4°C . The humidity of the air should be:-

At plus 4°C . not more than 75%.
At plus 3°C . not more than 78%.
At plus 2°C . not more than 81%.
At plus 1°C . not more than 85%.
At 0°C . not more than 88%.

6. The humidity is to be registered by a self-regulating hygrometer, which must be tested from time to time.
7. Meat which has been kept in the cooling room for twenty-one days, must not be sent to market till it has been certified by a veterinary inspector as of good quality and free from taint.
1. Before the meat is placed in the freezing room it must be cooled to air temperature. When a cooling room is at hand, further cooling to about plus 5°C . is suitable.

Directions 2, 3, 4 and 7 are the same as for the cooling room.

5. The average temperature of the freezing room should be at least -6°C . to -8°C .
6. The frozen meat should not be cut up before thawing, but should be thawed "in the piece". Any mould present on the surface should be removed with a knife before thawing.

The best temperature for thawing is from plus 5°C . to plus 6°C ., and a humidity of 75%.

Buri (1915) proposed a scheme for the judgment of measly beef, applicable to Switzerland, which coincided almost identically with that in use in Germany at that time. In this scheme, Buri

discriminated between "single measled", "multi-measled" and "heavily measled" bovine carcasses.

(According to von Ostertag, quite a number of workers in Germany and elsewhere, amongst whom were Müller, Noack and Lauff, raised objections to the detention for treatment of "single-measled" carcasses, especially those in which no further cysticerci were found after careful search.)

Judgment of Measly Carcasses in Holland.

In Holland, the Netherlands Vleeschkeuringswet of 1919 as amended in 1922, prescribed inter-alia:-

Lightly infected beef carcasses can be passed as fit for human consumption:-

- a. After sterilization, and also after the meat has been
- b. ten days in a freezing chamber at -10°C ., or,
- c. has been pickled for three weeks in 20% salt solution, in pieces of 3 Kgm., or,
- d. has been preserved for three weeks in a chilling room at a maximum temperature of plus 4°C .

For France, Piétte (1922) recommended any of the following modes of treatment of lightly infested measly meat. According to that writer, it would appear that up till 1922 no Regulations existed in France for the treatment of measly meat:-

- (a) Heating; (b) Pickling; (c) Freezing; (d) Cooling chambers.

Referring to Syria, Valade (1927) recommended :-

- a. Total condemnation in cases of generalized cysticercosis.
- b. Total condemnation of emaciated carcasses with only a few localized

cysticerci.

- c. Passing of the carcass in those cases in which only one or two measles are found in the predilection sites named by him.

Judgment of Measly Carcasses in the United States.

The United States Bureau of Animal Industry Order 211, Regulation 11, Section 17, is quoted by Edelmann, Mohler and Eichhorn (1934) This Regulation allows the passing for sterilization of carcasses affected with Cysticercus cellulosae, but if the infestation is excessive, the carcass is condemned.

Edelmann, Mohler and Eichhorn state that measly carcasses of pork are sterilized by high temperatures and strong brine solutions, but provision for the freezing of measly pork carcasses has not yet been incorporated into the American meat regulations.

"Meat is considered heavily infested when the measles are found alive or dead in large numbers in areas as large as the palm of the hand, on incising muscles in the favourite locations of the measles. This is the case, as a rule, when in the majority of the cut surfaces more than one measles is found in each section."

The same writers quote the Bureau of Animal Industry (U.S.A.) Order 211, Regulation 11, Section 16, which deals with the judgment of measly beef carcasses:-

"Carcasses of cattle (including the viscera) infested with tapeworm cysts known as Cysticercus bovis shall be condemned if the infestation is excessive, or if the meat is watery or discoloured. Carcasses shall be considered excessively infested if incisions in various parts of the musculature expose on most of the cut surfaces

two or more cysts within an area the size of the palm of the hand.

A carcass in which infestation is limited to one dead and degenerated cyst may be passed for food after removal and condemnation of the cyst.

Carcasses of cattle showing a slight or moderate infestation, as determined by a careful examination of the heart, muscles of mastication, tongue, diaphragm and its pillars, and portions of the carcass rendered visible by the process of dressing, may be passed for food after removal and condemnation of the cysts, with the surrounding tissues, provided the carcasses and parts, appropriately identified by retained tags, are held in cold storage, or pickle for not less than twenty-one days, under conditions which will insure proper preservation; and provided further, that if the temperature at which such carcasses and parts are held in cold storage does not exceed 15°F., the period of retention may be reduced to six days. As an alternative to retention in cold storage or pickle, such carcasses and parts may be passed for sterilization. Fats of carcasses passed for food or for sterilization under the above provisions may be passed for food provided they are melted at a temperature of not less than 140°F. The edible viscera, except the lungs and heart, of carcasses passed for food or for sterilization under the provisions of the above paragraphs may be passed for food without refrigeration or other process of sterilization, provided they are found to be free from infestation upon final inspection. The intestines, weasands and bladders from beef carcasses affected with Cysticercus bovis which have been passed for food or for sterilization may be used for casings after they have been subjected to the usual methods of preparation and may be

passed for such purpose upon completion of the final inspection."

Judgment of Measly Carcasses in Canada.

The Canadian "Meat and Canned Foods Act" of 1924 as revised March 29th, 1932, provides for the treatment in Cold Storage for twenty-one days of carcasses slightly affected with Cysticercus bovis.

