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KERATITIS IN REINDEER

RELATION TO THE PRESENCE OF 1ST INSTAR LARVAE OF THE NOSTRIL FLY (CEPHENOMYIA TROMPE L) IN THE CONJUNCTIVAL SAC AND TO NATURAL ULTRAVIOLET RADIATION

By

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REHBINDER, CLAES: *Keratitis in reindeer. Relation to the presence of 1st instar larvae of the nostril fly (Cephenomyia trompe L) in the conjunctival sac and to natural ultraviolet radiation.* Acta vet. scand. 1977, *18*, 75—85. — The significance of the presence of 1st instar larvae of the reindeer nostril fly (Cephenomyia trompe L) in the conjunctival sac of reindeer was investigated. The influences of natural ultraviolet radiation upon the development of inflammatory reactions of the eyes was also studied. It is stated that both 1st instar larvae of the Cephenomyia fly, when deposited on the eye, and natural ultraviolet radiation may act as predisposing or enhancing factors in the etiology of keratitis in reindeer. In certain cases keratitis may develop when both parameters are present.

reindeer; keratitis; nostril fly larvae; Cephenomyia trompe; ultraviolet radiation.

The presence of the 1st instar larvae of the nostril fly (Cephenomyia trompe L) in the conjunctival sac of reindeer has been considered as a possible etiological factor of keratitis in this animal (*Rehbinder* 1970).

Further investigations have revealed the presence of 1st instar larvae of the reindeer nostril fly in numerous cases of conjunctivitis or keratitis-affected eyes of reindeer from different forest herds, the number of occurrences increasing during the calf-marking season (principally the 26th—28th weeks of the year). In clinically normal eyes occasional findings have also been noted (*Rehbinder*, to be published). Outbreaks of keratitis in reindeer occur mainly during the summer season, starting during hot

weather and disappearing in the autumn. The disease is more prevalent and severe during hot, dry summers, and the outbreaks are often seen in connection with weather changes from cold to hot and sunny (*Bergman* 1912, *Hadwen & Palmer* 1922, *Nikolaevskii* 1961, *Rehbinder* 1970, *Winqvist & Rehbinder* 1973). Thus the disease coincides with the annual peak of solar ultraviolet radiation, as is the case with most outbreaks of infectious bovine kerato-conjunctivitis (*Hughes & Pugh* 1970, *Pedersen* 1973), and with the main season of activity of the reindeer nostril fly (*Bergman* 1916—1917, *Breew* 1956). The aim of the present work was to investigate whether 1st instar larvae of the reindeer nostril fly (Cephenomyia trompe L) when deposited on the eye is a primary etiological factor in keratitis in reindeer and also whether ultraviolet radiation acts as an enhancing factor in a developing inflammatory reaction of the conjunctiva and cornea.

MATERIALS AND METHODS

Thirty-four clinically healthy reindeer calves with their also clinically healthy dams were selected out of the Ängeså reindeer herd 1 week before the first calf-marking of the year, July 8. The animals were carefully examined with a lamp and fluorescein staining and then brought to 2 different corrals, 17 calves with dams in each corral. The corrals were located in an area isolated from the grazing herd. The eyes of all the animals were controlled daily 6 consecutive days before the start of the experiment.

One of the corrals was entirely sheltered from the sun by tarpaulins and sackcloths. The other was unsheltered and located in an open field. Both corrals were built with one end into the Ängeså river, giving the animals free access to fresh water. The animals were given commercially produced fodder (Fors renfoder), newly-mown grass and fresh leaves from birch and sallow.

Nostril flies were captured with flynets during the calf-marking in the main herd when the flies rested on stones, trees and white reindeer skins placed on the ground.

The day before the instillation of larvae, the bacterial flora of the conjunctival sac was checked. Samples were taken from the ventral conjunctival sac with a platinum loop. Direct cultivation was performed on blood agar plates. These were sent to the National Veterinary Institute, Stockholm, for routine bacteriological

examination. At the end of the experiment new samples were taken in the same manner. Bacteriological examination was not performed on the dams. The clinical condition of the eyes of every animal was checked and tabulated daily. Manipulations of the eyes were restricted to a minimum in order to maintain as natural conditions as possible. The character of the eye secretions was operationally defined following macroscopic inspection. Greyish, viscous secretions were defined as mucopurulent, clear non-viscous secretions which overflowed the margins of the eyelids were defined as serous. The onset of keratitis is marked by a minor greyish swelling or an initial diffuse opacity of the cornea.

