9-1914

The Destruction of the Vitality of *Cysticercus bovis* by Freezing

Brayton H. Ransom
Bureau of Animal Industry, United States Department of Agriculture

The Journal of Parasitology

Volume 1 SEPTEMBER, 1914 Number 1

THE DESTRUCTION OF THE VITALITY OF CYSTICERCUS BOVIS BY FREEZING

B. H. RANSOM

Bureau of Animal Industry, U. S. Department of Agriculture.

The question as to the length of time *Cysticercus bovis* may survive after the death of its host has been quite definitely settled by the researches of Perroncito, Zschocke, Ostertag and others. Perroncito (1877) found that the cysticerci in an artificially infested calf were all dead fourteen days after the slaughter of the animal. However, Zschocke (1896) succeeded in infesting the human subject with a tapeworm by feeding five cysticerci from beef kept from fourteen to sixteen days after slaughter. No infestation followed the swallowing of five cysticerci from beef kept twenty-one days after slaughter. Ostertag (1897) examined in a thermostat a large number of cysticerci from beef kept in cold storage at temperatures above freezing for various periods of time after slaughter and concluded that the parasites are no longer capable of development on the twentieth day, although slight movements were observed in a few cysticerci as late as twenty-four days after slaughter. These results were confirmed by feeding experiments in which thirty-four persons swallowed cysticerci from beef held in cold storage at temperatures above freezing for from twenty to twenty-one days after slaughter. No tapeworm infestation resulted in any case.

The conclusions from these investigations are that a lapse of twenty-one days after slaughter is amply sufficient to insure the death of the beef cysticercus, and on the other hand that fourteen days is not sufficient, although in some cases, as determined by Perroncito in one instance, the parasites may have lost their vitality within this shorter period of time. Cognizance has been taken of these results in the meat-inspection regulations of Germany, United States and other countries, which provide that beef carcasses showing infestation with cysticerci in a certain slight degree may be passed for food after retention in cold storage for twenty-one days.

The question of the period of time *Cysticercus bovis* may survive after the death of its host having been settled, the next question which arises is whether this period may be shortened by artificial means. The means which naturally suggests itself as the least objectionable in its effects on meat and the most practicable of application is exposure to low temperatures. Reissmann (1897) has reported that beef cysticerci inserted into the depths of large pieces of meat which were then kept at temperatures of from — 8 to — 10 C. (17.6 to 14 F.) do not survive when thus exposed for three days. *Cysticercus cellulosae* appeared to be somewhat more resistant and required four days exposure before its vitality was destroyed. Prior to Reissmann, Glage (1896) noted that in the case of a measly pork ham (11 kg. in weight) which was exposed to a low temperature and solidly frozen, most of the cysticerci were still alive after two days of such exposure. As a result of several experiments Boccalari (1903) concluded that *Cysticercus bovis* and *C. cellulosae* die in four days at a temperature of from — 4 to — 6 C. (24.8 to 21.2 F.) and in six days at a temperature of from 0 to — 2 C. (32 to 28.4 F.).

Recent experiments by the writer on *Cysticercus bovis* have led to somewhat different results than those obtained by Reissmann and Boccalari, and in fact have shown that the exposure of measly beef to temperatures as low as 15 F. for four days is not sufficient to insure a complete destruction of the vitality of the cysticerci. In these experiments two beef carcasses, heavily infested with live cysticerci, were used. The carcasses were allowed to hang for about twenty-four hours after slaughter in a chill-room, the temperature of which was somewhat higher than the freezing-point. They were then quartered and placed in a cold-storage compartment (freezer), in which the temperature varied during the experiments between 11 and 15 F.; most of the time between 14 and 15. The temperature of the freezer was taken at four-hour intervals. The thermometer used was checked with a thermometer recently standardized by the Bureau of Standards. In the case of one of the carcasses, a quarter was retained in the chill-room, in order that check observations might be made on unfrozen cysticerci. Examination of one of the quarters of beef was made two days after it had been placed in the freezer, at which time it was found that the deeper portions of the meat had not yet become solidly frozen. All of the beef kept in the freezer longer than two days was found to be solidly frozen throughout.

Portions of one of the carcasses were removed from the freezer after a lapse of two, three and six days, respectively, allowed to thaw, and eighteen to twenty-four hours after removal dissected. The cysticerci were isolated, removed from their cysts and examined on a

warm stage kept at a temperature of 40 to 45 C. Careful observations were made to detect signs of life. If the parasite did not move and showed no response to stimulation with a needle-point it was considered dead. The heads of those cysticerci which showed no movement in the retracted condition were evaginated by pressure and carefully observed, as it was found that in such cases the head and neck sometimes still showed feeble movements, not perceptible in the retracted cysticercus.

Lack of opportunity prevented a prompt and careful examination of thirty-six cysticerci removed from the beef kept two days in the freezer, but it was observed that one of them showed definite signs of life. These cysticerci were taken from the superficial frozen portions of the meat.

Sixteen cysticerci from the beef kept three days in the freezer were examined and seven, or 44 per cent., were found to be alive.

