AN ANALYSIS OF REPUTED PATHOGENICITY OF THYSANOSOMA ACTINIOIDES IN ADULT SHEEP

By Reed O. Christenson

Department of Entomology and Zoology, Agricultural Experiment Station of the University of Minnesota

INTRODUCTION

Since the work of Curtice (1) there have been numerous reports concerning the pathogenicity of the fringed or fimbriated tapeworm, Thysanosoma actinioides (Taenia fimbriata) Dies., 1834. Oftentimes these reports, especially more recent ones, are contradictory regarding symptoms and diagnosis. "Fimbriata" infection, like hemorrhagic septicemia, is all too often a convenient blanket term to cover various ailments of sheep.

Very often loco and silvery lupine poisoning have been confused with the tapeworm infections. Curtice (1) considered the condition of many so-called locoed sheep due to this parasite. Ward (8, p. 288) states: "It seems probable that the loco of the western sheep has for its exciting cause this or a similar form." Marshall (5), on the other hand, examined 11 locoed sheep and found 9 of them harboring the fringed tapeworm. Durrell and Glover (2) found chronic lupine poisoning more common in sheep than loco, the latter being more prevalent in horses. They found that lupine poisoning is often associated with liver disorder and jaundice. It is not the purpose of this paper to consider the relationship of tapeworm infection to poisoning but to point out that, contrary to popular belief, Thysanosoma infection is rarely lethal to adult sheep.

Attention was directed to the problem by the fact that recently in certain feed lots in Minnesota excessively high mortality occurred, mounting to weekly losses of 14 sheep per thousand. Post-mortems by veterinarians revealed Thysanosoma actinioides in the liver and bile passages. The losses were attributed to this parasite, although the symptoms were atypical. The explanation was that the presence of the tapeworms in the bile and pancreatic ducts prevented the flow of these juices into the small intestine. Since these essential juices were lacking the flow of food from the stomach was immediately closed off. The stomach would thus be full of food in a fermenting condition, and the animal would die of autointoxication. A copper sulphate treatment was advised. This supposedly caused many of the sheep to recover and presumably removed the worms from the intestine and the liver with equal efficacy. This was regarded as substantiated by post-mortems on three sheep, all of which were found negative.

This theory of the rôle of thysanosoma being accepted, the writer was asked to take up the study of the life cycle of the worm with a...
view to developing control measures. Early in the work doubt arose as to the validity of the previous conclusions and it was decided to study the incidence of the thyssanosomes in sheep presenting symptoms of succumbing to the disorder.

RESULTS OF EXPERIMENTAL EXAMINATION OF SHEEP

Doubts first arose in connection with the records of mortality among some 30,000 sheep over a 2-year period. As shown in the curve, the greatest losses occurred toward the end of the feeding period. (Fig. 1.) Figure 2 shows the normal death rate of sheep under feed-lot conditions. Providing chances for reinfection are not present, one would expect the peak of the curve near the beginning of the feeding period when the most heavily diseased animals would die. Again, one would expect the highest mortality when the weather conditions were adverse as pointed out by Curtice (1) and Ward (8). Upon this basis the losses were charted against the temperature. During the subzero weather of January the mortality curve approached the base line, and during the abnormal moderate weather of December the peak in the curve was reached.

In a preliminary examination to determine the extent to which the fringed tapeworm might be incriminated, 12 sick sheep, which presented typical symptoms of the prevailing disorder, were selected from the isolation pen. Some were on the verge of collapse. All had diarrhea, a certain nervousness expressed by shaking of the head, but were possessed of good quality in wool and flesh. Postmortems showed that four were infected with the tapeworm, but that only one had sufficient numbers to clog the bile ducts materially. Yet all presented typical symptoms, and some were down prior to the time the examination was made. None showed evidence of jaundice.

The next 250 sheep showing typical symptoms, many on the verge of collapse, were killed and examined. The result was astonishing. Here the rate of infection by *Thysanosoma actinioides* was but 4.1 per cent. This slight incidence in the same lot of sheep examined
by the veterinarian could readily account, upon a chance basis, for the three uninfected animals treated with the copper sulphate, as previously mentioned. A physical examination of the 10 sheep represented by the 4.1 per cent showed little intestinal inflammation, no appreciable glandular enlargement, and the meat to be of excellent quality and the wool in perfect condition. Indeed these sheep were among the biggest and fattest in the lot, and did not at all appear as if infected by an insidious disease.

These studies led to the examination of 253 apparently normal sheep for comparison. In this lot 6.7 per cent were infected, or a 2.6 per cent higher rate than in those presumably dying from the tapeworm. This was subsequently checked by the examination of 500 more apparently normal animals, from the same pen containing the sick sheep, and a 5 per cent infection was noted, this again being higher than in the ailing sheep.

