Cancer eye of cattle

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Cancer of the eye and eyelids is mainly a disease of cattle, although it occasionally occurs in most species of animals and in man. It is the most common cancer in cattle, especially in certain breeds.

The disease has become very important to breeders of Hereford cattle in recent months because of the decision at export meatworks to reject any animal showing obvious signs of cancer eye. This article sets out the current knowledge of the disease and provides information on breeding cattle for resistance to cancer eye.

In Western Australia, meatworks records show that of the 5850 total or partial condemnations in the past three years, 509, or 8.7 per cent, were for cancer eye. The United States Department of Agriculture reported that, for a five year period, 82 per cents of all condemnations of cattle for cancers were for cancer of the eye.

Signs
The first signs of cancer eye are usually raised, whitish areas on the edge of the cornea, or coloured part, of the eye. In a study in the U.S., 75 per cent of the cancers started at the edge of the cornea of the eye. Cancers can also develop on unpigmented areas of the eyelid margin or the third eyelid (or nictitating membrane).

The earliest signs usually take one of the following forms— (1) A raised whitish area or plaque at the outer or lateral junction between the cornea and the white of the eye. (2) A wart-like growth, also on the eyeball. (3) A similar wart-like or horny growth on the skin of the eyelid on or near the hair line.

As the disease progresses, the eye becomes ulcerated; bleeding and excessive tear production is common, and the growth is invaded by bacteria and develops externally into a festering, foul-smelling cancer. The cancerous tissue also grows inwards and invades the deeper tissues behind the eye, the lymph nodes of the head and finally the internal organs such as the lungs and liver. Those cancers that begin in the third eyelid or on the outer eyelids usually invade the deeper tissues more quickly than those that start on the eyeball. The bones of the face surrounding the eye are commonly affected.

Incidence
Cancer eye has always been associated with the Hereford breed more than any other, although it has been recorded at a very low incidence in Friesians. In one study in the
U.S., 3314 cattle from 25 breeds and breed crosses showed the following incidence of cancer eye: Herefords 12 to 37 per cent, Hereford crosses 1 to 8 per cent, Friesians 0 to 1 per cent, others 0 per cent. These figures clearly show that the highest incidence is in Herefords.

Observations in many parts of the world also suggest that there is a higher incidence of cancer eye in cattle in tropical areas than in temperate areas, Table 1 shows results obtained in the U.S., which indicate the effect of latitude, altitude and hours of sunlight on the frequency of the disease.

Incidence of cancer eye also increases with age—it is rarely seen in cattle younger than four years. The percentage of cattle affected then increases to a maximum at 11 to 12 years. The age incidence in a group of Hereford cattle ranged from 0.5 per cent at four years to 12.1 per cent at 12 years.

Animals left untreated usually live an average of 2 to 5 years from the first appearance of the cancer, but in many cases animals can become weak and emaciated within six months. It is rare for more than one eye to be affected on an animal.

**Meat export requirements**

Cattle consigned to export abattoirs are inspected by Department of Primary Industry veterinary officers before slaughter. Any cattle showing clear and unmistakable evidence that they are affected by disease or condition that would necessitate condemnation of their carcass as a source of human food are classified as “Aust. Condemned”. Such cattle are not eligible for treatment over the slaughter floor, and no part of the carcass is permitted to enter or pass through any section of the abattoir where edible product is being handled, prepared or stored.

Cattle with cancer eye would be condemned if—(1) there is extreme loss of condition regardless of the extent of eye abnormality, and (2) there is extensive eye damage or other areas near the eye are involved and there is gross infection of the tumor.

Cattle affected to a lesser degree than that set out above are classified as “Aust. Suspect”. These cattle have signs which are inconclusive or suggest that should the animal be slaughtered it may be possible to salvage all or part of the carcass for human food. If the tumor has spread to the deeper lymph nodes of the body, to internal organs, muscles etc., the carcass will be condemned regardless of the extent of the lesion on the eye. With lesser degrees of cancer eye, the carcass may be passed if the head and tongue are removed and provided the carcass is in good condition.

**Predisposing causes**

Besides the results listed in Table 1, many other observations provide evidence of the association between cancer eye and sunlight. They all support the hypothesis that sunlight, more specifically the ultraviolet component of sunlight, is an important factor in the development of cancer eye.

Further support for this hypothesis comes from the observation that cancers frequently develop on unpigmented parts of the eyelids. In records of many thousands of eyes no cancers have ever been observed to originate in the pigmented areas of the eyelids. In one survey of 842 cattle, 17.6 per cent of the animals with no lid pigmentation in either eye had lid cancers compared to 8.9 per cent of those with lids partially pigmented and 4.8 per cent with lids heavily but not completely pigmented. No animals with completely pigmented lids had lid cancers.