The instillation of the larvae was performed by squeezing the posterior part of the fly between the forefinger and thumb, thereby squirting 30—50 larvae into the eye. These quickly moved into the conjunctival sac. Instillation was performed according to Tables 1 and 2. Larvae from 10 flies were squirted directly onto agar plates where they moved rapidly from the centre of the plates to the circumference in a fanlike motion. These plates were also sent to the National Veterinary Institute, Stockholm, for routine bacteriological examination.

Fifteen calves from the main herd with bilateral findings of 1st instar larvae of Cephenomyia trompe L fly in the conjunctival sac were slaughtered. The lacrimal duct was opened on both sides, and after being moistened with formaldehyde (10 %) according to *Bergman* (1917) to make any present larvae more detectable, carefully examined for larvae of the nostril fly.

RESULTS

During the preparatory control period, all animals remained healthy, exhibiting no signs of conjunctivitis or keratitis. The routine bacteriological examinations preceding the instillation of larvae revealed a non-specific mixed flora in most of the eyes. In 2 calves (nos. 13 and 30) Pasteurella multocida was isolated from both eyes and in 1 (no. 31) from the left eye. Pure culture of Staphylococcus aureus was present in the right eye of 1 calf (no. 102). The samples taken toward the end of the experiment were unfortunately destroyed during transportation. Routine bacteriological examination of 1st instar larvae of the nostril fly also revealed a non-specific mixed flora. The results of the experiment

Table 1. Clinical symptoms after instillation of nostril fly larvae in eyes of reindeer in sheltered corral.

No./date		8.7	9.7	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7	19.7	20.7	21.7
1	L	0	i	1	2	3	3	3	2	1	1	1	1	1	(1)
	R	0	i	1	1	2	3	3	2	1	1	1	(1)	(1)	0
2	L	0	i	(1)	1	1	2	2	1	1	1	1	0	0	0
	R	0	i	0	(1)	2	2	2	2	1	1	(1)	0	0	0
3	L	0	i	(1)	1	1	1	1	1	1	1	0	0	0	0
	R	0	i	0	1	1	2	1	1	1	1	0	0	0	0
4	L	0	i	1	3	4	3	3	2	2	1	(1)	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
5	L	0	i	1	1	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
6	L	0	i	1	1	1	1	(1)	1	1	1	(1)	0	0	0
	R	0	i	3	4	3	3	2	1	(1)	(1)	(1)	0	0	0
7	L	0	i	1	3	3	3	3	1	1	1	(1)	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
8	L	0	i	1	3	2	2	2	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
9	L	0	i	1	4	2	2	2	1	1	1	1	1	1	1
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
10	L	0	i	(1)	1	2	1	1	1	(1)	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
11	L	0	i	3	2	2	1	0	0	0	0	0	0	0	0
	R	0	i	0	0	0	0	0	0	0	0	0	0	0	1
12	L	0	i	3	2	1	0	0	0	0	0	0	0	0	0
	R	0	i	(1)	(1)	0	0	0	0	0	0	0	0	0	0
13	L	0	i	2	1	1	(1)	0	0	0	0	0	0	0	0
	R	0	i	1	(1)	0	0	0	0	0	0	0	0	0	0
101	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
102	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
103	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
104	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0

Key to the tables 1 and 2.

1 = Serous mild conjunctivitis.
2 = Mucopurulent mild conjunctivitis.
3 = Mucopurulent moderate conjunctivitis.
4 = Mucopurulent severe conjunctivitis.
5 = Keratitis and conjunctivitis.

i = 1st instar larvae of the reindeer nostril fly (Cephenomyia trompe L) instilled.
c = control eyes.
L = left.
R = right.

Table 2. Clinical symptoms after instillation of nostril fly larvae in eyes of reindeer in open corral.

