SUMMARY: Bovine enzootic haematuria was diagnosed in Queensland in coastal areas in association with bracken fern (Pteridium esculentum) on 3 properties, or with mulga fern or rock fern (Cheilanthes sieberi) on 4 properties. In inland areas, it was associated with C. sieberi on 3 properties. In the absence of bracken fern, long-term ingestion of C. sieberi is suggested as a cause of bovine enzootic haematuria. Haemangiomas, haemangiosarcomas, transitional cell carcinomas, papillomas, fibromas and an adenoma were detected in the urinary bladders of 19 affected cattle and were accompanied by chronic cystitis.

Introduction

Bovine enzootic haematuria (BEH) is a worldwide disease (Pamukcu 1963), characterised by chronic haemorrhage from neoplasms in the urinary bladder mucosa. It has been known in Australia since the late nineteenth century (Stanley 1892) and has been reported from all states (Dickinson 1940).

Long-term ingestion of bracken fern (Pteridium aquilinum) by cattle has been shown to cause the disease under experimental conditions by Rosenberger and Heeschen (1960) and Pamukcu et al (1967a). Pteridium esculentum, the common bracken in Australia, is closely related to P. aquilinum and produces the same acute toxicity syndrome in cattle (Skerman and Newton 1952). P. esculentum is the only species of bracken in southern Queensland, where it is generally confined to coastal districts (Everist 1974).

Some recent Queensland cases of BEH have originated from properties in inland districts beyond the recognised range of P. esculentum. This finding prompted an investigation of BEH in Queensland, some results of which are reported here.

Materials and Methods

Properties affected by BEH between 1960 and 1976 were identified by examining departmental records and specimens submitted from clinical cases during 1973 to 1976. Clinical diagnoses were based on case history, haematology and urine examination. Specimens for pathological examination were collected at autopsy or after slaughter at abattoirs. Tissues for histopathological examination were fixed in 10% formalin, paraffin sections cut at 6 μm and stained with haematoxylin and eosin. Neoplasms detected were classified in accordance with the World Health Organisation International Histological Classification of Tumours of Domestic Animals (Pamukcu 1974; Weiss 1974).

Properties where BEH occurred were visited, and pastures on which affected cattle grazed were examined with particular reference to types of fern present. Information was obtained on pasture management practices and on the occurrence of papillomatosis in the cattle herds.

Occurrence

Between 1960 and 1976, cattle diagnosed clinically and pathologically as affected by BEH originated from 10 properties from which epizootiological information was obtainable. These properties were in the Dundas, Brightview, Dayboro, Kilkivan and Atherton districts in the coastal region, and in the Taroom, Roma and Morven districts to the west. (Figure 1). Cases of BEH occurred sporadically on these 10 properties, on 4 of which only one clinical case was reported. On another 4 properties the number of cases reported was 2, 3, 4 and 9; and on the 2 worst affected, 16 and 20 cattle in herds of between 100 and 300 cattle developed BEH in the 5 year period to 1975. All affected cattle had been born and reared on these properties, except on one property where the animals had been introduced 8 years before becoming affected.

Clinical Findings

Cows of both beef and dairy breeds were affected, namely Hereford, Hereford-Shorthorn cross, Beef Shorthorn, Dairy Shorthorn and Friesian. When first noticed ill most were 4 to 6 years of age (range 3 to 14 years). Owners reported these cows as failing to thrive when compared with the remainder of the herd and/or some were passing dark brown to red urine. Some cows passed blood clots in their urine. The severity of haematuria fluctuated considerably in early cases, but gradually worsened. Haematology revealed anaemia in most cases, which worsened as the haematuria intensified. In severe cases haemoglobin fell to levels of the order of 3 g/100 ml, haematocrits to 10%, and serum protein levels to 4 g/100 ml. Numerous erythrocytes were seen on microscopic examination of urine. These
animals were cachectic and had developed ascites and submandibular oedema.

Pathology

Autopsy of 19 affected cattle revealed pale tissues, depleted fat reserves, and commonly ascites and submandibular oedema. The urine was dark brown to red, often with blood clots, and the urinary bladder walls contained the neoplasms indicated in Table 1.

The adenoma was a sessile polyp 2.5 cm in diameter in the neck of the bladder, composed of multiple acini of tall columnar epithelium extending into the submucosa. The transitional cell carcinomas were sessile and infiltrating with sheets of epithelial cells penetrating into the submucosa.

The haemangiomas were dark red, sessile polyps 0.5 to 1 cm in diameter and were composed of numerous irregular vascular spaces distended with blood in the lamina propria in close apposition to the epithelium. The haemangiosarcomas were larger lesions (up to 5 cm diameter) with ulcerated surfaces and adherent blood clots. They comprised multiple, blood-filled, irregular, closely grouped, fine channels lined by endothelial cells with prominent nuclei and relatively abundant cytoplasm. These structures penetrated the submucosa, the muscular layers of the bladder wall and the subserosa.

Fibromas were discrete, smooth, white nodules 1 to 3 mm diameter composed of loosely-whorled fibrocytes and collagen lying in the lamina propria. The papillomas were pedunculated structures having a single layer of transitional epithelium on a many-branched, fine, connective tissue stroma.

