Acta vet. scand. 1977, *18*, 159—167.

From the National Veterinary Institute, Stockholm, Sweden.

LENS LESIONS IN THE ELK

By

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KRONEVI, T., B. HOLMBERG and K. BORG: *Lens lesions in the elk.* Acta vet. scand. 1977, *18*, 159—167. — During the period 1973—1976, eyes from 17 elks (Alces a. alces L) were examined, bilateral cataract being found in nine elks, and a cataract found in an additional elk, from which only one eye was submitted for examination. Macroscopically, the lenses were more or less deformed and reduced in size, being milky white or brownish grey and shrunk, their surface uneven and granular. Microscopically, there was a marked fluid accumulation between the lens fibers and apparently also a swelling of the lens fibers. Proliferation and swelling of epithelial cells were observed as well. Etiological factors are discussed.

cataract; elk; congenital; senile; dinitrophenols; ergot; road accidents.

In Sweden, free-living elks (Alces a. alces L) are remarkably often observed to behave as if they were blind. During the years 1973—1976, a number of such as well as normal elks were examined more closely to try to establish any lesions of the eyes as a cause of the presumed blindness.

MATERIALS AND METHODS

Seventeen elks were examined. A complete post-mortem examination was performed in eight elks, and in the remaining ones only eyes and certain organs were provided for examination. Some of the elks were submitted because they were supposed to be blind, others were selected as controls.

After inspection for gross lesions, the eyes were fixed in 10 % neutral formalin and sectioned for histological examination a

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Table 1. Lens lesions in elks (Alces a. alces L), killed or found dead in diftude 56°—57°, Y = latitude 62°—63°). Cadaverous changes (Cc) are denoted in

Animal no.	S.V.A. J.no.	Month County	Sex Age	Body weight	Cc	State of nutrition	Anamnesis —	Post-mortem findings, Bact. exam., etc.
1	P3504/73	Sept. K	♀ 10 yrs	—	3	—		Brain: 0, Eye: 0 Bact.: 0
2	P4741/73	Nov. X	♀ 14 yrs	—	5	Moderately good	Found dead	Chron. ind. nephritis, myocarditis, Bact.: 0
3	O3894/73	Dec. E	♂ 7 yrs	207 kg	4—5	Inanition	Found dead	Chron. arthritis, panaritium
4	O3941/73	Dec. B	♂ 4 yrs	190 kg	3	Inanition	Found dead	Old traumatic injuries, absc. pleuro-peritonitis
5	O3987/73	Dec. D	♂ ½ yr	141 kg	3	Poor	Found dead	Fresh fracture, cervical vertebra, Bact.: 0
6	O3996/73	Dec. Y	♀ 2—3 ms	50 kg	3	Inanition	—	Serous atrophia, Bact.: 0
7	O4022/73	Dec. S	♂ 2—3 ms	61 kg	3—4	Inanition	The calf probably lost its mother	Arthritis, Toxicol: 0, Bact.: β-hemol. streptococc.
8	P1025/74	March S	♀ 5 yrs	—	—	—	Injured in road accid.	Chron. cystitis, Bact.: Pseudom. aeruginosa
9	O1517/74	May C	♀ 5 yrs	240 kg	5	Good	Found dead, calf blind	Parturition obstacle, 2 mature fetuses
10	„	„	Fetus	—	—	Moderately good	Fetus of O1517/74	—
11	P3057/74	Aug. S	— ½ yr	—	4—5	—	Tried climb steepest part of pond wall, drowned	Brain: 0
12	P3596/75	Aug. U	♀ 16 yrs	—	—	Inanition	Behaved as blind, killed	Chron. nephrit. Cataracta capsulolenticularis
13	O4360/75	Sept. O	♀ 3—4 ms	100 kg	4	Good	7 dead elks in the area	Fresh fract. cervical vertebra, Bact.: Cl. perfr.
14	O6250/75	Dec. B	♀ 8 yrs	203 kg	—	Inanition	4 dead elks in the area	Acute myocarddegen. lymphohist. nephr. Bact.: 0
15	P5523/76	Sept. P	♀ 9 yrs	—	3	Poor	Moved in circles	Purulent meningitis
16	P5887/76	Sept. Y	♀ 2 yrs	—	—	—	Killed	Bilateral iridocyclitis, keratitis (Mal. cat. fev?)
17	P6201/76	Oct. D	♀ 18 yrs	—	—	Inanition	Blind, killed	Brain: 0

ferent parts of Sweden. Finding places are indicated by county letters (K = latidegrees from slight (1) to severe (5), age in years (yrs) or months (ms).

