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## STRUCTURE OF THE CORNEA IN SOME CERVIDAE

By

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REHBINDER, C., G. WINQVIST and C. ROOS: *Structure of the cornea in some cervidae*. Acta vet. scand. 1977, 18, 152—158. — The structure of the corneas of adult and young reindeer, roedeer and elk was studied. The corneas were strikingly similar in general appearance. The number of squamous cells was found to be the main difference. The thickness of the cornea and that of the membrane of Descemet was found to be greater in older animals.

cornea structure; biometry; reindeer; roedeer; elk; cervidae.

In a previous publication (Winqvist & Rehbinder 1973) it was noted that the cornea of reindeer (*Rangiferus tarandi* L) had an unusually thick epithelium compared to that of the ox and many other mammals (Tretjakoff 1912, Prince et al. 1960, Ehlers 1970). It was considered to be of some interest to compare the reindeer cornea with that of 2 other cervidae, i.e. the elk (*Alces alces* L) and the roedeer (*Capreolus capreolus* L). Since it is known from developmental studies that the membrane of Descemet is much thinner in young individuals, material was chosen from young as well as from adult animals for measurements of the various layers.

### MATERIAL AND METHODS

Corneas were obtained from 1 adult reindeer bull, 1 year old, and 2 reindeer calves, 1½ months old, 1 male and 1 female, from 1 roedeer buck, 1½ years old, 1 roedeer male kid, 5 months old, 1 elk bull, 3 years old, and 1 female elk calf, 5 months old. The reindeer were slaughtered, while the roedeer and the elk were

Table 1. Relation between cell layers of the epithelium. Spurr-embedded material.

Species Epi- thelial cell layers	Reindeer adult			Reindeer calf			Roedeer adult			Roedeer kid			Elk adult			Elk calf		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Squamous cells	15	31	29	15	25.5	29	9-10	19.5	21	9-10	18	21	12-13	26	12-13	24	25	25
Polyhedral cells	5-6	45	43	4-5	43	49	5	47.5	50	4-5	47	55	5	45	46	5	47.5	50
Basal cells	1	29	28	1	19.5	22	1	28	29	1	21	24	1	27	28	1	23.5	25
Total	21-22	105	100	20-21	88	100	15-16	95	100	14-16	86	100	18-19	98	100	18-19	95	100

A = Number of cells.

B = Average thickness in  $\mu$ .

C = % of total thickness.

shot during hunting. The reindeer corneas could thus be fixed almost immediately, while some time elapsed before those of the other species could be fixed (2 to 10 min.). For fixation a 3 % glutaraldehyde solution, buffered to pH 7.4 with cacodylate, was used. Small pieces were postfixed in 2.67 % OsO<sub>4</sub> solution buffered with S-collidine and embedded in Spurr medium. Transverse sections (1—2 μ) were cut and stained with toluidine blue for light microscopy. For electron microscopy thin sections were cut on an LKB ultratome, picked up on formvar coated grids, stained with barium permanganate followed by uranyl acetate, further by lead citrate, and examined in a Philips EM 201 at magnifications varying between 1,500 and 10,000 times. From each cornea material was also embedded in paraffin, without postfixation, and sections were stained with haematoxylin-eosin and van

Table 2. Average thickness of cornea layers with different embedding media.

Species Structure	Ultrastructural measurements. Spurr-embedded material					
	Reindeer adult μ	Reindeer calf μ	Roedeer adult μ	Roedeer kid μ	Elk adult μ	Elk calf μ
Epithelium	105	88	95	86	98	95
Bowman's membrane	2.6	2.1	1.1	1.0	3.0	2.5
Stroma <sup>1</sup>	520	420	470	390	550	515
Descemet's membrane	13	6.1	24	5.4	22.7	10.3
Endothelium	2.9	2.9	3.1	3.5	3.0	2.9
Total	644	519	593	486	677	626
	Light microscopy measurements. Paraffin-embedded material					
Epithelium	70	65	65	60	70	65
Stroma <sup>2</sup>	370	320	460	345	525	480
Descemet's membrane	20	10	27	6	24	12
Endothelium	2	2	2	2	2	2
Total	462	397	554	413	621	559

<sup>1</sup> The stroma measured on 1 μ sections at light microscopy.

