

From the Department of Microbiology and Immunology, Norwegian College of Veterinary Medicine, Oslo and the State Veterinary Laboratory for Northern Norway, Harstad, Norway.

## CORYNEBACTERIUM PSEUDOTUBERCULOSIS INFECTION IN GOATS IV.

### COURSE OF THE INFECTION IN TWO RECENTLY INFECTED GOAT HERDS

By

*Gudmund Holstad*

HOLSTAD, G.: *Corynebacterium pseudotuberculosis* infection in goats IV. Course of the infection in two recently infected goat herds. Acta vet. scand. 1986, 27, 609—616. — Adult animals from 2 herds were examined clinically and serologically, 5 (Herd A) and 4 (Herd B) times during the same period of 3½ years.

Serum samples were examined for antibodies against *Corynebacterium pseudotuberculosis* using the bacterial agglutination test (BAT) and the hemolysis inhibition test (HIT).

The results of the first examination showed that no animal in Herd A was seropositive, while in Herd B 1 animal showed a high positive titre in BAT. The prevalence of animals with superficial swellings was then 2 % in Herd A and 4 % in Herd B. In both herds, the prevalence of animals with superficial swellings and seropositive reactions increased during the following 1—2 years. About 30 % of animals had superficial lesions and close to 100 % were seropositive. The proportion of animals with superficial swellings and seropositive reactions was almost constant on subsequent examinations.

In some of the animals, superficial swellings were found during 2 or more of the examinations, a few animals having such lesions at the same site on both or all occasions.

Animals in Herd A became infected through grazing together with goats from infected herds. Caseous lymphadenitis was introduced into Herd B by animals obtained from infected herds.

superficial swellings; seropositive animals;  
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Caseous lymphadenitis caused by *Corynebacterium pseudotuberculosis* is common in goat herds in Norway (Holstad 1986a). Some farmers assert that caseous lymphadenitis affects animals mainly during the first period following introduction of infection into the herd. However, no investigations have been carried

out to clarify the clinical picture in newly infected herds, and the subsequent course of the disease in these herds.

The purpose of the present work was to study the course of *C. pseudotuberculosis* infection during the first 3 years following the introduction of the disease into a previously clean herd and a newly established herd.

## MATERIALS AND METHODS

### *Herds*

Clinical and serological examinations were carried out in 2 newly infected herds during a period of 3½ years.

**H e r d A.** The herd was established several years before the investigation started. Examinations were carried out altogether on 5 different occasions. Table 1 shows when the examinations were performed, and the number of animals examined. Most adult animals (1 year of age or older) were examined. The mean age of goats in the herd increased by 1 year from October 1981 to September 1984. After caseous lymphadenitis had been diagnosed, the herd became member of a goat "breeding circle"<sup>1</sup> together with other infected herds. At the time of the first examination, some goats were placed singly in stalls, the remaining goats being placed in pens. At subsequent examinations, all the goats were kept in pens. During the summer, the animals grazed at pasture though they were housed at night. According to the farmer, the goats were in contact with animals from infected herds at pasture. The kids were born in February and March and were placed in separate pens in the same room as adult animals.

**H e r d B.** The herd was a newly established one. Some months before the time of the first examination, animals had been obtained both from herds with a history of caseous lymphadenitis and from herds which were considered to be free of infection. Altogether 4 examinations were carried out. Table 2 shows the periods during which examinations were carried out, and the number of animals examined. Most of the adult animals were examined each time, and were about one year old at the time of the first examination. The mean age of the goats ex-

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<sup>1</sup> Breeding system practised in Norway in which several herds share the use of the same breeding males.

amined increased by 1 year from September 1982 to September 1984. The animals were placed in pens. During the summer of 1981 and 1982, the animals were indoors, while during the summer 1983 and 1984 they were put out to pasture. The kids were born in January and February and were placed in pens in the same room as adult animals.

#### *Clinical examinations*

The animals were inspected and palpated. The sites at which superficial swellings were present were registered. Swellings on the shoulder and chest were, however, excluded as lesions at these sites were considered to be granulomas arising after vaccination against paratuberculosis.

#### *Serological examinations*

Blood samples were collected from each animal on the same day as clinical examinations were carried out. Sera were prepared according to standard procedures and stored at  $-20^{\circ}\text{C}$ . All the sera were examined for antibodies to *C. pseudotuberculosis* using the bacterial agglutination test (BAT) and the hemolysis inhibition test (HIT) (Holstad 1986b).

