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KERATITIS IN REINDEER RELATION TO BACTERIAL INFECTIONS*

By

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REHBINDER, CLAES and VERENA GLATTHARD: *Keratitis in reindeer. Relation to bacterial infections.* Acta vet. scand. 1977, 18, 54—64. — In forest reindeer of northern Sweden outbreaks of keratitis regularly appear in the height of summer in connection with marking of the calves.

In forest reindeer conjunctival and corneal lesions, primarily due to foreign bodies and trauma, are found in abundance. In addition, large amounts of different bacteria are present in the conjunctival sacs of clinically healthy as well as diseased animals. It is suggested that the abundance of bacteria and the conjunctival and corneal lesions primarily are a result of the herding conditions of the forest reindeer, and furthermore that they cooperate as etiological factors in the development of keratitis.

reindeer; bacterial infections; keratitis; eye lesions.

Keratitis in reindeer regularly appears in the northern parts of Scandinavia, USSR and North America (*Bergman* 1912, *Hadwen & Palmer* 1922, *Nordkvist* 1960, *Nikolaevskii* 1961, *Winqvist & Rehbinder* 1973 and *Kummeneje* 1976).

Outbreaks are reported mainly from the forest regions with the disease appearing during the height of summer in connection with warm and sunny weather (*Hadwen & Palmer*, *Nikolaevskii*, *Winqvist & Rehbinder*, *Rehbinder* 1977) and with a gradual spread among the animals.

There are also reports on outbreaks of keratitis during spring (*Bergman*) and autumn (*Bergman*, *Eneqvist* 1956, *Kummeneje*). The reports by *Bergman* and *Kummeneje* concern mountain reindeer while the report by *Eneqvist* is from a forest herd.

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According to *Nordkvist* (1969) keratitis in reindeer may appear during different seasons in different parts of the Swedish reindeer herding area. The etiology of keratitis in reindeer was not established in most outbreaks. *Bergman* considered it contagious but could not establish any causal agent. *Muir* (1935) suggested traumatic lesions of the cornea followed by an infection with pyogenic bacteria.

Nikolaevskii states that conjunctivitis is common when reindeer are herded in sandy or dusty areas during summer and that it may lead to keratitis. He does not consider the disease to be contagious.

Nordkvist & Karlsson (1962) report on keratitis in connection with epizootic outbreaks of pasteurellosis in mountain reindeer herds. *Eneqvist* (1956) suggests rickettsia as a possible etiological agent in an outbreak during late spring yet without having demonstrated the organism. *Nordkvist* (1966) proposes that the disease is contagious but does not exclude other factors, such as vitamin-A-deficiency and trauma.

Winqvist & Rehbinder (1973) conclude that the histological and ultrastructural pictures of the cornea from forest reindeer affected by keratitis do not have any specific features which give a clue to the etiology. *Kummeneje* isolated *Neisseria ovis* and *Colesiota conjunctivae*-like microorganisms from cases of keratoconjunctivitis in mountain reindeer in northern Norway, affected in late fall. *Rehbinder* (1977) states that 1st instar larvae of the reindeer nostril fly, when deposited on the eye, and natural ultraviolet radiation may act as predisposing or enhancing factors in the etiology of keratitis in forest reindeer.

In reindeer from forest herds, eye lesions such as conjunctivitis and erosion of corneas are common (*Rehbinder*, to be published). These lesions were proposed to be of traumatic origin, primarily caused by foreign bodies and due to the herding conditions. The aim of this investigation was to clarify whether bacterial infections are associated with the etiology of keratitis in reindeer.

MATERIAL AND METHODS

In June and July 1972, in connection with the marking of the calves, 236 samples for bacterial examination were obtained from the conjunctival sacs of 118 reindeer calves. On June 27 and 29 1973, 40 animals from the Ängeså herd were examined, giving 80

Table 1. Samples from conjunctival sacs for bacterial examination obtained during calf-marking seasons 1972 and 1973.