No./date		8.7	9.7	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7	19.7	20.7	21.7
21	L	0	i	3	4	4	3	3	2	1	1	0	0	0	0
	R	0	i	3	4	4	4	3	3	3	2	0	0	0	0
22	L	0	i	3	3	3	2	2	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
23	L	0	i	2	4	3	2	2	1	1	1	1	0	0	0
	R	0	i	2	4	3	3	2	(1)	0	0	0	0	0	0
24	L	0	i	2	2	2	2	1	1	1	1	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
25	L	0	i	5	5	3	3	3	3	3	3	2	(1)	0	0
	R	0	i	4	4	3	3	3	3	2	2	1	1	0	0
26	L	0	i	4	4	3	3	3	2	1	(1)	1	0	0	0
	R	0	i	3	4	4	2	3	3	0	(1)	(1)	0	0	0
27	L	0	i	2	2	2	2	2	1	2	(1)	1	1	0	0
	R	0	i	2	2	2	2	2	1	(1)	(1)	(1)	0	0	0
28	L	0	i	3	2	2	1	1	1	1	1	1	1	1	1
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
29	L	0	i	3	4	3	2	2	3	2	3	3	2	2	2
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
30	L	0	i	5	5	5	4	4	4	4	4	4	3	2	2
	R	0	i	4	4	4	4	4	4	4	3	3	2	1	1
31	L	0	i	4	5	5	5	4	4	4	4	2	1	1	1
	R	0	i	1	(1)	1	0	0	(1)	0	0	0	0	0	0
32	L	0	i	4	3	3	2	2	2	2	1	0	0	0	0
	R	0	i	2	1	0	0	0	0	0	0	0	0	0	0
33	L	0	i	3	4	4	4	2	2	2	2	1	1	0	(1)
	R	0	i	2	2	1	1	(1)	(1)	0	0	0	0	0	0
105	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
106	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
107	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0
108	L	0	c	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	c	0	0	0	0	0	0	0	0	0	0	0	0

are shown in Tables 1 and 2. All eyes on which 1st instar larvae of the reindeer nostril fly were instilled showed clinical symptoms of conjunctivitis, while all control eyes remained unchanged. The clinical symptoms were more pronounced in the unsheltered corral. Three of the animals in this corral also developed a typical but mild unilateral keratitis characterized by small (2—3 mm in diameter), greyish, slightly protruding lesions located in the centre of the corneae. None of the cases of keratitis developed beyond this stage and all 3 cases healed after 2—3 days without leaving any traces on the cornea (Table 2). The keratitis in the left eye of 1 calf (no. 25) was associated with a moderate mucopurulent conjunctivitis, while the keratitis of the left eye of 2 calves (nos. 30 and 31) was associated with a severe mucopurulent conjunctivitis.

The larvae were found to move frequently on the surface of the cornea during the first night after instillation, while during the day they remained hidden in the conjunctival sac. Only occasionally larvae were found to move on the surface of the cornea during the second and third nights after instillation. After 72 hrs. no larvae were found outside the conjunctival sac. In order to maintain natural conditions as much as possible during the experiment, no attempts were made to control the presence of larvae in the fornix conjunctiva until the final inspection of the eyes 12 days after instillation. Only occasionally larvae were found in the conjunctival sacs at that time. No larvae were found in the lacrimal ducts of the 15 slaughtered reindeer calves with larvae bilaterally present in the conjunctival sacs.

All the dams remained without ocular changes; but 1 died of indigestion on the last day of the experiment.

The weather was dry and sunny during the first 6 days but changed to variable cloudiness and scattered showers for the remainder of the experiment.

DISCUSSION

Flies of the Oestridae group seldom attack man or animals other than their normal hosts. In such cases, however, they may deposit their larvae not only in the nostrils but also on the eyes and lips and in the outer ear (*Porchinskii* 1915, *James* 1947, *Keiser* 1948, *Krümmel & Brauns* 1956, *Zumpt* 1965).

When deposited on a man's eye, these larvae produce a pain-

ful yet seldom serious form of conjunctivitis. One case of ocular myiasis interna caused by the deposit of 1st instar larvae of Oestrus ovis has, however, been reported from South Africa (*Rakusin* 1970). In typical cases the patient reports having been struck in the eye by an insect or a small foreign body. A few hours later a more or less painful conjunctivitis develops (*Zumpt*).

A finding of 1st instar larvae of Oestrus ovis in the external auditory canal of sheep has been reported by *Roberts & Colbenson* (1963). *Bergman* (1917) and *Mishin* (1954) report that the Cephenomyia trompe flies may attack animals other than reindeer. *Mishin* also reports a case of a boy having suffered from ocular myiasis caused by 1st instar larvae of the reindeer nostril fly.