#### *Statistical analysis*

Statistical calculations were carried out using Chi-square analysis.

## RESULTS

### *Herd A*

Table 1 presents the results of the clinical and serological examinations.

Most superficial swellings were localized in or close to the superficial lymph nodes. The difference between the prevalence of animals with superficial swellings in October 1981 and September 1982 was significant,  $P < 0.005$ . There was, however, no significant difference in the prevalence of animals with such lesions found at each of the last 3 examinations.

The difference between the prevalence of seropositive animals in October 1981 and September 1982 was significant both for BAT and HIT,  $P < 0.005$ . Later there was no difference.

Table 1. Results of clinical and serological examinations in Herd A.

Time of examination		Number of animals examined	Percentage of animals with superficial swellings	Percentage of animals positive in		
				BAT <sup>1</sup>	HIT <sup>2</sup>	BAT and/or HIT
March	1981	46	2	0	0	0
October	1981	39	5	36	28	41
September	1982	39	31	100	92	100
October	1983	40	28	100	98	100
September	1984	42	29	100	90	100

<sup>1</sup> Bacterial agglutination test.

<sup>2</sup> Hemolysis inhibition test.

Of the animals examined, 19 individuals were included in each and every one of the 5 investigations. Superficial swellings were found once in 6 of these animals, and twice in 6 others. In 4 of the latter group, the swellings were located on the same part of the body on both occasions. One animal had superficial swellings on 4 of the 5 occasions on which it was examined, the swellings being located on the same part of the body on 3 occasions.

In October 1981, altogether 6 of these 19 animals were positive in BAT while 2 were positive in HIT. In September 1982, October 1983 and September 1984 17, 18 and 19 animals were positive in HIT respectively, while all animals were positive in BAT.

### *Herd B*

Table 2 presents the results of the clinical and serological examinations.

Most superficial swellings were localized in or close to superficial lymph nodes. The difference between the prevalence of animals with superficial swellings in March 1981 and in September 1982 was significant,  $P < 0.005$ . Later there was no difference.

In March 1981, 1 animal had a high positive titre in BAT but superficial swellings were not detected in this animal. In September 1982, 77 % and 59 % of the animals were positive in BAT and HIT, respectively, and the difference between the prevalence of positive animals in the tests was significant,  $P < 0.005$ . The

Table 2. Results of clinical and serological examinations in Herd B.

Time of examination	Number of animals examined	Percentage of animals with superficial swellings	Percentage of animals positive in		
			BAT	HIT	BAT and/or HIT
March 1981	57	4	2	0	2
September 1982	102	28	77	59	84
October 1983	96	27	100	99	100
September 1984	105 <sup>a</sup> /88 <sup>b</sup>	18	98	93	99

<sup>a</sup> Examined clinically.

<sup>b</sup> Examined serologically.

difference between the prevalence of seropositive animals in September 1982 and in October 1983 was significant both for BAT and HIT,  $P < 0.005$ .

Among the examined animals, 23 individuals were examined on all 4 occasions. Superficial swellings were found once in 6 of these animals, and twice in 2 others. In both the latter mentioned animals, the swellings were located on the same part of the body on both occasions. In 1 animal, superficial swellings were found during 3 of the examinations.

In September 1982, 19 of the 23 animals were positive in BAT and 12 were positive in HIT. In October 1983 and September 1984, 23 and 21 animals were positive in HIT, respectively, while all were positive in BAT.

## DISCUSSION

The prevalence of seropositive animals increased during the first 1—2 years after caseous lymphadenitis had been first diagnosed. By then, most animals in both herds had antibodies against *C. pseudotuberculosis*. During this period, the prevalence of animals with superficial swellings increased to the same level as in herds in which the disease had existed for quite a long time (*Holstad 1986a*).

In Herd A, the animals became infected at pasture through contact with infected animals. Infection in Herd B was introduced by animals obtained from infected herds. Though the owner of Herd A thought that the animals might have become infected during the summer prior to the first examination, results seem to indicate that the animals in this herd may have become in-

ected during the period between the first and second examination. *Ashfaq & Campbell* (1980) reported that several months could elapse between experimental infection with *C. pseudotuberculosis* and abscess formation in lymph nodes. *Abdel-Hamid & Zaki* (1973) found that antibodies could not be detected in goat sera using the mouse protection and anti-haemolysin inhibition test until 4—8 weeks after experimental infection.