Sixty-three cysticerci from the beef kept six days in the freezer were examined and none was found alive. Six others were removed from the same meat with special precautions to prevent possible injury. The cysts were left intact, together with a small amount of surrounding muscular tissue. These six cysticerci were swallowed by a human subject (the writer). Eighteen weeks (Sept. 23, 1913, to Jan. 29, 1914) have elapsed and no signs of tapeworm infestation have yet appeared.

Meat from the other carcass was removed from the freezer after a lapse of four, five and six days, respectively, and allowed to thaw, after which the cysticerci were isolated and examined as in the case of the first carcass.

Forty per cent. of the cysticerci from the beef kept four days in the freezer proved to be alive; that is, ten out of twenty-five examined.

Only one out of twenty-one cysticerci, or 5 per cent., was still alive in the beef kept in the freezer for five days, and this one showed such faint signs of life that it probably would have been incapable of development in the human host.

Thirty cysticerci were examined from the beef kept six days in the freezer and none showed any evidence of being alive. Five others, intact in their cysts and surrounded by small portions of muscular tissue, were swallowed by a human subject (the writer). An examination was made of twelve cysticerci from the portion of the same carcass, which had been kept since slaughter, eight days in all in an unfrozen condition, and all were found to be alive and active. Fifteen weeks (Oct. 16, 1913, to Jan. 29, 1914) have elapsed since the five cysticerci above referred to were swallowed and no evidence of tapeworm infestation has yet appeared.

From these experiments it may be concluded that if measly beef carcasses are exposed for six days to a temperature not exceeding 15 F. (—9.44 C.) the vitality of the cysticerci will be destroyed, that some may survive in carcasses exposed for five days to this temperature, though it is doubtful whether they will retain sufficient vitality to develop in the human host, and finally that a considerable proportion may survive in carcasses exposed to a temperature of 15 F. for four days or less. Though it is possible that the vitality of the cysticerci, which were observed to be alive after exposure of the infested beef to a temperature of 15 F. for four days, had been so seriously affected that they would have been incapable of producing tapeworm infestation, the fact that they were alive and active justifies the adoption of a longer period of retention when refrigeration is employed as a sanitary measure. Likewise it would seem, notwithstanding the evidently weakened condition of the only cysticercus which survived in beef exposed five days to a temperature of 15 F., that it is not justifiable to accept five days as a safe period for refrigeration, and that six days should be required until it shall be shown that a shorter period of refrigeration is fully sufficient to prevent the possibility that cysticerci present in the refrigerated meat may retain enough vitality to continue their development in the human host. On the basis of the results which have been herein recorded, an amendment to the federal meat inspection regulations has been issued providing that beef carcasses showing a certain slight degree of infestation may be passed for food if held for six days at a temperature not exceeding 15 F., as an alternative to the requirement of retention for twenty-one days. As over 40,000 beef carcasses are annually retained on account of *Cysticercus bovis* in establishments under federal inspection, this modification of the regulations will result in a considerable saving in the handling of such carcasses. Some carcasses, particularly heavy carcasses of the highest quality of beef, suffer little or no deterioration when held for twenty-one days in coolers at temperatures above freezing, and these are likely to be held in coolers as heretofore for the full twenty-one-day period. Many of the carcasses, however, which are retained on account of *Cysticercus bovis,* are of such a character that they cannot be kept unspoiled for three weeks unless they are frozen. Under the new regulations, instead of being refrigerated for three weeks, these carcasses will be held for six days at a temperature not higher than 15 F. and then released for food. The refrigeration expense will thus be greatly reduced. Only about a third as much cold will have to be produced for each carcass, and only about a third as much storage space will be required to take care of the carcasses. Heretofore at many establishments the freezers have been more or less constantly

congested with retained carcasses, and at times more carcasses have been retained than there was room for in the available freezer space. Such conditions will be greatly relieved by the new regulations.

REFERENCES

Boccalari, Abelardo. 1903. La notevole diffusione del *Cisticercus bovis* nel bestiame da macello italiano. Gior. r. Soc. ed Accad. vet. ital., 52: 409-415.

Glage, Friedrich. 1896. Versuche über die Lebenszähigkeit der Finnen. Ztschr. f. Fleisch- u. Milchhyg., 6:231-234.

Ostertag, Robert. 1897. Untersuchungen über das Absterben der Rinderfinnen im ausgeschlachten und in Kühlräumen aufbewahrten Fleische. Ztschr. f. Fleisch- u. Milchhyg., 7:127-132.

Perroncito, Edoardo. 1877. Esperimenti sulle produzione del *Cysticercus* della *Taenia mediocanellata* nelle carni dei vitelli; altre prove fatte sulla sua tenacità di vita e sul rapido sviluppo della corrispondente *Taenia mediocanellata* nell'uomo. Medico vet., 6:538-553, uls. 1-4.

Reissmann, 1897. Ein Beitrag zur Frage der Finnenabtötung durch Kälte. Ztschr. f. Fleisch- u. Milchhyg., 7:132-137.

Zschocke, A. 1896. Zur Frage der Verwerthung finnigen Rindfleisches. Deutsche thierärztl. Wchnschr., 4: 233-236.