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TOXOPLASMOSIS IN SHEEP

EPIDEMIOLOGICAL STUDIES IN FLOCKS WITH REPRODUCTIVE LOSS FROM TOXOPLASMOSIS*

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WALDELAND, H.: *Toxoplasmosis in sheep. Epidemiological studies in flocks with reproductive loss from toxoplasmosis.* Acta vet. scand. 1977, *18*, 91—97. — The epidemiology of toxoplasmosis was studied in 51 flocks with reproductive loss from the infection. Overt toxoplasmosis was diagnosed on 2—4 neighbouring farms on 6 occasions, involving a total of 15 flocks. In 14 of the 51 flocks the frequency of abortion was highest in a definite part or age group of the flock.

Evidence was found that the source of infection may be confined to a particular part of an area or of a farm. There was apparently no transmission of Toxoplasma gondii from sheep with overt or latent toxoplasmosis to susceptible sheep. There were good reasons to believe that the parasite might have been transmitted via the silage in 1 of the flocks.

toxoplasma infection; epidemiology; abortion; sheep.

In a previous paper the author discussed a possible influence of climate and management on the importance of toxoplasmosis as a cause of reproductive failure in sheep from different parts of Norway (*Waldeland* 1976 a). The present paper describes observations on the epidemiology in some of the flocks where the author diagnosed reproductive loss from the infection during the period 1968—1973 (*Waldeland* 1976 b).

MATERIALS AND METHODS

The investigation was confined to 51 flocks within a short distance from this laboratory. The reproductive behaviour, the management and grazing pattern were recorded in each flock.

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A total of 806 serum samples were examined for toxoplasma antibodies by the dye test (DT) as previously described (*Waldeland* 1976 c). Some of these samples from 3 flocks were examined before the outbreak of overt toxoplasmosis as part of a serological survey. Details will be given later.

Characteristics of the local sheep husbandry

The majority of the sheep are of the 2 Norwegian breeds "Rygja" and "Dala", and are kept on farms based mainly on dairy farming. The number of breeding ewes in most flocks ranges from 40 to 100. Breeding from lambs is common.

After lambing in April most sheep are kept on farm leys or on permanent, fertilized grassland until about the middle of June. They are then moved onto hill or mountain pastures where they stay until the middle of September. From the mating season in November and throughout the winter the sheep are usually housed during nights and also during days of bad weather conditions, and fed supplementary with hay, grass silage and concentrates. They are shorn 4—6 weeks before lambing, and are subsequently kept indoors for the rest of the gestation period.

RESULTS

Overt toxoplasmosis was diagnosed on 2—3 neighbouring farms during the same season on 6 different places, involving a total of 15 flocks. In 14 of the 51 flocks, the frequency of abortion was highest in a definite part or age group.

Overt toxoplasmosis on neighbouring farms

The frequency of reproductive loss and the stage of gestation when the foetuses succumbed or were expelled varied as much between neighbouring flocks as between any of the other flocks. There were no distinct differences in management, farm density or density of human population in areas where reproductive failures occurred on neighbouring farms compared with areas where the infection was diagnosed on single farms only.

Details from 4 neighbouring farms with reproductive loss are described in the following.

Flock no. 1. In this flock of 58 ewes, 30 returned to heat about 3 months after mating. Vaginal discharges were occasionally seen. Twelve ewes examined at random showed DT titres in

the range from 1/64 to 1/512. Two years earlier 3 of 12 ewes had titres of 1/16, whereas the remaining 9 were DT negative (titres $< 1/16$).

Flock no. 2. This flock comprised 49 ewes, 14 of which were housed in a shed near the main building where the remainder was kept. Usually all the sheep grazed together, but during some periods in the winter the 14 ewes grazed separated from the others near their shed on a pasture adjacent to the building where flock no. 1 was kept. Five of the 14 ewes aborted, whereas no abortion occurred in the main part of the flock. Eight of the 14 ewes examined shortly after the abortions showed DT titres in the range from 1/128 to 1/512. Ten months later, 1 of 6 lambs from the affected group was DT positive, whereas all of 5 younger ewes had titres of $\geq 1/64$. In the main part of the flock 3 of 9 ewes examined at random 10 months after the abortions were DT positive with titres of 1/16.