Time between fixation and examination	Lens diameter, mm right	left	Lens status
1 day	—	—	Both lenses cataractous and reduced in size, particularly the one lens
2 days and 2½ yrs, resp. lesions similar	17½ × 17½	19 × 19	Right lens smaller than left and slightly cataractous, left moderately cataractous
1 day and 2½ yrs, resp. lesions similar	17 × 14	—	Only right eye examined, lens cataractous, deformed and reduced in size
„	17 × 17	17 × 17	Both lenses normal, transparent, well formed
1 day	16 × 16	16 × 16	„
1 day and 2½ yrs, resp. lesions similar	14 × 12	14 × 12	Right lens somewhat deformed and cataractous, left cataractous and markedly deformed
2 days and 2½ yrs, resp. lesions similar	12 × 12	12 × 12	Both lenses transparent, each with a central, 5 mm indentation on the posterior surface
„	18 × 18	17 × 17	Right lens normal, transparent, left lens somewhat smaller, transparent
„	15 × 15	15 × 15	Both lenses cataractous and somewhat reduced in size
„	11 × 11	11 × 11	Both lenses cataractous
1 day and 2½ yrs, resp. lesions similar	10 × 9	10 × 10	Both lenses cataractous, milky white, right also somewhat deformed with focal indentations, all the lens content transformed into intensely milky white opaque masses
1 day	—	—	Both lenses cataractous and deformed
2 days and 2½ yrs, resp. lesions similar	13 × 13	12 × 10	Both lenses slightly cataractous, the left one somewhat reduced in size
1 day	18 × 18	18 × 18	Both lenses transparent, normal
Examined before fixation and after 18 days, no changes	18 × 18	18 × 18	„
2 days	18 × 18	18 × 18	„
5 days	18 × 18	18 × 16	Both lenses cataractous with intensely milky white, opaque cortical zone

few days later. In addition, lenses from two juvenile and two adult elks (nos. 7, 11, 15 and 17, see Table 1) were sectioned for histological examination. Stains used were hematoxylin and eosin, van Gieson and PAS.

Lenses from all elks were kept in formalin for a varying period of time (see Table 1) in order to establish whether the fixation process itself influenced the transparency of the lens.

RESULTS

Information on the elks, such as sex, age, body weight, anamnesis, as also the time and place of origin, pathological lesions including results of bacteriological examination, and finally lens status, is given in Table 1.

Macroscopical examination

In nine elks there was a bilateral opacity of the crystalline lens of the eye, or of its capsule, obstructing passage of the waves of light, i.e. a cataract. In further one elk from which only one eye was submitted, the lens was cataractous. The cataractous lenses were usually more or less deformed and reduced in size, being milky white or brownish grey and shrunk, their surface uneven and granular (Figs. 1, 2 and 3).

In a female elk as well as in her fetus (nos. 9 and 10), lenses were cataractous and reduced in size, the lenses of the fetus being considerably smaller than those of the mother (Fig. 3).

Figure 1. Right and left cataractous lenses from elk no. 11 (lower part of picture) and a transparent lens from elk no. 7.

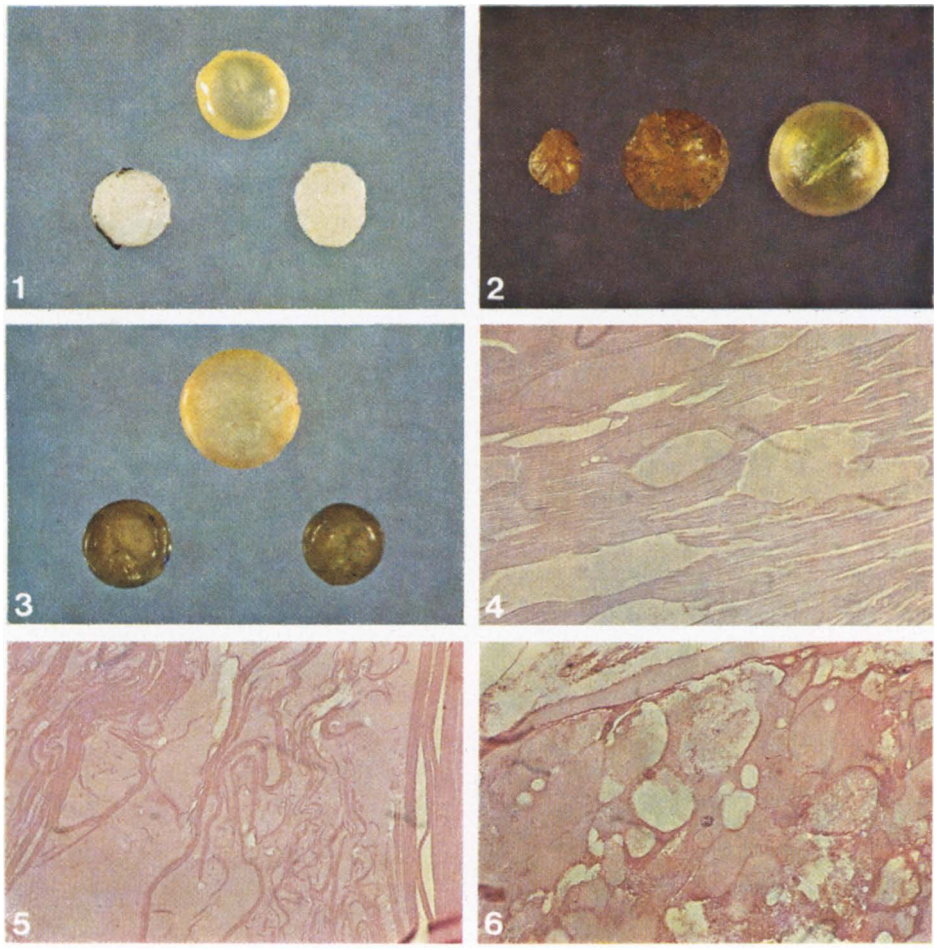
Figure 2. Two cataractous lenses from elk no. 1 (on the left of the picture) and a transparent lens from elk no. 5.