<sup>2</sup> The stroma includes Bowman's membrane.

Gieson for light microscopy. Counting of cell layers was done on electron micrographs. Measurements of all layers except the stroma were done on electron micrographs. The thickness of the stroma was measured directly in the light microscope on Spurr embedded material using an eye piece micrometer. All layers were also measured in the light microscope on paraffin-embedded material for comparison's sake.

### RESULTS

The number of cell layers of the epithelium and their thickness are shown in Table 1. It can be seen that the squamous cell layer (Fig. 1) was thickest in reindeer, followed by elk and thin-

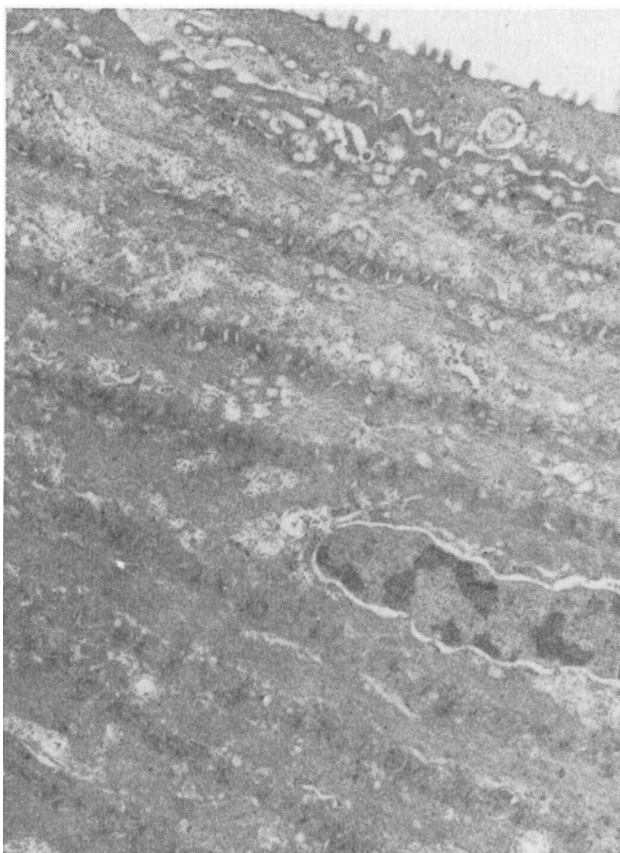


Figure 1. Surface of corneal epithelium. Note cell projections, desmosomes and numerous fine filaments in squamous cells. Adult elk. Magnification 10,500  $\times$ .

nest in roedeer. In all 3 species examined the young animal appears to have a slightly thinner squamous layer, although the number of cells is the same as in adults.

Table 2 gives a comparison of the thickness of different layers in the 3 species and also a comparison of Spurr-embedded and paraffin-embedded material.

The endothelium (Fig. 2) showed very little variation. The membrane of Descemet (Fig. 3), on the other hand, was thickest in adult roedeer, followed by elk and thinnest in reindeer. Most striking, however, was the great difference between young and adult individuals, the young having a much thinner membrane. This difference was most marked in roedeer.

The stroma (Fig. 4) was thickest in the elk. In Spurr-embedded material the stroma was thicker in reindeer than in roedeer, but the opposite was the case for paraffin-embedded material. Adults had a thicker stroma than young.