Hoflund (1956) states that 1st instar larvae of Oestrus ovis may cause keratitis in sheep. He suggests that the larvae occasionally reach the eye through the lacrimal duct.

In the case of reindeer, the number of larvae found in the conjunctival sacs usually varies from 5 to 50 (*Rehbinder*, to be published). Since no larvae have been found in the examined lacrimal ducts of the 15 slaughtered reindeer calves containing larvae in the conjunctival sac, it is likely that the Cephenomyia trompe fly occasionally deposits its 1st instar larvae directly on the eyes of reindeer.

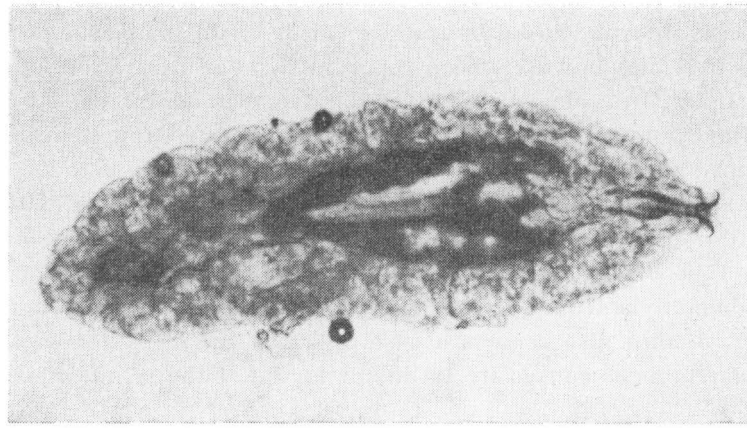
The results of the present experiment show that keratitis occasionally may develop as a result of deposition of 1st instar larvae of the Cephenomyia trompe fly on the eye of reindeer in the presence of sunshine, i.e. ultraviolet radiation.

The main clinical feature is, however, conjunctivitis of different severities and durations. These findings in some respects correlate to the clinical feature of Thelazia infection in the eye of cattle (*Eckert et al.* 1964).

It is likely that keratitis occasionally develops as a result of minor abrasions caused by the large hooks of the larvae (Figs. 1—3) and a concurrent bacterial infection of the conjunctival sac. The larvae have not been proven to act as vectors, foreign bodies or through chemical irritation.

Bacteria different from the normal flora were found in 6 out of 66 eyes (Pasteurella multocida in 5 eyes and Staphylococcus aureus in 1 eye). It is known that in man as well as in animals, bacteria with potentially pathogenic properties to the eye may be harboured in the conjunctival sac without giving any signs

1.



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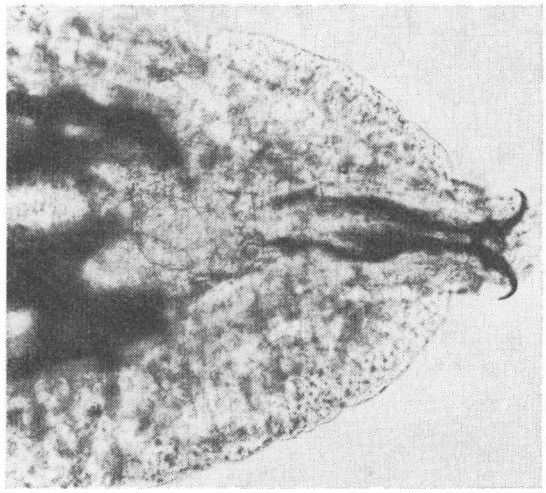

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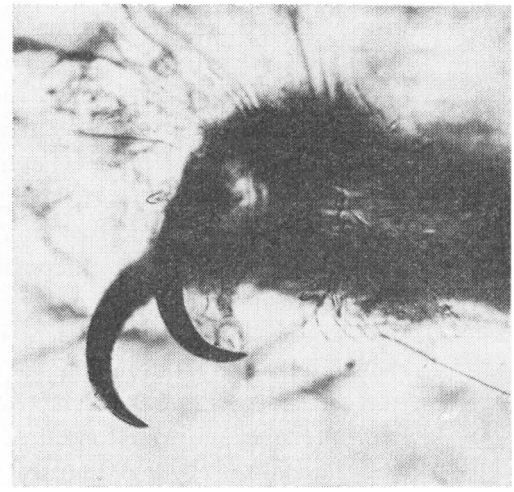

Figure 1. First instar larva of reindeer nostril fly (Cephenomyia trompe L) recovered from the conjunctival sac of a naturally infected reindeer calf. Ventral view. (× 60).