Flock no. 3. In this flock 2 of 176 ewes aborted. Three months earlier, 9 DT positive individuals (about 15 %) were found by random sampling of 1/3 of the ewes. Nine months after the abortions, 4 of 20 (20 %) younger ewes examined at random were DT positive. One abortion from toxoplasmosis had also taken place in this flock 4 years earlier, and by random sampling of 50 ewes at that time, 4 (8 %) DT positive individuals were found.

Flock no. 4. This flock comprised 56 ewes, 2 of which aborted. Nine months after the abortions all of 11 2-years old ewes were DT positive, and 8 of these had titres of $\geq 1/128$. During the previous 2 years only 2 DT positive ewes were found among 15 examined at random.

The yards of the farms nos. 1, 2 and 3 were located within 20—50 m from each other. The distance to the yard of farm no. 4 was about 1 km, but the pastures of all the farms were adjacent.

Abortion in a definite part of the flock

A high frequency of abortion in a definite part or age group occurred in 14 flocks. Details from 1 of these have already been given (flock no. 2). In 10 of the remaining flocks mainly younger ewes were affected, whereas in 3 flocks abortions occurred only among the older ewes.

Abortion among younger ewes

In 1 of the 10 flocks the hoggs which aborted were kept on farm leys and the older ewes on permanent grassland during the pregnancy. In the remaining 9 flocks all the sheep had been kept together both indoors and on the pasture during the last year before the abortions. Details from 1 of the latter flocks are given below.

Flock no. 5. Of the 105 ewes in this flock, 29 were 2-years old. The latter had been kept separated from the older ewes after they returned from mountain pastures when they were about 5 months old and till the age of 1 year. Of the 29 ewes 28 aborted, and 1 delivered 1 dead and 1 live lamb. Serological examination of 12 of them showed titres in the range from 1/512 to 1/4096. Of 5 older ewes examined at random 4 had positive titres from 1/16 to 1/64. The hoggs were not mated. Three hoggs examined at random were DT positive with titres from 1/16 to 1/1024.

Abortion among older ewes

In 2 of the 3 flocks the hoggs were kept on farm leys and the older ewes on permanent grassland during the pregnancy. Details from the third flock will appear from the following.

Flock no. 6. The 70 sheep in this flock were kept together on the pasture throughout the year. During the nights the hoggs were kept in a separate pen in the same room as the older ewes. Indoors the hoggs were fed hay and the older ewes grass silage, in addition to concentrates. Eighteen of 57 ewes in the age of 2—6 years aborted. Of 13 hoggs 3 were mated and lambed normally. Thirteen ewes which had aborted showed titres in the range from 1/32 to 1/1024, whereas 1 ewe with a normal pregnancy was DT negative. Only 1 of 6 hoggs examined was DT positive with a titre of 1/16. The DT negative sheep were still negative when examined 6 months later.

DISCUSSION

Studies on experimental toxoplasmosis by *Watson & Beverley* (1971) indicated that ewes which abort probably have acquired the infection during the first 3—4 months after mating, i.e. infection resulting in abortion must take place during a short period of the year. It is therefore probable that sheep on neighbouring farms are affected more frequently during the same year than found by the present investigation.

The examinations of the flocks nos. 1, 3 and 4 prior to the clinically apparent toxoplasmosis indicated that most sheep in that area were susceptible. The first evidence of overt toxoplasmosis appeared in flock no. 1. The reproductive behaviour indicated that the ewes had acquired the infection shortly after the first mating. Abortions then occurred in flock no. 2 among the ewes which during some periods had grazed on a pasture adjacent to the house of flock no. 1. Abortions occurred later in flock no. 3, and at last in flock no. 4. In the latter, the low frequency of abortion and the high DT titres in ewes examined 9 months later indicated that the sheep were infected at a late stage of gestation or after lambing.