The membrane of Bowman was only measured on Spurr-em-

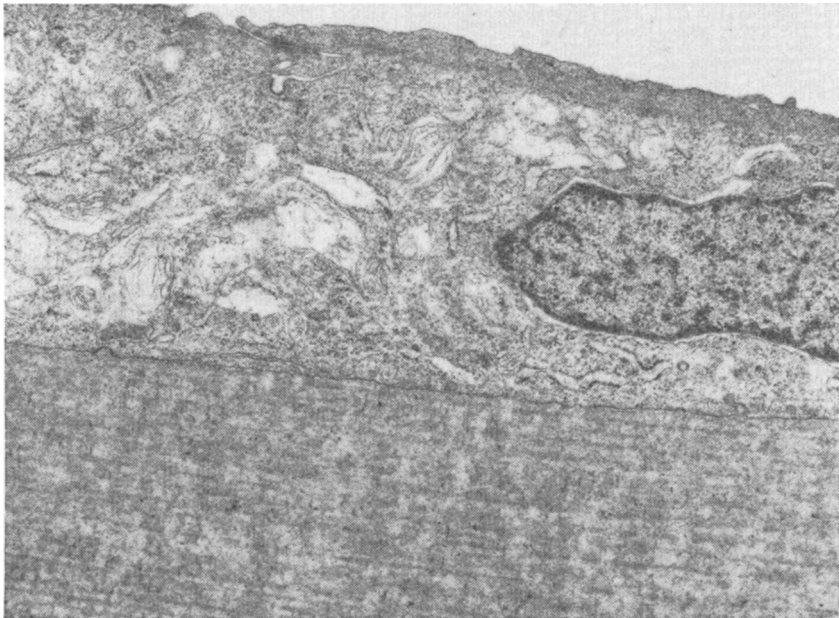


Figure 2. Base of Descemet's membrane and endothelium. Note tight junction near posterior surface of the endothelium, rough surfaced endoplasmic reticulum and mitochondria in endothelial cells.

Adult roedeer. Magnification 15,750  $\times$ .



Figure 3. Descemet's membrane bordered by part of stroma and part of endothelium, respectively. Reindeer calf. Magnification 6,750  $\times$ .

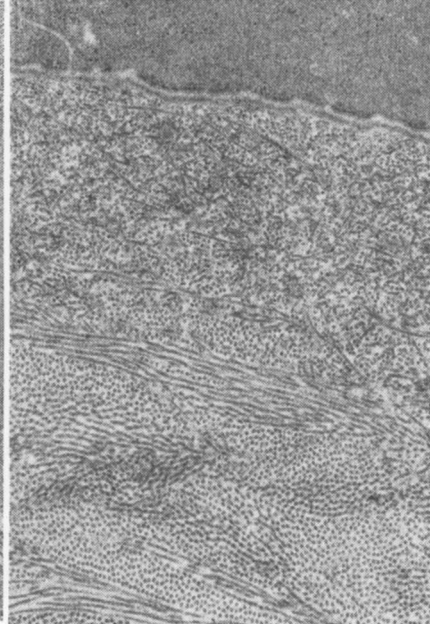


Figure 4. Basal layer of corneal epithelium with hemidesmosomes, basal lamina, membrane of Bowman and part of stroma. Reindeer calf. Magnification 15,750  $\times$ .

bedded material. It was thickest in elk, followed by reindeer, and thinnest in roedeer.

The thickness of the epithelium was much less on paraffin-embedded material. On the whole the cornea was thinner in paraffin-embedded than in Spurr-embedded material.

The ultrastructure of the various layers was the same in all 3 species as described for the normal reindeer cornea in a previous paper (*Winqvist & Reh binder 1973*).

#### DISCUSSION

The structure of the cornea in the 3 species of cervidae examined is strikingly similar. The only noteworthy difference is in the layers of squamous cells in the corneal epithelium, as can be seen from Table 1, the reindeer having the most and the roedeer the fewest cell layers.

The thickness of the cornea was found to be greater in older animals. The opposite seems to be true for human beings (*Ehlers*

et al. 1976). The finding that the membrane of Descemet increased manyfold with age is in agreement with reports in the literature concerning man and animals (Jakus 1964, Hay & Revel 1969, Cogan & Kuwabara 1971, Wulle 1972).

The difference in the thickness of the cornea in Spurr- and paraffin-embedded material may depend on shrinkage or swelling, respectively, during the preparation.

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#### SAMMANFATTNING

*Hornhinnans byggnad hos unga och vuxna renar, rådjur och älgar.*

Hornhinnans byggnad hos unga och vuxna renar, rådjur och älgar har studerats. Det förelåg stora likheter i uppbyggnad. Antalet platt-epitelceller utgjorde den största olikheten emellan de olika djurslagen. Cornea och Descemet's membran befanns vara tjockare hos äldre djur.

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