In making the examinations only the liver and the bile ducts were examined. This was done on the assumption that it is in these localities that the lethal action occurs. To render the above statistics more valid it must be shown that there was no migration of the worms into the intestine after the death of the animal and that the liver infection is really an index to the rate of intestinal infection. This was done in the following manner:

Post-mortems were performed on 100 apparently normal sheep, they being first examined for hepatic infection, and then checked for intestinal incidence. Of these, 20 per cent showed infection, 15 per cent having parasites in the liver and intestine and 5 per cent in the liver alone. Then a similar lot of 125 apparently normal sheep was examined and a 74 per cent infection found. These sheep were shipped from Colorado, where the parasite is reported to be most common. In these the intestinal infection was checked first, with subsequent liver examination. Eight animals had hepatic infections alone, 50 had intestinal infections, and 35 had coincident infections of the liver and the intestine. It is thus clear that although the intestine is the primary habitat of this tapeworm, it also is found quite commonly in the liver. It seems that a concentrated bile content is essential for the parasite, inasmuch as it is found only in the upper part of the duodenum, the liver and bile ducts, and rarely in the pancreatic ducts.

DISCUSSION

It has been assumed that the pathogenicity of thysanosomes was produced by clogging the bile passages. In the last lot of sheep examined a few presented traces of jaundice in the conjunctivae and the subcutaneous tissues. It was decided to study the extent of bile stoppage in such animals. To demonstrate this the sheep having a slight jaundice because of extremely heavy infection were tested for bile, using both Gmelin’s and Kettendofer’s tests. All were positive for bile in both the duodenum and the feces.

These studies show that the fringed tapeworm did not cause the losses in the present case and that this diagnosis resulted from the chance finding of worms commonly regarded as lethal. To recall the recorded symptoms associated with this parasite we refer to Curtice and Hall.
Curtice (1) reports that lambs infected with thysanosomes are large-headed, with undersized bodies and hidebound skins. Their gait is stiff, and they have difficulty cropping the shorter grass. Others do not see well, and apprehend danger poorly. The liver is smaller, the kidneys flabbier and paler, the lymphatics somewhat darker and the muscles thinner and weaker than in normal animals. In all cases there is leanness of muscle and a diminution of fat. The symptoms and pathogenic lesions are those of malnutrition. These conditions prevail in both adults and lambs in heavy infections.

Hall (3) reports that the obstruction of the bile ducts causes inflammation of these ducts. The parasite causes alteration of secretion, with digestive disorders as a consequence. An unthrifty condition is produced which shows in poor quality of flesh and wool. Infected sheep are liable to die during adverse weather conditions and are commonly hidebound and suffer from diarrhea.

On the other hand, Jungherr and Welch (4) find stiff gaitedness due to three infections: (1) Umbilical infection, (2) coccidiosis, and (3) Vibrion septique infection. Welch (9) reports the fringed tapeworm as common in the bile ducts of young lambs and old ewes in Montana, but is unable to attribute actual damage to it. This same attitude is taken by Newsom and Cross (6), who consider this tapeworm of little significance.

In the earlier part of this paper reference is made to the use of copper sulphate for removing the worms from the affected sheep. All authorities agree that medication is ineffective, removing at best only worms located in the intestine. Curtice (1) tried all of the standard taeniasfuges with no success. Ward (8) discourages treatment on the basis that drugs used to kill the parasites in the liver would undoubtedly have a serious effect upon the host. Hall (3) states that no successful treatment is known, those used having failed, and that the best recommendations for infected animals are careful nursing and good feeding.

Stiles (7) in summarizing the distribution of Thysanosoma actinioides lists the following countries and States: Brazil, Colorado, Utah, Nebraska, New Mexico, California, Oregon, Missouri, and Washington, D. C. (imported from Colorado). Hall (3) finds the eastern limit to be North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. W. A. Riley records the occurrence of T. actinioides in Minnesota, in addition to this range. Of 30 native Minnesota sheep examined by the writer 5 were found infected with this parasite.

SUMMARY

The symptoms associated with infection with Thysanosoma actinioides are often confused, and therefore it has been given undue pathogenic importance. Post-mortem studies of over 1,200 sheep here reported have shown that in well-organized feed lots no great damage is done to the host except where excessively heavy infections occur. In cases of heavy infection the symptoms simulate those of malnutrition, and this fact should be given due weight before the mortality is attributed to the presence of a few thysanosomes in the liver. The conditions prevalent in the ailing sheep examined were fairly similar to those of sheep suffering from apoplexy as described by Wing (10, 11), or from what Newsom and Cross term “overeating.” Unlike
the work of the latter writers, however, the author’s studies show but few animals to have the extensive hemorrhagic areas which they figure.

The liver appears to be part of the normal habitat of the parasite. Whether the migration to that locality is cyclic or not cannot be said, but it is evident that the parasite occurs there almost as frequently as in the intestine.

Even where the liver infection is most heavy, analyses show that bile is present in both the duodenum and feces. Undoubtedly, as Curtice holds, the flow is not of normal regularity. For that matter a sheep’s feeding is not periodic in feed lots, and much of the bile could function in a normal manner.

The area in which *Thysanosoma actinioides* infection occurs is gradually increasing. Minnesota sheep are infected as well as those from regions previously recorded. In spite of this gradual spread, and the prevailing idea of its pathogenicity in growing lambs, nothing is yet known regarding the life cycle of *T. actinioides* except that it probably requires an intermediate host.

**LITERATURE CITED**