Figure 3. A cataractous lens from elk mother (upper part of picture) and two cataractous lenses (right and left) from her fetus.

Figure 4. Elk no. 11. Fluid accumulation between fibers and apparently swelling of fibers in the lens cortex.

Figure 5. Elk no. 17. Fluid accumulations between fibers and apparently swelling of fibers in the lens cortex. Part of lens nucleus (to the right) with no changes present. Empty clefts between nuclear fibers are the result of technical shrinkage.

Figure 6. Elk no. 17. Numerous "bladder cells" subcapsularly in the equatorial region of the lens.


1
2
3
4
5
6

In one elk (no. 7), the eyes without any signs of cataract, there was an irregular central deformity on the posterior side of each lens.

Microscopical examination

Lens sections from the two elks with macroscopically transparent lenses (nos. 7 and 15) showed no changes.

In the two elks with macroscopically cataractous lenses (nos. 11 and 17), one calf and one old elk, conspicuous changes were present. Thus, in the lens cortex of both elks there was a marked fluid accumulation between the lens fibers and apparently also a swelling of the lens fibers (Figs. 4 and 5). In addition, in the old elk there was a proliferation and swelling of epithelial cells, so-called "bladder cells" or "Wedl cells", in the equatorial region of the lens (Fig. 6).

The fibers in the lens nucleus of the elk calf were swollen, while in the old elk they seemed to be intact.

According to *Hogan & Zimmerman* 1962, the "bladder cells" or "Wedl cells" represent abortive attempts to form lens fibers.

Microscopical examination of other parts of the eyes revealed no changes in the remaining elks, except bilateral iridocyclitis and keratitis in elk no. 16. Despite severe inflammation in the eyes, no lens changes were seen in this elk. The eye lesions mentioned suggest malignant catarrhal fever which will be mentioned below.

DISCUSSION

No differences in the lens status were observed in various stages of postmortal cadaverous qualities.

Some lenses were examined not only after one or two days of formalin fixation, but in addition after a few weeks or years of fixation. The degree of transparency was not influenced by the time of fixation.

Cataractous lens lesions were found in elks of both sexes and of different ages, in fetus as well as in very old animals. Cataractous lenses were also found in elks from different parts of Sweden and during all seasons. The material is not too comprehensive, but yet, the conclusion seems justified that there might be different forms of cataract, which seems rather frequent in the Swedish elk population. The etiological background is, however, unknown.

Cataract may be congenital or caused by a variety of postnatal factors, such as senility, mechanical injuries, metabolic disorders, deficiencies, radiation, inflammatory processes and chemical substances.

Indicated by the finding of one case of blindness due to lens opacity in a fetus of a cataractous elk mother, the Swedish elk population may be affected by congenital cataract. Cataract was also found in young elks, further corroborating the idea that congenital cataract might be significant in the Swedish elk population. Whether this cataract is hereditary or due to a transplacental transport of cataractogenic agents is an open question.

In man, senile cataract is the most frequent form. Some of the elks examined were very old, indicating that this form of cataract also may occur in the elk.

A cataract due to a mechanical injury by which the pigment from the posterior surface of the iris has been detached, was not observed in this material.

A cataract associated with diabetes seems very unlikely to occur in the elk. Diabetes is extremely rare in ruminants and, to our knowledge, this disease has not so far been observed in the elk.

Radiation-induced cataract is known from laboratory animals and man exposed to gamma- or x-rays. It seems, however, unlikely that wild animals, like the elk, should be exposed to intense radiation in their environment.