Section 15 prescribes that such carcasses must be reported on a prescribed Form, and must be re-inspected on the day they are taken out of cold storage, and if then condemned, they must be certified on another Form as "Condemned on re-inspection."

In Australia no regulations for the sterilization of measly carcasses exist. According to Drabble (1936), pig measles has never been found in that country, and also, according to personal advice from that author (1936), "Wholesome meat is cheap and plentiful in Australia, and the public will not buy frozen measly meat."

The incidence of measles in Australia is so low, that the economic significance of destruction of the half-a-dozen, or so, measly bovine carcasses which have been found from time to time, has been negligible. It has been considered justifiable to condemn any carcass which might show a single measle.

Judgment of Measly Carcasses in Some Parts of Africa.

Madagascar:-

On the island of Madagascar, according to Poisson (1929), "a pig affected with cysticercosis, whether seriously or not, is

not to be delivered for alimentation until it has been cut up in pieces weighing about one kilogramme, and boiled for three hours; this is to avoid any danger to public health."

Northern Rhodesia:-

The Medical Officer of Health, Ndola writes (11/11/36):-
 "During 1933 efforts were made to reduce losses through cysticer-
 cosis by freezing, but it was found to be uneconomical, and since
 then all carcasses showing cysts are condemned, irrespective of
 the degree of infestation."

Tanganyika Territory:-

The following information on the degree of infestation which justifies the condemnation of measly carcasses, has been kindly supplied by Capt. H.J.Lowe, M.R.C.V.S., of the Department of Veterinary Science and Animal Husbandry, Mpwapwa (24/10/36):-
 "In more civilized countries the presence of a single cyst would be sufficient to condemn the whole carcass, but in a country such as this, where the incidence of C.bovis is high, such a procedure could not possibly be enforced. As a general rule our method is to condemn only those carcasses in which more than half-a-dozen cysts can be demonstrated in two or more sites, and in other cases the carcass is sterilized by boiling and sold as cheap meat to the natives. This is admittedly not very satisfactory in that many infected carcasses are passed for human consumption after the few demonstrable cysts have been removed, but it is thought that any improvement must await the time, when by education, the natives can be persuaded to adopt more sanitary habits in regard to the disposal of excreta and general cleanliness."

Kenya Colony.

In Kenya the standard adopted in the past has been based on that formerly applied in South Africa and in certain parts of Germany. Carcasses in which less than six viable measles can be found by the meat inspector, are passed for consumption, after removal of the infected portions of meat. Carcasses in which six or more viable measles are found are condemned, and are treated in the by-products plant at the abattoir. It is proposed to tighten up the Regulations in respect of measled carcasses in the Nairobi Municipal Abattoir in the near future, and if the proposals that have been put forward are eventually adopted, a single viable cysticercus will be sufficient to cause the condemnation of the whole carcass. (Daubney, 1936). Mr. Daubney informs me that the Medical Officer of Health (Nairobi) recently informed the Stock Owners Conference that were the standard of inspection raised so that any animal with a single viable cysticercus was condemned, the percentage of condemned cattle would be increased by 4.7 in the case of grade cattle and by 7.4 in the case of native cattle.

Union of South Africa.

In the Union of South Africa, Section 115 of the Public Health Act, No. 36 of 1919, as amended by Government Notice No. 1456 of 1933, provides for the treatment of lightly infested measly carcasses in cold storage.

Paragraph 16(2) of that Section now reads:-

"Every carcass found to be infected with bladderworm disease ("measles") shall, together with the viscera, be condemned as unfit

for human consumption and destroyed or treated and disposed of so as not to endanger health save where-

(a) during examination as aforesaid less than ten bladderworms are disclosed; and

(b) less than six cysts are found in the carcass apart from the head, tongue, pluck, stomach and intestines; and

(c) cold storage to the satisfaction and under the control or supervision of the local authority, and in which a temperature of or below minus ten degrees Centigrade is continuously maintained, is available; and

(d) the owner or his agent in charge of the carcass requests that it be placed in such cold storage, and furnishes a written undertaking to the satisfaction of the local authority to defray the cost of so doing."

Paragraph 16(3) :-

"If the conditions specified in Paragraph 16(2) hereof are complied with, but not otherwise, the carcass, after removal of all obviously diseased portions, may be placed and kept in such cold storage for at least fourteen days, and may thereafter be examined and passed as fit for human consumption."

Since no Regulations are framed to the contrary, and no exceptions are made in the existing Regulations, of swine carcasses, these can also be treated in the freezing chamber. It has already been mentioned that on account of economy, it is not customary in most South African abattoirs to freeze measly pork carcasses, and many abattoir superintendents and laymen are under the erroneous impression that the Regulations do not provide for the freezing of measly pig carcasses.

The writer was informed that at some centres, where no freezing facilities exist at the abattoir, the local authorities, by arrangement, permit the freezing of measly carcasses in the chambers on premises of commercial firms. I know of at least one case, in which a measly ox carcass was sent from one of the smaller rural centres to a Bloemfontein commercial house for the required freezing. The carcass was then, certainly not under the supervision of the local authority concerned, nor could that particular local authority be satisfied that proper freezing at -10°C was continuously being carried out for 14 days. Such dealings are quite illegal, because Regulations expressly read that cold storage to the satisfaction and under the control or supervision of the local authority, etc. must be available. Cold stores on the premises of privately-owned commercial houses cannot be controlled or satisfactorily supervised by a local authority, and particularly so if that cold store is actually situated in another town, some two hundred miles away! It might be wise if the responsible Government inspectors could investigate such malpractices and satisfy themselves that abattoirs which do not possess freezing chambers do not permit the treatment of their measly carcasses in chambers quite out of their control.