In Herd B, the adult animals were about 1 year old at the time of the first examination and only 1 had a positive titre in BAT. Some of the 1 year old animals in this herd had been obtained from herds with a history of caseous lymphadenitis, and shortly before the investigation started, kids had been introduced from infected herds. A few of these kids had antibodies against *C. pseudotuberculosis* (*Holstad* 1986c). No measures to prevent the spread of the disease had been introduced in either herd.

Results from the second examination showed that, in Herd B, significantly more animals were positive in BAT than in HIT. This might indicate that agglutinins can be demonstrated at an earlier stage than antihemolysins in sera from naturally infected goats.

The present study shows that superficial swellings in goats may persist at the same body site for several years. In some animals, the swellings disappeared, only for lesions to develop at other sites. This may be due to spread of infection (*Nagy* 1976, *Ashfaq & Campbell* 1980). Results from the clinical examinations in the present study indicate that animals were subject to a longstanding exposure to *C. pseudotuberculosis*. This is in accordance with *Holstad* (1986c) who found that antibody titres against the bacterium increased with age.

Caseous lymphadenitis is a chronic disease, animals with superficial swellings usually appearing to be healthy. *Abdel-Hamid* (1973) found that clinical symptoms in experimentally infected goats without antibodies against *C. pseudotuberculosis* varied according to dose and route of infection. When a culture of *C. pseudotuberculosis* was applied on skin abrasions, animals showed a slight rise in temperature for a few days, while subcutaneous inoculation of 2 ml of the same culture caused acute toxæmia. Superficial wounds are reported to be the most important route of infection for *C. pseudotuberculosis* (*Nagy* 1976). In the present study both owners reported that several animals had shown signs of general ill health during the first period after

the disease had first been observed in the herds. It is likely that lack of immunity may well result in acute symptoms in animals in newly infected herds. As immunity develops, acute symptoms disappear and the nature of the disease becomes chronic. However, more comprehensive investigations must be carried out to clarify the clinical course of caseous lymphadenitis in goats in newly infected herds.

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## SAMMENDRAG

*Corynebacterium pseudotuberculosis* infeksjon hos geit IV.  
Forløpet av infeksjonen i to nyinfiserte geitebesetninger.

Det ble foretatt kliniske og serologiske undersøkelser i alt 5 ganger av voksne dyr (1 år eller eldre) i en besetning (A). Tilsvarende undersøkelser ble foretatt 4 ganger i en annen besetning (B). I begge besetningene var det 3½ år mellom den første og siste undersøkelsen. Sera ble undersøkt for antistoffer mot *Corynebacterium pseudotuberculosis* både ved bakterieagglutinasjonstest (BAT) og anti-hemolysintest (AHT).

Ingen dyr var serologisk positive i besetning A ved den første undersøkelsen. I besetning B hadde 1 dyr høyt positivt titer ved BAT på dette tidspunkt. I besetning A og B var det henholdsvis 2 og 4 % av dyrene som hadde overfladiske hevelser ved den første undersøkelsen.

Prevalensen av dyr med overfladiske hevelser og av serologisk positive reagenter i besetningene økte i løpet av de første 1—2 årene etter at sykdommen ble påvist. Ca. 30 % av dyrene hadde overfladiske

hevelser, og de fleste var seropositive. Prevalensen av dyr med overfladiske hevelser og av serologisk positive dyr holdt seg tilnærmet konstant ved senere undersøkelser.

Noen dyr hadde overfladiske hevelser ved 2 eller flere undersøkelser, og på noen av disse dyrene var lesjonene lokalisert på samme sted på kroppen ved forskjellige undersøkelsestidspunkt.

I besetning A ble dyrene smittet på beite ved kontakt med dyr fra besetninger med kaseøs lymfadenitt. I besetning B kom sykdommen inn med dyr innkjøpt fra besetninger med kaseøs lymfadenitt.

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Reprints may be requested from: Gudmund Holstad, the Department of Microbiology and Immunology, Norwegian College of Veterinary Medicine, Postbox 8146, Oslo Dep., Oslo 1, Norway.