In all cases neoplasms were accompanied by chronic inflammation of the surrounding mucosa, including proliferative epithelial changes (von Brunn's nests, cystitis cystica). Papillary cystitis was seen in 5 bladders. Congestion, oedema and haemorrhage occurred in the lamina propria in all cases, with erythrocytes also present between and within transitional epithelial cells in 12. Diffuse and focal infiltrates of lymphocytes and plasma cells were present in the lamina propria and submucosa, with haemosiderin-containing macrophages in 6 cases.

In addition to bladder neoplasms, 2 cattle from 2 Dayboro district properties, on which P. esculentum grew, were found to have multiple haemangiomas in their livers. These lesions were distinguished from telangiectasis by being up to 4 cm in diameter, composed of irregular vascular spaces lined by endothelium of immature appearance, and surrounded and infiltrated by young fibrous tissue and mononuclear inflammatory cells.

Epizootiological Findings

In the coastal region 6 affected properties were in hilly terrain which had been cleared of the original forest vegetation and 1 was based on flood plains of watercourses, with part of the property on low ridges with lighter soil types. The 3
properties in inland regions were in various types of semi-arid woodlands and scrublands.

All but 1 coastal property practised annual burning of their pastures during late winter or early spring, between one-quarter and the whole property being burnt each year. Inland properties did not "burn off" regularly. Cattle stocking rates varied widely between properties and with changing seasonal conditions. Most cattle herds were reported occasionally affected by infectious papillomatosis.

*P. esculentum* was available to cattle on 3 properties in the coastal region, but on none inland. *Cheilanthes sieberi* (mulga fern or rock fern) was present in moderate to large quantities on the other 4 coastal region properties, and on all 3 inland properties. *Cheilanthes distans* and *Adiantum* sp were found on some properties but these ferns were in small amounts and confined to small areas. The ferns detected on affected properties are indicated in Figure 1.

Where *C. sieberi* was present on affected properties, it grew in intimate association with pasture grasses as well as in separate discrete clumps throughout the pastures. Evidence that fronds had been grazed was seen on close inspection of these pastures.

**Discussion**

This investigation has established the clinical signs and pathology of BEH in Queensland as consistent with those described from other enzootic areas of the world (Plummer 1944; Pamukcu 1955, 1957; Resang and Sikar 1960; Mugera and Nderito 1968; Nandi 1969; Smith and Beatson 1970). Haemangiomas of the liver associated with BEH have previously been reported in Kenyan cattle with access to bracken (Pedley 1974). In a feeding trial (unpublished) conducted in 1975-6, 2 cows, each fed 20 gm *C. sieberi* daily for 600 days, developed no clinical signs of BEH, possibly because of inadequate dosage of fern, inadequate duration of feeding, or other factors.

On Queensland coastal properties annual burning of pasture may encourage the growth of *C. sieberi*. This fern grows rapidly from its rhizome following rain, and the reduction of competition for light by the burning of surrounding grasses may have improved its capacity for growth and dispersal in the pasture. Its habit of growing in close association with the pasture grasses makes it particularly liable to involuntary ingestion by grazing cattle. In areas of western Queensland where mulga (*Acacia aneura*) is the dominant tree, *C. sieberi* is abundant and often comprises the only ground cover where the tree canopy is dense (Pedley 1974). A large number of sheep have access to this fern in western Queensland but neither a haemorrhagic syndrome nor neoplastic lesions have been attributed to this association. Bladder neoplasms have been recorded in Victorian sheep with access to *P. esculentum* (Harbutt and Leaver 1969). In a feeding trial (unpublished) conducted in 1975-6, 2 cows, each fed 20 gm *C. sieberi* daily for 600 days, developed no clinical signs of BEH, possibly because of inadequate dosage of fern, inadequate duration of feeding, or other factors.

The virus of bovine cutaneous papillomatosis cannot be completely disregarded as a possible cause of BEH in Queensland as warts were occasionally reported in affected herds. Bovine bladder tumours have been produced by experimental inoculation of this virus and it has also been isolated from naturally-occurring bovine bladder tumours (Olson et al 1969). However, some doubt...
had been raised about this hypothesis by the failure of vaccination with the virus to protect cattle against BEH (Pamukcu et al. 1967b). Herpes-like virus has also been isolated from bovine bladder neoplasms but its significance is unknown (Kaminjolo et al. 1972).

This investigation has provided further evidence that bracken is a cause of BEH and considerable circumstantial evidence that the ingestion of C. sieberi is a major cause of BEH in Queensland cattle.

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BOOK REVIEW

SALT POISONING IN PIGS

In a doctoral thesis* from the Royal Veterinary and Agricultural University of Copenhagen, Nils Gyrd-Hansen gives an account of the occurrence, experimental induction, changes in tissue composition, and therapy of salt poisoning. It is difficult to induce salt poisoning in pigs fed individually with salted food and restricted in access to water unless the animals are previously fasted. The pig exhibits a marked capacity to adjust the intake of salted food according to the size of the water ration. The concentrating ability of the pig kidney is comparatively low, but given free access to water, the pig can excrete very large amounts of sodium and chloride without any change in glomerular filtration rate or renal blood flow.

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