Various amendments to this paragraph caused the time specified for freezing of measly carcasses to be reduced from 84 days to eventually 14 days. This reduction of the specified time resulted from reports on various viability tests with measly carcasses which had been performed in Europe.

B.

DESTRUCTION OF CYSTICERCI IN MEAT :-
 VARIOUS METHODS OF TESTING VIABILITY OF CYSTICERCI.

Cysticercus cellulosae and Cysticercus bovis in meat can be destroyed, and the meat rendered suitable for human consumption by any of the following agencies, without seriously damaging the food value of the meat:-

1. By heat up to certain temperatures.
2. By pickling in certain strengths of salt solution.
3. By cold storage at certain temperatures for specific, continuous periods of time.

Other agencies, e.g. electric rays may also be mentioned, but some writers (Clarenburg, 1932, and others) have had little or no success with them.

Before discussing the various methods of destroying cysticerci, it will be necessary to consider the various tests which have been employed for the viability of cysticerci. Such tests have been used with a view to proving whether or not cysticerci in meat, which has been subjected to any of the above methods of rendering it fit for human consumption, have actually been destroyed in the process, or, as von Ostertag at various times, Glietenberg (1931) and others have suggested, have been rendered innocuous, although not necessarily killed.

The reactions of cysticerci to external conditions, or to the influence of chemical, physical and physiological agencies, have

have been taken as criteria of the viability of the cysticerci.

Mönnig (1928) very conveniently classified the agencies which caused phenomena which were accepted by the various workers up to that time as criteria of the capability of development of cysticerci.

Mönnig's classification can, therefore, be followed to a great extent, with the additional details of some experiments by previous and subsequent workers.

1. Reaction to Warming.

"This," Mönnig mentions, "was the first criterion employed, and, in combination with other methods (warming in media), is still the most important, according to many authors. Perroncito (1877), Ostertag (1897), Ransom (1914), Porter (1923) and others employed this method."

Ransom (1914), according to Mönnig, states that if the heads show no movement in the retracted state, they should carefully be evaginated by pressure, after which they will sometimes still show movement.

Perroncito (1876) isolated Cysticerci cellulosa from pork and placed them on a Schulze's warm stage. At low temperatures (16°C. to 20°C.) the bladderworms remained inert, but when the temperatures passed 30°C. to 35°C., fairly lively movements of the scolices and particularly of the suckers were observed. The movements became even more intense as a temperature of 42°C. to 46°C. was reached, and gradually ceased after that temperature, until at about 48°C., they stopped altogether. In 1877 Perroncito observed

that a temperature of 45°C. was sufficient to kill C. bovis. He based his criterion on his observations that at that temperature the cysticerci had a cloudy appearance, no motility was noticed when they were examined microscopically, and infection experiments on humans gave negative results.

Von Ostertag (1913), in describing his experiments of 1897, states that he found warming cysticerci on a stage the most convenient method. "Living cysticerci, when heated to a temperature of 30 to 40°C., exhibit under the microscope active movements of the rostellum, sucking discs and other parts of the head and neck, while dead cysticerci remain motionless. This thermo-microscopic investigation may be undertaken conveniently in the Nuttall microscope thermostat, or in the simpler and cheaper warming apparatus for microscopic investigation devised by Kabitz and Rissling."

Porter (1923) did not accept motility of cysticerci when warmed to certain temperatures, as any guide to viability. She found that while some living cysticerci certainly did show motile powers on gradual warming of the stage, she also found that some cysticerci which were definitely dead, showed the same movements. Porter mentioned that some isolated cysts which she had kept in boiling water for an hour, showed motility after cooling and subsequent re-heating on a warm stage. She also found the same type of movement on warm stages with certain materials (whether these had been frozen or not), such as indiarubber, parchment, pig's bladder, silk, catgut and chamois leather. To sum up, she did not consider that any test of viability based on the movement of isolated cysticerci on exposure to heat could be regarded as a reliable criterion

of the viability or otherwise of cysticerci in a joint or carcass that had been exposed to freezing.

2. Appearance and Physical Condition.

Mönnig (1928) quotes Ostertag, Killisch, Brohmann, Glage, Reissmann and others, who observed changes in the appearance and physical condition of cysticerci, at death.

Von Ostertag (1913) quotes Hertwig, who found in cysticerci which had been exposed to a temperature of 65°C., and was thus killed, that the scolex, which in a living condition was unusually resistant to pressure, was so soft that it could be compressed between two glass slides, like beef tallow. "This alteration must be considered as an excellent criterion of the accomplished destruction of cysticerci by boiling. By means of the above demonstration, Hertwig simultaneously disproved the widespread erroneous view that cysticerci which had been killed by boiling or roasting could be detected in eating the meat, by a crackling sound between the teeth."

Killisch (1923) and Brohmann (1924) stated that the vesicles of live cysticerci are glistening and pale white, offering a certain amount of resistance on pressure, while in dead specimens they are turbid and easily burst.

"In live cysticerci, the scolex can be fairly easily extruded on pressure between the fingers, and appears to 'swing out' of the bladder; in dead cysticerci, the scolex is sticky, drawing threads and is not easily extruded, but frequently breaks, while a

whitish turbid fluid exudes from it." (Mönnig, 1928).