Herd	Date	Number of samples
Östra Kikkijaure-Mausjaure	26/6-72	44
Östra Kikkijaure-Mausjaure	6/7-72	60
Ängeså	29/7-72	22
Ängeså	4/7-72	20
Ängeså	8/7-72	50
Laevas	20/6-72	20
Kalix	2/7-72	10
Tärendö	10/7-72	10
Ängeså	27, 29/6-73	80
Total number of samples		316

samples for the bacterial investigation. The clinical picture of each eye was noted, and on July 9—11 the same animals were recontrolled. Table 3 presents the bacterial status and its corresponding clinical picture from the first examination, and correlates the clinical picture of the first and second examinations.

Samples were obtained from several herds according to Table 1. Of these herds, Laevas is a mountain herd where keratitis is utterly rare, while the others are forest herds where keratitis regularly appears every summer.

All eyes were examined, and observed lesions were classified into 4 groups: erosions, conjunctivitis, erosions and conjunctivitis, and keratitis. In the 1973 investigation, foreign bodies and nostril fly larvae were not separated from the main groups, nor were they specifically noted.

In April 1973, 34 samples were obtained from the conjunctival sacs of 17 clinically healthy reindeer calves of the Ängeså herd.

In September 1972, samples for bacteriological examination were obtained from the nasopharynx of 45 slaughtered reindeer bulls from different herds (Gällivare 20, Ängeså 10, Östra Kikkijaure 5 and Laevas 10).

All samples from the conjunctival sacs were collected with a platinum loop with a diameter of 3 mm which was carefully brought down into the fornix conjunctivae and then applied directly onto growth media. The samples from the nasopharynx region were taken from slaughtered bulls with sterile cotton swabs which were then applied directly onto growth media.

The bacteria were cultured on blood agar plates (blood agar base, No. 2 CM 271, oxid + 5 % horse blood) and meat infusion peptone broth with 1 % lactose and bromcresol as indicator.

The coagulase test of the staphylococci was performed with rabbit plasma diluted 1:4 (1 colony of the bacteria + 0.5 ml of the diluted plasma). Bacteria classified as not typed enterobacteriaceae were assigned to this group as being Gram negative and fermenting lactose on the meat infusion peptone broth. When classified as mixed flora there was growth mainly composed of α -hemolysing streptococci, coagulase negative staphylococci and not typed enterobacteriaceae. Even when not in pure culture, positive findings of *Pasteurella multocida* were considered important enough for them to be classified into the *Pasteurella multocida* group. In all such cases there was always a moderate to ample growth. The pathogenicity of the *Pasteurella multocida* and *pasteurella*-like strains was tested on mice. Each strain was inoculated intraperitoneally with 0.5 ml of a 24 hr.-broth culture.

RESULTS

The conjunctivae of forest reindeer were frequently found to harbour different kinds of bacteria, in healthy as well as diseased

Table 2. Samples from forest reindeer herds. Obtained bacterial growth in relation to the condition of the eyes.

Condition of eyes	Bacterial growth								
	Number of cases	<i>pasteurella</i> -like	<i>Pasteurella multocida</i>	α -hemolysing streptococci	coag. — staphylococci	coag. + staphylococci	enterobacteriaceae (not typed)	mixed flora	no growth
normal	81		1	1	8	3	27	30	11
erosions	16			1	3	1	3	3	5
conjunctivitis	92	3	12	2	8	4	39	21	3
conjunctivitis and erosions	24		4		2	10	5		3
keratitis	83	8	14	—	2	4	11	34	10
Total number	296	11	31	4	23	22	85	88	32

eyes. Lesions of the eye were also common in animals from these herds (Table 2). Of clinically healthy eyes of forest reindeer, 86 % produced bacterial growth. Of the diseased eyes, 90 % produced bacterial growth, showing a prevalence of bacteria with potentially more pathogenic properties than those from the clinically healthy eyes. However, enterobacteriaceae and mixed flora were the most common finding in both unaffected and diseased eyes.