Figure 2. Anterior part of the larva in Fig. 1. (× 90).

Figure 3. Mouth-hooks of 1st instar larva of reindeer nostril fly (Cephenomyia trompe L). (× 500).

of inflammation (*Cason & Winkler* 1954, *Bistner et al.* 1969, *Ojo et al.* 1972, *Young & Hill* 1974, *Rehbinder & Tschäppät* 1974).

Conjunctivae of man having inflammations induced by foreign bodies have been shown to harbour more potentially pathogenic bacteria than those without inflammation (*Christensen & Fahmy* 1974).

In this study it has not been possible to confirm the role of bacterial infections due to the loss of the agar plates during transportation which prevented completion of the bacteriological investigations.

Histopathological investigations have not revealed any signs of internal ocular myiasis (*Winqvist & Rehbinder* 1973).

In the etiology of bovine kerato-conjunctivitis, natural ultraviolet radiation is considered to be an enhancing factor (*Hughes et al.* 1965, *Gray* 1966, *Hubbert & Hermann* 1970, *Hughes & Pugh* 1970, *Pugh & Hughes* 1971, *Pedersen* 1973). The results of the present experiment indicate that these considerations are also relevant when applied to the development of keratitis in reindeer due to the fact that only the animals kept in the unsheltered corral developed keratitis and also developed an overall more severe conjunctivitis than those in the sheltered corral. It is evident that both the 1st instar larvae of the reindeer nostril fly (Cephenomyia trompe L) when deposited on the eye, and natural ultraviolet radiation, may act as predisposing or enhancing factors in the etiology of keratitis in reindeer. In certain cases keratitis may develop when both factors are present.

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REFERENCES

Bergman, A.: Smittosam hornhinneinflammation, keratitis infectiosa, hos ren. (Contagious keratitis in reindeer). Skand. Vet.-T. 1912, *2*, 145—154, 177—207.

Bergman, A.: Om renens oestrider. (Oestridae in reindeer). Skand. Vet.-T. 1916, *6*, 309—340, 1917, *7*, 1—34.

Bistner, S. J., S. R. Roberts & R. P. Anderson: Conjunctival bacteria. Mod. vet. Pract. 1969, *50*, 45—47.

Breew, K. A.: Attack intensity of the reindeer warble fly (Oedemagena tarandi) and bot fly (Cephenomyia trompe L) on reindeer and the parameters regulating this activity. (Swedish transl.). Par. Samml. Akad. Wiss. USSR, zool. Inst. 1956, *16*, 155—185.

Christensen, J. N. & J. A. Fahmy: The bacterial flora of the conjunctival anophthalmic socket in glass prosthesis-carriers. Acta ophthal. (Kbh.) 1974, *52*, 801—809.

Cason, L. M. A. & C. H. Winkler: Bacteriology of the eye. 1. Normal flora. Arch. ophthal. 1954, *51*, 196—199.

Eckert, J., M. Stöber & H. Schmidt: Beobachtungen über das Vorkommen von Augenwürmern (Thelazien) beim Rind in Nordwestland. (Observations on the occurrence of eye worms [Thelaziae] in cattle in North West Germany). Nord. Vet.-Med. 1964, *16*, suppl. 1, 506—516.

Gray, A. P.: Clinicopathologic observations of experimental infectious bovine kerato-conjunctivitis. Thesis, Coll. Vet. Med., Manhattan, Kansas 1966, 169 pp.

Hadwen, S. & L. J. Palmer: Reindeer in Alaska. US Dept. Agric., Bull. no. 1089, Washington 1922.

Hoflund, S.: Fårsjukdomar. (Diseases of sheep). *In* Landbrukets djurbok. Lauritzson, ed., Stockholm 1956, vol. 3, 105.

Hubbert, W. T. & G. J. Hermann: A winter epizootic of infectious bovine keratoconjunctivitis. J. Amer. vet. med. Ass. 1970, *157*, 452—454.

Hughes, D. E. & G. W. Pugh: A five year study of infectious bovine kerato-conjunctivitis. J. Amer. vet. med. Ass. 1970, *157*, 443—451.