Annie Porter (1923) made direct observations on the physical condition of fresh cysticerci both macroscopically and microscopically, and carefully compared the results with those observed in cysticerci from carcasses slaughtered at different times, and which had undergone various periods of freezing. She noted:-

- (i) In the normal fresh cysticerci of T. solium and T. saginata, that they glistened in appearance, were whitish to pinkish in hue, firm to the touch, not easily ruptured. The fluid within the fresh, normal bladder was practically colourless, clear and contained very few cellular elements.
- (ii) After three weeks' freezing of a large hind-quarter of beef, its superficial cysts might be slightly less firm than fresh cysts, but deep-seated cysts, on thawing, were practically as tense as fresh cysts.
- (iii) After four weeks' freezing, and then gradual thawing, the superficial cysts showed slight change in the colour of the fluid in the bladders, though the change was rarely more than a very pale straw colour. Deep-seated cysts, or cysts well protected by fat rarely showed such change.
- (iv) After six weeks' freezing, followed by gradual thawing, some of the more superficial cysts might show a pinkish tint, unlike that of the fresh bladders, as if some haemolysis had occurred within them. This was really some indication of change of physical condition; the wall of the cysticercus had become more porous. In Porter's opinion this was not necessarily indicative of the death of the cysticercus.

(v) After eight weeks' freezing, the cysticerci, when thawed, showed more marked colour changes. The superficial ones were brownish red, the deeper ones near bone were pinkish, and the deepest cysticerci or those well protected by layers of fat, still showed little change.

Porter found that cloudiness of the contents of the bladder was not necessarily a feature in dead specimens.

She also found that freezing up to three months seemed to make little difference to the morphology of the cysticerci. In the majority of cases the suckers of the worm retained their distinctness, the hooks of Cysticercus cellulosae or of Echinococci remained in situ and showed no tendency to separate, and the calcareous bodies showed no obvious signs of degenerative effects. Porter did not notice the dissociation of the calcareous corpuscles in frozen cysticerci, as was observed by Reissmann (1897).

Killisch (1923) also placed no value upon the casting of the hooks as a criterion of viability of cysticerci. He found that frequently the hooks of Cysticerci cellulosae, which might still be alive, although possibly damaged by cold, might be cast or loosened.

Schmey and Bugge (1931) used the demonstration of the excretory "flame" cells as a criterion of viability. Active "flame" cells were demonstrated by them up till 39 days after slaughtering.

3. Warming in Saline and Bile Mixtures.

A method of testing the viability of cysticerci by immersion in warm fluid media was first used by Perroncito (1877), von Ostertag (1897) and Glagé (1896).

These workers placed fresh, living cysticerci in water, which was warmed up to 37°C., or a maximum of 40°C. Von Ostertag noticed that a living cysticercus in this simple medium evaginated the scolex, which frequently showed lively movements.

An improvement on the earlier methods of Perroncito, Glagè and von Ostertag was effected by Franke (1914), who added various quantities of bile to the water, so as to cause the conditions to be more like those normally in the human intestine, in which the cysticercus had to evaginate and develop. Franke also found that active evagination of the scolices of cysticerci occurred in physiological saline solution, to which a few drops of ox or pig bile had been added, and which had been heated to a temperature of plus-minus 38°C.

A still bigger improvement on the Franke method was effected by Wagner (1922). He found that the most effective evagination of scolices occurred in concentrated bile solutions - 50% concentrations, or stronger, at temperatures of 41°C. to 42°C. Wagner also recommended the use of only ox bile for Cysticercus bovis tests, and pig bile for Cysticercus cellulosae. These could be warmed on Nuttall's microscope thermostat at 37°C., gradually increasing the temperatures to 41°C.

"Müller (1923) performed his tests with C. tenuicollis and found the most successful results by using 2 to 4% bile solution at 38°C. Killisch (1923) found ready evagination of scolices of C. cellulosae in 0.75% solutions of pig bile in saline. Movements could be readily seen of the evaginated scolices, when warmed from 30°C. to 49°C. and examined on Nuttall's microscope thermostat. Rhythmic movements of the head to the right and the left were visible to the naked eye, and

expansion and contraction of the suckers were plainly visible.

Glietenberg (1930) used pure pig bile, undiluted, and claimed very good results.

Sachs (1931) described the following method of testing the viability of Cysticercus bovis by evagination tests:

- a. The measle is carefully removed from its connective tissue capsule.
- b. The liberated measle is then placed in a shallow watch glass in fresh ox bile. (No pig bile nor physiological saline solution is used.)
- c. If an incubator is not available, the watch glass is floated on the surface of water heated to 40°C. - 42°C., and the water bath is covered with a lid, if better results are to be expected.
- d. After 1 to 3 minutes the scolex is evaginated and under the microscope lively movements may be observed.

Clarenburg (1932) obtained the best results in 5% bile solution, and he found the optimal temperature to be 40°C. He gave the following table in respect of measles taken from veal which had been preserved for 38 days in a cooler. (Probably his results may have been even more conclusive if he had used fresh measles for this particular test for the best strength of bile solution.)

Out of 10	<u>cysticerci</u>	in 100%	bile,	after 1 hour,	1 completely evaginated.
" "	" "	" 50%	" "	" 1	completely & 2 partly "
" "	" "	" 25%	" "	" 1	" & 5 " "
" "	" "	" 5%	" "	" 4	" & 3 " "
" "	" "	" 1%	" "	" 1	" & 0 " "

Clarenburg, like Diemont (1923), found that the most rapid evagination of scolices occurred when the bile solution and the glass receptacle were first heated to 40°C. before the cysticerci were placed in them,

and the test commenced. He also found that young cysticerci evaginated more rapidly (after about 10 minutes), than older cysticerci, which sometimes took about eight hours to evaginate.