In the conjunctival sac of 10 mountain reindeer (20 samples) — Laevas herd — bacterial growth was found in 7 (35 %) of the samples (α -hemolysing streptococci 2, coagulase negative staphylococci 1, enterobacteriaceae 3, mixed flora 1), while the remaining 13 samples yielded no growth. Out of these 10 animals one had a minor laceration of the cornea combined with growth of enterobacteriaceae. The other eyes were all clinically normal.

In the 1973 investigation of the Ängeså forest herd (Table 3) it was found that lesions of the eye sometimes did heal, but also that more potentially pathogenic bacteria, mainly *Pasteurella multocida*, were more frequently observed in connection with the development of keratitis.

Samples obtained in spring 1973 from 17 clinically healthy reindeer calves from the Ängeså forest herd revealed the presence of bacteria in 32 out of 34 eyes: *Pasteurella multocida* 5, α -hemolysing streptococci 1, coagulase negative staphylococci 10, not typed enterobacteriaceae 2, mixed flora 14, no growth 2 (the mixed flora usually only consists of α -hemolysing streptococci and coagulase negative staphylococci).

The samples obtained from the nasopharynx of 45 slaughtered reindeer bulls revealed a bacterial growth in many respects similar to the findings of the conjunctival samples. *Pasteurella multocida* was found in 5, α -hemolysing streptococci in 1, coagulase positive staphylococci in 1, not typed enterobacteriaceae in 6 and mixed flora in 28 samples.

The *Pasteurella*-like strain which was found only in 1 forest herd (in fact an isolated part of the Ängeså herd) showed satellite growth in the neighbourhood of hemolytic colonies of *Staphylococcus aureus* on blood agar. However, the tested biochemical and other criteria were identical with the *Pasteurella multocida*, and later growth passages showed that some strains did not need satellite growth but appeared identical to *Pasteurella multocida*.

The *Pasteurella* and the *pasteurella*-like strains were pathogenic to mice and killed them within 24—96 hrs. The inoculated strains were recovered from cardiac blood samples.

DISCUSSION

Keratitis in reindeer is a common disease of forest reindeer in northern Sweden. The disease appears every year in the height of summer with a gradual spread among the animals, apparently correlated to the number of round-ups undertaken with the herds. The etiology of these outbreaks has so far not been established (*Rehbinder*, to be published).

Outbreaks of keratitis in reindeer appearing in late spring and fall and with a fast spread among the animals have been reported (*Bergman* 1912, *Eneqvist* 1956 and *Kummeneje* 1976). In 1 of these outbreaks, *Kummeneje* established the presence of *Neisseria ovis*, and colesiota-like organisms are earlier reported in connection with kerato-conjunctivitis in sheep (*Lindqvist* 1960, *Surman* 1973). Neither *Neisseria ovis*, colesiota-like organisms (*Rehbinder* 1977 b) nor *Moraxella bovis*, the most common organism associated with infectious bovine kerato-conjunctivitis (*Wilcox* 1968), have been demonstrated in the investigations undertaken on Swedish forest reindeer.

It is stated that bacteria, even potentially pathogenic ones, often can be found in the conjunctival sac in clinically healthy animals (*Bistner et al.* 1969, *Ojo et al.* 1972, *Okuda & Campbell* 1974, *Rehbinder & Tschäppät* 1974) as well as in man (*Cason & Winkler* 1954). This appears to be the fact with reindeer too. However, mountain reindeer have fewer cases of infected eyes and fewer potentially pathogenic bacteria than forest reindeer.

During the periods of calf-marking forest reindeer herds are held in corrals for several hours. The circumstances, with several hundred chased animals whirling up dust, should provide the conjunctiva with a rich additional flora of bacteria, among them feces-bacteria. The herding conditions of mountain reindeer are markedly different (*Rehbinder*, to be published).