Hughes, D. E., G. W. Pugh & T. J. McDonald: Ultraviolet radiation and Moraxella bovis in the etiology of bovine infectious keratoconjunctivitis. Amer. J. vet. Res. 1965, *26*, 1331—1338.

James, M. T.: The flies that cause myiasis in man. US Dept. Agric. Misc. Publ. 1947, *631*, 112—118.

Keiser, F.: Der erste Fall von Ophthalmomyiasis, hervorgerufen von Oestrus ovis L., aus der Schweiz. (The first case of ophthalmomyiasis caused by Oestrus ovis L in Switzerland). Verh. naturf. Ges. Basel, 1948, *59*, 29—44.

Krümmel, H. & A. Brauns: Myiasis des Auges. (Myiasis of the eye). Z. angew. Zool. 1956, *43*, 129—190.

Mishin, J. P.: Invasion of Oestrus nasalis in reindeer on Sachalin in dependence on vibrissae. (Swedish transl.). Zool. Zh. 1954, *33*, 162—165.

Nikolaevskii, L. D.: Diseases of reindeer. *In* Reindeer Husbandry. P. S. Zhigunov, ed. Moskva 1961, Israel Program of Scientific Translation.

Ojo, M. O., T. T. Isoun & D. H. Hill: Avian kerato-conjunctivitis in Nigeria. Trop. Anim. Hlth Prod. 1972, *4*, 156—159.

Pedersen, K. B.: Infectious kerato-conjunctivitis in cattle. Thesis, Royal Veterinary and Agricultural University, Copenhagen 1973, 156 pp.

Porschinskii, J. A.: The russian horse bot fly (Rhinoestrus purpurens) who deposits its larvae in the human eye. (Swedish transl.). Trav. Bur. Entom, Com. Sc. Minist. Agric. Petrograd 1915, *6*, 44 pp.

Pugh, G. W. & D. E. Hughes: Infectious bovine kerato-conjunctivitis induced by different experimental methods. Cornell Vet. 1971, *61*, 23—45.

Rakusin, W.: Ocular myiasis interna caused by the sheep nasal bot fly. S. Afr. med. J. 1970, *44*, 1155—1157.

Rehbinder, C.: Observations of 1st instar larvae of nostril fly (Cephenomyia trompe L.) in the eye of reindeer and their relation to keratitis in this animal. Acta vet. scand. 1970, *11*, 338—339.

Rehbinder, C.: Clinical and epizootiological studies on keratitis in reindeer (to be published).

Rehbinder, C. & V. Tschäppät: Pasteurella pneumotropica, isoliert von der Konjunktivalschleimhaut gesunder Laboratoriumsmäuse. (Pasteurella pneumotropica isolated from the conjunctival sac of healthy laboratory mice). Z. Versuchstierk. 1974, *16*, 359—365.

Roberts, J. J. & H. P. Colbenson: Larvae of Oestrus ovis in the ears of sheep. Amer. J. vet. Res. 1963, *24*, 628—630.

Winqvist, G. & C. Rehbinder: Fine structure of the reindeer cornea in normal conditions and in keratitis. Acta vet. scand. 1973, *14*, 292—300.

Young, C. & A. Hill: Conjunctivitis in a colony of rats. Lab. Anim. 1974, *8*, 301—304.

Zumpt, F.: Myiasis in Man and Animals in the Old World. London 1965, 267 pp.

SAMMANFATTNING

Keratit hos ren. Relation till förekomsten av nässvalgflugans (Cephenomyia trompe L) första-stadie-larver i konjunktivalsäcken samt naturlig ultraviolett strålning.

Betydelsen av att renens nässvalgflugas (Cephenomyia trompe L) första-stadie-larv ibland deponeras i konjunktivalsäcken i stället för näshålan på värddjuret har undersökts. Likaledes har inflytandet av den naturliga ultravioletta strålningen på den inflammatoriska processen i samband med installationen av larver studerats. Det står klart, att nässvalgflugans första-stadie-larver, när de deponeras på ögat, och det naturliga ultravioletta ljuset, var för sig och tillsammans, kan verka som predisponerande eller agraverande faktorer vid uppkomst av keratit hos ren. Keratit kan utvecklas när båda faktorerna föreligger.

(Recived December 1, 1976).

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