Malkani (1933) used fresh Cysticerci bovis for his tests. After having removed their outer connective tissue capsules, each cyst was placed in a petri-dish containing bile diluted with distilled water. Some petri-dishes were kept at room temperatures, while others were kept at an incubator temperature of 37°C. No change was visible in the cysts kept at ordinary room temperatures. In the case of those kept at incubator temperatures, peristaltic movements were seen, during which the alternate "protrusion and retraction of the extremity bearing the scolex was very striking." Evagination of the scolex occurred within 20 hours.

Instead of using bile, various bile salts have been employed by some authors. Amongst the bile salts which have been used have been sodium glycocholate, sodium taurocholate, sodium palmitate and sodium stearate. Clarenburg obtained very little success in evaginating scolices in sodium palmitate and sodium stearate. He found that sodium taurocholate gave better results than the glycocholate, and the optimal temperature was 40°C. A 1% solution of sodium taurocholate had almost the same successful results as a 1% bile solution. He did not obtain better results by using stronger solutions (3.5% and 10% solutions.) Clarenburg, therefore, maintained that a 5% bile-saline solution was the best medium for artificial evaginations of scolices.

Using sodium taurocholate solution, Malkani, on the other hand, obtained his best evaginations of scolices of C. bovis. By using a 1% aqueous solution of sodium taurocholate at room temperatures, no movements or evaginations occurred, but at 37°C. incubator temperature, somewhat

sluggish movements resulted and evagination of the scolices in 18 hours. By using a 5% aqueous solution of sodium taurocholate, very active movements resulted in a very short time in the incubator. Evagination of scolices occurred in 20 minutes to 2 hours.

By using 1% and 5% aqueous solutions of sodium glycocholate, Malkani obtained rather less successful results. In these solutions cysts usually contracted somewhat and assumed a globular appearance, usually showed no movement, and evagination occurred usually more than 20 hours after.

Clarenburg also did evagination tests in various digestive juices. He found that evaginations did not take place readily in choline and acetochole solutions, nor in pepsin in various concentrations in 0.2% hydrochloric acid. He, however, found good results in the use of pancreatic extract, trypsinogen and pancreatin.

4. Staining Reactions.

These were sometimes used by earlier authors (Reissmann, who showed that dead cysticerci took aniline stains, whereas living cysticerci did not), but later workers (Killisch, Brohmann) did not consider them as sure criteria, except Porter, who based almost her entire criteria on the reactions she obtained to various stains. Monnig, in reviewing Porter's work states:- "It must be noted here that the 'dead' cysticerci, used for comparison in Porter's tests were boiled and, since Porter's conclusions are based chiefly on staining reactions, all other tests being regarded as unsatisfactory or indefinite, the conclusions arrived at on this basis must be read in this light, since dead tissues cannot be expected to stain like boiled tissues without further proof, and if they do not, they can likewise not be considered to be still alive."

Porter found that Delafield's haematoxylin and an acidulated solution of aqueous methyl green, particularly the latter, proved most effective. She found, for example, with methyl green solution, that dead cysts, namely those boiled for three hours, stained a deep green in the heads; cysts frozen for 22 days showed very faint green heads; cysts from a freshly killed animal remained unstained. She found that some cysts from carcasses frozen for 77 days stained very feebly, denoting, as she concluded, slight signs of life. Similarly faint stains were noticed in C. cellulosa from a pig frozen for 41 days.

5. Infectivity Tests.

These give the only conclusive proof of vitality of cysticerci. Several writers, and in particular von Ostertag, have attempted to show that although cysticerci might be weakened owing to external influences, their power of infection to human beings has been considerably reduced.

Actual infection tests on human subjects were performed by Perroncito (1877), Zschokke (1896), von Ostertag (1897), Ransom (1914), Porter (1923), Schmey and Bugge (1930).

That infection of the human subject with Taenia saginata and even more so with Taenia solium was not without serious risk to the subject, was appreciated by several writers. Schmey and Bugge (1931) were criticised by various persons, who averred that their claim that 21 days', or even 40 days' chilling of beef was not sufficient to kill the contained measles or render them innocuous, was based on criteria obtained by artificial means, and not by actual infection tests on their own persons. They, therefore, performed infection tests on six persons, of whom three

developed six Taeniae saginatae. In the article in Tierarzt. Rundsch. 1931 pg. 719, in which they describe their experiments, Schney and Bugge stress the danger of actual infection tests on humans. They had, therefore, intended doing such infection tests with C. tenuicollis and C. pisiformis on dogs. In order to silence all criticism of their work, they undertook the infection tests, and remarked:- "It is easy enough to utter criticism, but we wish our critics would undergo a tapeworm infection along with us, then they will change their tune."

I would not suggest that fear of infection prompted most workers between the end of last century, when von Ostertag and Zschokke performed their infection tests and quite recently, to discard actual infection tests. Franke's bile-saline method, with the subsequent improvements effected by Müller, Wagner, etc. was considered a good criterion, since conditions approached those of natural infection. Nevertheless, a certain amount of doubt must have existed as to the correctness and certainty of results obtained by those methods.