Some inflammatory processes in the eye may secondarily lead to cataracts (*Hogan & Zimmerman* 1962). In our elk material, there is one case with eye lesions suggestive of malignant catarrhal fever, yet without any signs of cataract. This will be more closely described in a future paper.

Cataract may be caused by a variety of toxic compounds, such as dinitrophenols, organic solvents, diquat, naphtalene, thallium and ergot alkaloids.

Dinitrophenols, some years ago used in man as antiobesity agents, resulted in many cases of cataract, lenticular opacity first developing in the anterior capsule (*Potts & Gonasun* 1975). Dinitrophenols are used as herbicides in pea crops in restricted areas of south Sweden. Pea crops are not elk habitat, however, and it seems very unlikely that elks might have the opportunity to ingest dinitrophenol-sprayed crops to any extent.

Prolonged administration of the dipyridylium-compound diquat in the diet led to bilateral cataract in the rat and the dog (*Calderbank* 1968, *Clark & Hurst* 1970). Diquat has a restricted use in Swedish agriculture, and it seems unlikely that it should be available for elks during a prolonged time.

The intake of naphtalene or thallium by the elk seems unlikely, although thallium was used as a rodenticide against voles some years ago. Both these compounds seem unlikely as causative agents of cataract in the elks examined.

Ergot, a fungeous disease in rye and some other grasses, may cause cataract. In different parts of Sweden, ryegrass is infected with ergots and is thus available to the elk. In fact, some years ago an elk calf was suspected to have been poisoned by ergot showing gangrene of its hind feet (*Nat. vet. Inst.* 1971, unpublished). Ergot as a cause of cataract in the elk seems not to be excluded.

Mono-, di- and trichloro phenoxyacetic acids as salts and esters are dispersed at low concentrations over large agricultural and forestry areas of Sweden. Comprehensive investigations have been performed, yet there are no indications of wildlife being intoxicated by these compounds (*Borg & Erne* 1976), nor to our knowledge do the phenoxyherbicides induce cataract. However, phenoxyherbicides cause an increased content of carbohydrates in some plants utilized as food by the elk (*Hilton et al.* 1963).

The mechanism of cataract formation in experimental animals fed high levels of certain monosaccharides has been much studied. Some enzymes responsible for the metabolism of galactose, xylose and fructose, are lacking in the lens. Overdosage of such saccharides leads to an accumulation of certain metabolites (*van Heyningen* 1971) thus disturbing the osmotic equilibrium in the lens. Disturbances in the glycolysis and respiration due to high galactose content in the lens does also occur (*Sippel* 1966) followed by osmotic disturbance.

The earliest changes appear in the form of subcapsular vacuoles in the equatorial region of the lens, and the cataract process proceeds rapidly to maturity (*Hogan & Zimmerman*).

The increase of carbohydrates in the plants after spraying phenoxyherbicides is moderate, however, and it seems really unlikely that cataract might be induced in this way.

A significantly increased incidence of lens cataract has been observed in workmen occupationally exposed to nitrocellulose

lacquers (*Glezerov* 1956) or generally to organic solvents (*Raitta et al.* 1976). Whether this is due to corneal penetration of solvent vapours or is a systemic effect due to inhalation, or both, is an open question. It is in this connection interesting that long term inhalation exposure of rats to a mixture of alkanes and cyclic hydrocarbons induces cataracts (*Nau et al.* 1966). The mechanism in cataract formation by solvents is unknown. Solvent exposure to wildlife is, however, probably not significant even in industrial areas.

ADDENDUM

During late years, an increasing number of road accidents, elks being involved, has attracted much concern. Mainly, this increase has been ascribed to the multiplying elk population and to the more intense traffic. Factors concerning the elks themselves seem not to have been noted (*Almkvist et al.* 1976).

The obviously high frequency of eye disorders in the elk may, perhaps, contribute to the high number of accidents, the elks not being aware of the traffic.

ACKNOWLEDGEMENT

The authors are indebted to A.-L. Ekborg, E. Jensen and I. Johansson for technical assistance and to I. Ericsson for preparing photographs.

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SAMMANFATTNING

Linsförändringar hos älg.

Under tidsperioden 1973—1976 undersöktes ögon från 17 älgar (Alces a. alces L). Bilateral cataract påvisades hos 9 av dessa älgar. Hos ytterligare en älg, från vilken blott ena ögat erhållits för undersökning, förelåg även cataract. Makroskopiskt befanns ögonlinserna mer eller mindre deformerade, förminskade och mjölkvita eller brungrå samt skrumpna. Ytan var ojämn och granulerad. Mikroskopiskt sågs en påfallande vätskeansamling mellan linsfibrerna och uppenbarligen också en ansvällning av linsfibrerna. Vidare observerades ansvällning av epitelcellerna. Etiologiska faktorer diskuteras.

(Received January 14, 1977).

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