This sequence of reproductive failures may be concordant with a spread of the parasite from farm no. 1 to the immediate surroundings. However, the DT titres in the main part of flock no. 2 10 months after the abortions, and also in a healthy flock on an adjacent farm where the sheep house was about 70 m from the yard of farm no. 1, indicated that the infective agent was not spread very far.

The possibility of transmission of Toxoplasma gondii from infected sheep to susceptible sheep was elucidated by observations in the flocks nos. 3, 5, and 6. In flock no. 3 the low prevalence of DT positive sheep did not change noteworthy during 4 years in spite of overt toxoplasmosis during 2 breeding seasons. In flock no. 5, the high frequency of abortion and the titre values among the 2-years old sheep indicated that they had not been exposed to the parasite until after mating, i.e. after they had been kept together with the older ewes for about 7 months, whereas the titres among the older ewes indicated a long-standing infection (*Waldeland* 1977). It seems unlikely that infection should not have taken place in any of the 29 2-years old sheep if the older ewes were of any importance as a source of infection. The high titres of the hoggs, which were not mated, rule out infection merely associated with mating. In flock no. 6, there was still a low prevalence of infection among the hoggs 6 months after the abortions in spite of the close contact with ewes that aborted.

These findings indicate that neither latently infected sheep nor sheep with overt toxoplasmosis are of any importance as a direct source of infection to susceptible individuals.

The normal course of pregnancy among older ewes in flock no. 5 illustrates that a long-standing infection usually protects against the harmful effects from re-exposure to the parasite. This probably also explains the higher frequency of abortion among younger ewes in the other flocks where all the sheep were kept together throughout the year.

An association between management and abortions in a definite part or age group was observed in 4 flocks. The results from 1 of these (flock no. 2) have already been discussed. In 2 of the remaining 3 flocks the hoggs, which had a normal pregnancy, grazed separated from the older ewes. The abortions could accordingly have been due to infection acquired on the pasture. However, some evidence of outdoor infection was only found in 1 of these flocks, where the contact indoors between the 18 hoggs and the older ewes was rather close in spite of the rails that separated their adjacent pens. It therefore seems unlikely that infection indoors should not affect the hoggs as well. In the other flock no conclusion could be made as to where the ewes acquired the infection, as the hoggs were also housed separated from the older sheep.

The observations in the remaining flock (flock no. 6) indicate that the infection took place indoors, as the prevalence of infection was low among the hoggs which were kept together with the older ewes on the pasture. There are good reasons to believe that the parasite could have been transmitted via the silage, which was fed only to gimmers and older ewes. This contamination might have taken place either outdoors before or during harvesting of the grass, or in the silo or the feeding trough. As the oocyst of T. gondii may survive for long periods when not desiccated (*Yilmaz & Hopkins* 1972), the conditions for survival in the silage should be favourable. However, further studies are required to elucidate this possibility.

In the present work the sources of infection were not identified. However, there are plenty of cats in this district. Cat faeces that contain oocysts of T. gondii are therefore a likely source of infection.

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SAMMENDRAG

Toxoplasmose hos sau. Epidemiologiske undersøkelser i flokker med reproduksjonstap på grunn av toxoplasmose.

Epidemiologiske undersøkelser ble foretatt i 51 flokker med reproduksjonstap forårsaket av infeksjonen. I 6 tilfelle ble toxoplasmose diagnostisert på 2 til 4 nabogårder i løpet av samme drektighetssesong. Disse tilfellene omfattet i alt 15 flokker. I 14 av de 51 flokkene var reproduksjonstapet størst i en viss aldersgruppe eller i en del av flokken som periodevis hadde vært holdt atskilt som egen enhet.

Enkelte observasjoner tydet på at spredningen av Toxoplasma gondii kan være avgrenset innen et område. Det ble ikke funnet holdepunkter for at sauer med klinisk eller latent toxoplasmose utgjør en smittekilde for mottakelige dyr i flokken.

Infeksjonsforløpet i en flokk kunne tyde på at siloföret var kontaminert.

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