We are, therefore, indebted to Iwanizky (1932), who devised a method which very nearly reached the identical to natural infection, without endangering the health of the subject on whom the test was to be applied. Iwanizky pointed out the fact that the methods employed up till 1932, to test the viability of health-damaging cysticerci did not come up to requirements. He, rightly, maintained that the only sure method of testing the viability of measles was by means of "infection tests" on the human subject. According to Iwanizky, even the apparently most

effective method hitherto employed, namely that of Franke, had its defects, eg. the use of pig bile instead of human bile; the use of artificially produced temperatures, instead of natural human body heat; the artificial isolation of the measles out of their capsules, and the absence of the influences of the human digestive juices.

Iwanizky, according to Keller (1935) wrote:- "Even if it were possible to put aside all the defects in Franke's method, by using human bile instead of swine bile, and that first the measles could be subjected to the influence of the human stomach juices, which in practice is not as easy as it seems, the controlled results of the viability of the measles (by using such a modified method of Franke) would depend upon quite a number of circumstances, for example, on the power of assimilation of the gastric juices, on the intensity of the influence of these on the measles, on the temperature, etc."

Iwanizky also pointed out the undesirability of self-infection tests, such as were performed on themselves and their assistants by von Ostertag, Schmey and Bugge, etc.

Actual human infection precludes the quick results sometimes necessary, since it takes a considerable time before the subject may be satisfied that he has, or has not, contracted tapeworm infection, and before he may observe segments in his stools. It has also been suggested that a measure of immunity in a subject to tapeworm infection may exist, which would negative infection tests; then again, it may be necessary for a subject to be repeatedly infected, which would lead to confusion in the results obtained, apart from the unpleasant discomfort which

the subject would experience.

These were among the factors which Iwanizky considered, when he devised a new and relatively safe method of testing the viability of cysticerci. He removed the measles out of the muscles and sewed them into small silk bags. According to Keller, it is clear that Iwanizky did not remove the measles from their connective tissue capsules. The silk sacs were smeared with butter, placed on the back of the tongue and swallowed. Some 20 to 24 hours later, the subject recovered the silk bags in his stools, and the contents of the bags were then examined to see whether digestion and absorption, in the case of dead measles, or whether evaginated and developing scolices, in the case of viable measles, had resulted. According to Iwanizky, the caudal vesicles were digested by the digestive juices of the subject, after evagination of the scolices therefrom, and the liberated scolices could be accepted as a definite criterion of viability of the future tapeworm.

Keller devised a still further improvement on Iwanizky's method, which he described in 1935. He realized that scolices evaginated or liberated from their caudal vesicles in the small intestine could be squashed inside the silk bag when passing through the large intestine. Keller explained that in the large intestine a coagulation of the contents of the intestine takes place, and the walls of the silk bags could thus be squeezed together, with resultant damage to their contents. Keller's modification consisted of placing the measles to be tested into small celluloid tubes, 10 mm. long, with an outside diameter of

7 mm. and a wall thickness of 0.5 mm.. "These tubes are sewn into a stretched silk bag, so that the two open ends are covered by an even layer of silk." The interior of the celluloid tubes can be penetrated, through the taut ends of the silk covers, by the digestive juices from two sides, and the measles are "protected from outward pressure, as it were, in a small cage."

Another advantage mentioned by Keller is the fact that the smooth tube and the tautly drawn (drumlike) silk ends of the tubes show no pleats, as often happens in using silk bags. He found, also, that the best results were obtained after he had carefully removed the cysticerci from their connective tissue capsules. According to Keller, liberation of the scolices by this method, which precludes any outside interference with the measles, must be accepted as the most satisfactory criterion of viability of measles, and he considered it quite unnecessary to do control or contemporary experiments in gall. As an absolute test of the effectiveness of his method, Keller used for one experiment, only absolutely fresh measles (from a newly-slaughtered animal). He pointed out that by his method, out of 13 measles swallowed, 10 evaginated their scolices undigested, whereas by using Iwanitzky's method, out of 12 measles swallowed, 6 were digested. (Probably as the result of destruction in the intestine).

Having considered the various methods which have been employed to test the viability of cysticerci, and the phenomena which have been taken as criteria that such cysticerci were actually dead, or else rendered innocuous, or thirdly were still capable of development, we may now continue with the discussion of

the agencies which have been found to be destructive to cysticerci.

1. The Effect of Heat on Cysticerci.

Most of the early workers realized that heat, at certain temperatures, will with certainty cause the death of cysticerci in meat.

The most thorough investigations regarding the power of resistance to heat, of the bladderworms of the pig, are due to Perroncito, 1872. (Leuckart.).

Perroncito was at first inclined to the opinion that it required a temperature of at least 125°C. to render the bladderworms harmless, but he was afterwards enabled, by means of a more conclusive test, to establish that the measles are certainly killed when the temperature of the surrounding fluid reaches 50°C, or even below that, and when the cysticerci remain in it longer than a minute. One of Perroncito's assistants swallowed several C. cellulosae which had been heated to 50°C., and remained free from tapeworm infection.

Pellizari and also Lewis and Cobbold opposed Perroncito's views and fixed the lethal temperature of C. cellulosae at 60°C. The effect of thoroughly cooking measly pork was observed by Pellizari, who showed that in Florence the inhabitants were immune to Taenia solium, because pork was never eaten half raw like beef, by them, and from eating the latter they frequently developed Taenia saginata. Marchi, according to Leuckart, 1886

and von Ostertag, 1913, only found a single T. solium in a certain time in Florence, out of thirty-five taeniae examined by him, although during that time no fewer than 13,000 measly swine had been consumed in Florence.