Lid pigment has little inhibitory effect on cancers developing on the eye itself or on lid cancers on the other eye if it is not pigmented. Pigment also occurs on the eye in the area at the junction between the cornea and the white of the eye. This is called corneoscleral pigment and is always present in almost all breeds of cattle, except Herefords and some Friesians. This pigment occurs to varying degrees in Herefords, but is usually not discernable until the animal is about five years of age. Pigmentation at the corneoscleral junction helps explain differences among breeds and breed crosses in their susceptibility to cancer on the eyeball (Table 2).

The scoring system explained in Table 2 shows that breeds such as Angus, Shorthorn, Santa Gertrudis, Jersey etc. have pigment throughout the entire or major parts of the corneoscleral area. In none of these breeds is there a complete absence of pigment. Cancer eye is rarely, if ever, observed in these breeds. By comparison, Herefords,

Table 1—Frequency of cancer eye according to amount and intensity of sunlight.

<table>
<thead>
<tr>
<th>Factor affecting radiation</th>
<th>Sunlight intensity or amount</th>
<th>No. of animals</th>
<th>Age adjusted frequency of cancer eye</th>
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</thead>
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<tr>
<td>Latitude</td>
<td>Low</td>
<td>3,445</td>
<td>3.6</td>
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<td></td>
<td>Medium</td>
<td>361</td>
<td>7.8</td>
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<tr>
<td></td>
<td>High</td>
<td>1,154</td>
<td>9.2</td>
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<tr>
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<tr>
<td></td>
<td>Medium</td>
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</tr>
<tr>
<td></td>
<td>High</td>
<td>381</td>
<td>9.7</td>
</tr>
<tr>
<td>Hours of sunshine</td>
<td>Low</td>
<td>3,445</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>823</td>
<td>5.6</td>
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<tr>
<td></td>
<td>High</td>
<td>692</td>
<td>11.7</td>
</tr>
</tbody>
</table>

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Hereford (aged). A—only two small areas of corneoscleral pigment. B—no pigment on the third eyelid. Surrounding flesh removed.

Hereford (aged). A—adequate corneoscleral pigment on inner and lower sides. Surrounding flesh removed.

Hereford crosses and some Friesians may have only small amounts of pigment in this area and it is in these breeds and crosses that eye cancers are most frequently observed.

These results show that cancer eye may develop in any breed or animal in which pigment is lacking from either the eyelids or the corneoscleral junction of the eye.

The genetics of cancer eye

Genetic studies of cancer eye have mainly been concerned with estimates of the heritability of the various eye characters involved, so that the value of selective breeding programmes can be determined. If the heritability is high (near 1.0) then a large proportion of the offspring will be like the selected parents. If the heritability is low (near 0.0) then calves will tend to be like the average of the herd rather than like their parents and selection will produce little improvement.

With eye cancer, the characters that have been investigated are susceptibility to the disease, lid pigment, corneoscleral pigment, and the relationship between lid and corneoscleral pigment. The results of these studies suggest the following heritabilities for these characters.

Susceptibility to the disease has a heritability of 0.2 to 0.4. This result was obtained with Herefords. There are large differences between breeds and breed crosses and these have been mentioned earlier in the article.

Lid pigment has a heritability of 0.4 to 0.5, and will respond well to selection.

Corneoscleral pigment has a high heritability of 0.5 to 0.7. This estimate has been calculated from studies of Herefords.

Lid and corneoscleral pigment appear to be genetically correlated. The genes affecting lid pigment also have an influence on corneoscleral pigment, and vice versa.

Prevention of eye cancer

Cancer eye in cattle can be controlled by selective breeding.

In the case of the disease susceptibility character, selection will be difficult because the disease does not express itself until the animal reaches an advanced age. It would be impractical to defer breeding until an age when the presence or absence of a cancer will allow selection to be carried out.

Selection for increased amounts of pigment in the lids and corneoscleral junction is an effective means of reducing the frequency of cancer eye. Since lid pigment is present at birth, or shortly afterwards, selection can be directed more towards lid pigment than corneoscleral pigment. Corneoscleral pigment is not fully expressed until about five years of age, but the positive relationship between this and lid pigment allows improvement in the amount of corneoscleral pigment in the course of selecting for pigmented lids.

With lid pigmentation having a heritability of 0.5 and the incidence of pigmentation being 40 per cent in a herd of Herefords, selection could change the incidence of pigmentation at the rate shown in Table 3.

Progress in selection for lid pigmentation can be very rapid and it could be firmly recommended that Hereford breeders practice strong selection for pigmented eyes in order to reduce the incidence of cancer eye. The breed points published by the Australian Hereford Society indicate that this pigment is desirable.

For those breeders who are not committed to the production of pure Herefords, cross breeding would provide a means of increasing the amount of pigmentation. For Hereford breeders, bulls should be selected for pigmentation in the lid and corneoscleral junction.

Producers breeding Hereford cattle would be well advised, regardless of what breeding and selection programmes they use, to cull all animals as soon as any sign of cancer eye or a precursor lesion is noticed. This will have the effect of reducing the condemnation level as well as allowing some salvage value for the animal before the more advanced stage of the disease prevents slaughter for human food.

References