In the forest reindeer herds the frequent snorting, due to dust, *Cephenomyia trompe* L larvae, and biting insects, principally attacking nose and eyelids, could be a mechanism for the transmission of bacteria from the nasopharynx region to the conjunctiva. *Pasteurella multocida* may be commensal in the throats

and noses of domestic and wild animals (Cowan 1974) and, as shown, also in reindeer. The biting insects may also transmit infections from eye to eye.

The presence of numerous foreign bodies and 1st instar larvae of the nostril fly (*Cephenomyia trompe* L) in the conjunctival sac and the numerous corneal lesions (Rehbinder 1976 a) can be contributed to the herding conditions of the forest reindeer.

According to Christensen & Fahmy (1974), conjunctivae of man having inflammations induced by foreign bodies have been shown to harbour more potentially pathogenic bacteria than those without inflammation. In a comparison between affected and unaffected eyes of the investigated reindeer the same pattern appears.

It has been shown that erosions of the cornea may develop into keratitis (Rehbinder, to be published), and this is emphasized by the results shown in Table 3. *Pasteurella multocida* and coagulase positive staphylococci apparently more often contribute to the development of keratitis, as seen in Table 2. However, all kinds of lesions, infected by any of the found bacteria, evidently may heal spontaneously. This is probably dependent on additional factors such as the size of traumas, presence of foreign bodies, amount of stress, quantity of ultraviolet radiation etc.

The presence of *pasteurella*-like bacteria is only shown from 1 single herd, an isolated subherd of the Ängeså herd. The biochemical and fermentative reactions were with exception for growth properties identical with those of the *Pasteurella multocida* strain found in the main herd of Ängeså. As this *pasteurella*-like strain after a number of growth passages did no longer acquire satellite growth in the neighbourhood of hemolysing staphylococci on blood agar, but behaved identically to the *Pasteurella multocida* strain from the main herd of Ängeså, this strain was considered to be *Pasteurella multocida* bacteria altered for unknown reasons.

Hogan & Zimmerman (1962) stated that in most corneal ulcers of bacterial origin the bacteria have been introduced into the corneal tissues after trauma. Few bacteria are able to penetrate intact corneal epithelium and cause ulcers. Obviously, the conjunctivae of reindeer at any time of the year may harbour a bacterial flora of a wide variety, including strains of the potentially more pathogenic bacteria, such as *Pasteurella multocida*, without showing any signs of disease. Thus pathological conditions will not occur without an additional releasing factor.

In forest reindeer, the frequent appearance of foreign body and nostril fly larvae induced conjunctivitis, corneal lesions and also the frequent occurrence of different bacteria in the conjunctival sac, obviously provide numerous opportunities for bacterially induced cases of keratitis.

Ultraviolet radiation is considered to be an enhancing factor in the etiology of the infectious bovine kerato-conjunctivitis (*Hughes et al.* 1965, *Hughes & Pugh* 1970, *Pedersen* 1973). This must also be considered for reindeer (*Rehbinder* 1977 a).

Thus, the development of keratitis may depend on several co-operating factors, for instance the bacteria commonly occurring in the conjunctival sac, the numerous conjunctival and corneal lesions mainly due to the frequently present foreign bodies and nostril fly larvae, and ultraviolet radiation. Several of these factors occur as a consequence of the herding conditions of the forest reindeer.

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SAMMANFATTNING

Keratit hos ren. Dess relation till bakteriella infektioner.

Utbrott av keratit ses regelbundet hos skogsren i norra Sverige. Utbrotten börjar i samband med kalvmärkningen vid midsommartid. Hos skogsren har påvisats rikligt med sjukliga förändringar i conjunctiva och cornea, i första hand avhängiga främmande kroppar och trauma. Därtill har en mångfald olika bakterier påvisats i conjunctivalsäcken hos såväl friska som sjuka djur. Den talrika förekomsten av olika bakterier i conjunctivalsäcken liksom även conjunctival- och cornealskadorna torde främst bero på de driftsformer som föreligger för skogsrenhjordarna och torde kunna ses som samverkande faktorer vid uppkomsten av keratit hos dessa djur.

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