Neumann (1892) pointed out the practical difficulty in knowing under what conditions the centre of a piece of flesh (pork) would reach the temperature destructive to the measles. In cooking large pieces of meat, Küchenmeister had noticed that after half-an-hour, when the external temperature was $60^{\circ}\text{C}.$, the temperature of the interior had reached $55^{\circ}\text{C}.$; in about three-quarters of an hour, the exterior temperature was $77-80^{\circ}\text{C}.$, and that of the interior $63^{\circ}\text{C}.$ Pellizari, testing measly pork, put two pieces weighing 600 grammes and 10 cm. thick, in boiling water - one piece for five minutes, the other for half-an-hour. When removed, the temperature of the former was $45.5^{\circ}\text{C}.$ in the centre, and that of the latter $81^{\circ}\text{C}.$. Taking into account the loss of heat by radiation, these two temperatures may be estimated at $51^{\circ}\text{C}.$ and $83^{\circ}\text{C}.$ (Neumann). For roasted pork, Vallin (Neumann) has found that while its external temperature necessarily exceeds $100^{\circ}\text{C}.$, beneath this superficial zone it is "touched" by cooking; a zone beneath this again oscillates between $52^{\circ}\text{C}.$ and $53^{\circ}\text{C}.$, but in the centre it does not exceed $46^{\circ}\text{C}.$ to $48^{\circ}\text{C}.$

With reference to C. bovis, Perroncito (1877) observed that a temperature of $45^{\circ}\text{C}.$ was sufficient to kill the measles. Perroncito found that C. bovis was sometimes destroyed at $44^{\circ}\text{C}.$, often at $45^{\circ}\text{C}.$ to $46^{\circ}\text{C}.$, and between $47^{\circ}\text{C}.$ and $48^{\circ}\text{C}.$ it was always destroyed. Three of his assistants voluntarily swallowed

a C. bovis each - one measle had been heated to 47°C., and gave no signs of life; another had shown no motility at 45°C.; the third was heated to 44°C. and had shown slight motile powers. In none of the three tests did a tapeworm develop.

Clarenburg (1932) found that C. bovis were killed within 15 minutes after immersion in boiling water.

2. The Effect of Pickling on Cysticerci.

Perroncito was among the first investigators who tested the possibility of destroying cysticerci in meat by pickling in brine. He used brine composed of 2½ parts saltpetre, 20 parts of cane sugar, 250 parts common salt, 1000 parts water. He found that cysticerci contained in measly beef and pork were killed in fourteen days, provided the meat was no thicker than 6 cm., or when the brine was injected into the meat by means of a syringe.

Von Ostertag (1913), in referring to his early investigations, described a process of demonstrating the completion of successful pickling of meat. He employed a 1 per-cent. solution of silver nitrate, which produced no striking change on the cut surfaces of fresh muscle meat, but, on the cut surfaces of completely pickled meat, a temporary milky cloudiness was produced (chloride of silver). Glage found that a 2% aqueous solution of silver nitrate was even more effective in this test.

Schmey and Bugge (1931) found that by using a brine-pump the time required for pickling measly meat could safely be reduced from 21 days to 7 days. They mentioned that fat was slower in the pickling process than fleshy meat.

Clarenburg (1932) noticed that C. bovis was killed in 5

days in solutions of 20% to 25% brine.

3. The Effect of Prolonged Preservation in Cold Storage on Cysticerci.

Perroncito (1877) believed that cysticerci would only survive for a limited time after the death of the host. In an experimental calf he found that measles were dead 14 days after the slaughter of the animal. Von Ostertag (1897) found that this was not so in all cases, and that death of the cysticerci did not necessarily follow within such a short period, but that by preserving beef in a cooler for three weeks, the cysticerci contained therein would be rendered innocuous. Von Ostertag performed various infection tests on human beings, with Cysticerci bovis, which had been preserved for periods varying between 16 days and 21 days. His tests resulted as follows:-

1	person	ate	2	measles	16	days	after	slaughter	of	animal	and	got	0	taeniae.
1	"	"	1	"	19	"	"	"	"	"	"	"	"	"
9	"	"	52	"	20	"	"	"	"	"	"	"	"	"
31	"	"	166	"	21	"	"	"	"	"	"	"	"	"
4	"	"	15	"	14-19"	"	"	"	"	"	"	"	"	10 "

After 21 days' preservation of the meat, in another test, he again failed to infect a man with tapeworm.

Glagé (1896) found that 15 days' preservation of beef was not sufficient to kill the measles. He swallowed three measles from such beef, and developed two tapeworms.

Zschokke (1896) infected himself with one tapeworm after having swallowed five C. bovis which had been preserved for 16 days in meat, after slaughter of the host. He repeated the test with five measles from a bovine carcass which had been preserved for 21 days, and failed to infect himself.

Kabitz, according to Clarenburg (1932), developed three tapeworms from three measles out of beef preserved for 15 days.

Von Ostertag (1897), and indeed until about 1930, maintained that the preservation of measly beef for 21 days was quite safe from a public health point of view, since no infection resulted from such measles, although certain movements could still be noticed under observation in Nuttall's microscope thermostat. When Müller and Wagner in 1922-23, and van Santen in 1928 disproved von Ostertag's claim that measles could not survive the death of the host by 21 days, he then steadfastly maintained that although those workers, by means of Franke's test, had caused evagination of scolices of such measles, he was not satisfied that those measles were still capable of developing into tapeworms, although the tests of his opponents might have shown that they were not dead. Von Ostertag thus discriminated between "measles killed, or dead" and "measles not actually killed, but weakened and thus rendered incapable of developing". This was considered and proved to be a very risky view, by Schmey and Bugge and by other subsequent workers.

Monnig (1928) gives the following table showing the proportion of measles which still showed movements in von Ostertag's tests of 1897, with the number of days after slaughter of the host:-

Days after slaughter	Proportion showing movement
14	23/41
15	8/12
17	3/10
18	6/12
19	12/29
20	13/68
21	8/71
22	2/10
23	2/9
24	2/16
25	0/16.

After 18 days' cooling, von Ostertag noticed only very slight neck movements, and on the 19th day the vesicle fluid was opaque; on the 20th day

the heads became opaque. Von Ostertag then advanced further confirmatory evidence by performing digestion tests with hydrochloric acid - pepsin and incubation at 37°C. He found that eleven cysts which had been preserved in meat for 20 days, and had shown slight neck movements on warming, were completely digested within an hour.

As the result of these tests von Ostertag maintained that the rendering of measly beef harmless by preservation in cold storage (at temperatures just above freezing), was the most rational method, since the meat thereby underwent the least depreciation in value, suffered only a minimum loss of weight and found a ready sale as raw meat. The same treatment was not applicable to C. cellulosa, since von Ostertag found them alive 42 days after slaughter of pig carcasses.

Franke (1914) found that after 16 days' cooling half the measles tested, evaginated the scolices, but none after 20 days' cooling.

Wagner (1922) was probably the first worker to doubt the reliability of von Ostertag's views. He found that after 24 to 26 days' preservation of beef, the measles still showed movement, and evagination of scolices still occurred in concentrated bile solutions (50% bile solutions, or even stronger.).

The danger of reliance on the opinion that 3 weeks' cooling of meat would be destructive to C. bovis, or otherwise render them innocuous, was further pointed out by van Santen (1928). This worker found that C. bovis was definitely not destroyed by three weeks' preservation of the meat, and, indeed, he found that after 37 days' cooling three out of 16 measles were capable of evaginating their scolices. Van Santen employed Franke's tests (1914), viz., warming in bile solution to 37°C. He supplied the following table as indicative of his results:-

After 19 days' cooling,	out of 16 tested	measles,	9 living.
" 20	"	"	"
" 21	"	"	"
" 22	"	"	"
" 23	"	"	"
" 24	"	"	"
" 25	"	"	"
" 26	"	"	"
" 27	"	"	"
" 28	"	"	"
" 29	"	"	"
" 30	"	"	"
" 31	"	"	"
" 33	"	"	"
" 35	"	"	"
" 36	"	"	"
" 37	"	"	"
" 38	"	"	"
" 40	"	"	"
" 41	"	"	"

Van Santen thus found that 70% of measles were still living after 21 days' cooling. He also observed lively movements of the heads of some of the evaginated scolices of measles which had been chilled for 33 days. Van Santen found that measles in pieces of meat of 3 Kgm. were destroyed in three weeks, when preserved in 20% brine. He strongly advocated extending the period of chilling of measly meat to at least 40 days.

DeVries (1930) found that in his tests 17% of the measles were still capable of evaginating their scolices after 21 days' cooling.

Clarenburg (1932) described various evagination tests with measles obtained from a very heavily infested calf, which had been artificially infected. His tests were performed early in 1931. He kept his chilling room temperatures at $\frac{1}{2}^{\circ}\text{C}$. to 1°C ., that is, just above freezing. Clarenburg found that after 3 weeks' cooling at those temperatures, putrefaction had set in, in the superficial musculature. This putrefaction had no apparent effect on the vitality of the cysticerci, and "even in putrefied meat very viable measles were noticeable." After 41 days' chilling he found that 12 scolices evaginated in bile solution.

Schmey and Bugge (Berl. Tier. Woch., , 1931), under the aegis of the German Ministry of Agriculture, did various tests and found that after 28 days' cooling Cysticerci bovis were still quite capable of development, and after 39-42 days definite signs of viability were noticeable, e.g. evagination of scolices, movement of the terminal organs and demonstration of "flame" cells. They, therefore, pointed out that chilling measly meat was positively dangerous, and recommended that the period be increased to at least 28 days.

In order to render the atmosphere in cooling chambers intended for prolonged chilling of measly carcasses "germ free", May (1931) recommended the modern katadynsterilisator, which could be prepared by painting or coating the air channels of the cooling chamber with a prepared silver solution.

In causing confirmatory tests to be applied in the United States, Mohler (1933) found that C. bovis was still viable after 21 days' cooling. He found that some C. bovis were alive in meat after ²26 days' cooling, but none was alive after 31 days' cooling.

Zunker (1935) had four negative results with infectivity tests with measles taken from bovine carcasses which had been chilled for 28 days, but he was not convinced that the capability of infection was lost in measles from beef chilled for that period.

Judging from the foregoing review of recent literature on the subject, it will be concluded that the chilling of measly bovine carcasses is not safe, from the public health point of view. In the light of our present knowledge, freezing of measly carcasses would appear to be the most effective method of rendering the meat safe for human consumption, and one would go so far as to say the least damaging to meat.