BOVINE BESNOITIOSIS, AN EMERGING DISEASE

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INTRODUCTION

Bovine besnoitiosis (elephant skin disease) is a costly endemic disease in the Middle East, Asia, tropical and subtropical Africa and is also emerging as a significant problem in Europe. In cattle infected with the causal organism, *Besnoitia besnoiti*, merozoites proliferate in macrophages, endothelial cells and fibroblasts causing vasculitis and thrombosis. The subsequent cellular destruction and immune response leads to the characteristic acute signs of anorexia, lethargy, generalised skin oedema and the chronic signs of alopecia and scleroderma (Radostits et al 2010).

Of the 7-9 species of *Besnoitia,* three affect domestic livestock. In addition to *B. besnoiti* in bovids, *B. caprae* infects goats and *B. bennetti* affects equids (Radostits et. al. 2007). *Besnoitia* belong to the phylum Apicomplexa, a diverse group of largely parasitic protozoa of considerable veterinary and medical importance. Members include the genera *Plasmodium*, *Cryptosporidium*, *Eimeria*, *Isospora*, *Giardia*, *Sarcocystis*, *Toxoplasma*, *Neospora*, *Theileria* and *Babesia*.

SIGNIFICANCE OF BOVINE BESNOITIOSIS

Bovine besnoitiosis is an important disease in Africa (for example Njagi et al 1998) and the Middle East. In the 1990s, it emerged in Spain, Italy (Manuali et al 2011), France and Portugal (Cortes et al 2006) causing considerable loss of production and occasional mortality (Jacquiet 2010, Maqbool 2012) (Figure 1). In common with bovine anaemia caused by *Theileria orientalis,* an apicomplexan disease now emerging in southern Australia, 'many aspects of the epidemiology of bovine besnoitiosis remain uncertain including prevalence and incidence of infection and disease in endemic areas, routes of transmission and risk-factors associated with infection and disease' (European Food Safety Authority 2010). While it is presumed that *B. besnoiti* has a heteroxenous life cycle involving intermediate and final hosts, definitive predatory host(s) have not been identified. There are, however, indications of horizontal transmission either directly through open skin lesions or from biting flies.

Figure 1. Geographic distribution of bovine besnoitiosis in Europe from before 1990 until 2010

CLINICAL SIGNS OF BOVINE BESNOITIOSIS

Typically, cases of bovine besnoitiosis have an acute then chronic stage with varying pathogenicity. Many infected animals are asymptomatic while some are severely affected. In 1-10% of cases, the infection is fatal. There appears to be no sex or breed predisposition, but calves less than six months of age are rarely affected. Acutely affected cattle may appear depressed, lame and febrile with anasarca, lymphadenopathy and weight loss. In the chronic phase of the disease, the skin, initially swollen and painful becomes increasingly thickened and folded with alopecia, hyperkeratosis and scleroderma. Parasitic cysts occur within the mucosa of the conjunctiva and /or vagina and in subclinical cases. These may be the only sign of the disease (European Food Safety Authority 2010). Bulls infected with *Besnoitia* develop cysts and necrosis in the testes, epididymes and blood vessels and may become sterile. Infected cows may abort (Maqbool 2012).

Figures 2. Painful thickened skin and 3, cystic scrotal dermatitis (and presumed orchitis). (Jacquiet et al 2010).

Figure 4. A chronic case of bovine besnoitiosis with scleroderma and typical cysts within the sclera and conjunctiva, (Jacquiet et al 2010). Arrow points to one of many typical pinhead sized cysts.

DIAGNOSIS

Cytology, serology, histopathology and PCR testing are available to diagnose bovine besnoitiosis (European Food Safety Authority 2010). Fernández-García et al (2010) reported that the ELISA test developed was highly sensitive and specific and could be a value both as a means to establish seroprevalence and in control programs. In Australian exotic disease exclusion, demonstration of the characteristic banana shaped merozoites (bradyzoites) in scleral conjunctival smears or skin biopsies would most rapidly and accurately establish a diagnosis.

TREATMENT

There are no effective drugs or vaccines currently available in Europe. However, a live-attenuated vaccine has been used successfully in South Africa and Israel (European Food Safety Authority (2010).

DISCUSSION

THE APICOMPLEXANS

The apicomplexans are a phylum of protozoa that are distinguished by possessing a complex of organelles at the apical end (Figure 5). Their life cycle has three phases, sporogony, merogony and gametogony. Aided by these apical organelles, all invade or attach to host cells at some stage. Some genera such as *Eimeria* and *Cryptosporidia* complete all three phases within one host and usually within the one cell or tissue type. They are therefore termed monoxenous (*mono* plus Greek *xenos* meaning guest-friend, stranger). Others, including *Toxoplasma, Neospora, Besnoitia* and *Sarcocystis*, however are heteroxenous and usually complete the intermediate, asexual phase of their life cycle in prey species and the final, sexual phase in a predator. Sporulated sporocysts passed in the faeces of the final host, when ingested by the intermediate host, produce merozoites, which invade the host tissues. They often show tropism towards muscle, brain, endothelial cells, testes or the foetus depending on the predilection of the species of parasite involved (Ajioka and Sibley 2007, Wiser MF 2012).

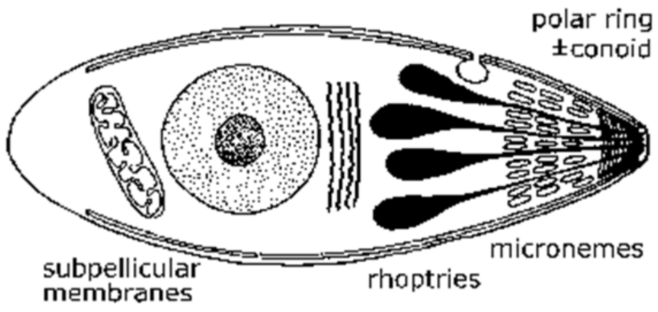

Figure 5. General Apicomplexan structure. Invasive and/or motile forms of apicomplexa exhibit distinctive ultrastructural features including the characteristic complex of organelles at the apical end (Wiser 2012).

In bovine besnoitiosis, both domestic and wild bovids act as intermediate hosts but the final hosts are unknown. Cats however are the definitive host in some other *Besnoitia* species. As mentioned, arthropods such as biting flies may transmit *B. besnoiti* and the alternate intermediate hosts, wild ruminants (such as antelopes) and rodents, may therefore act as reservoirs (European Food Safety Authority 2010).

BESNOITIOSIS IN AUSTRALIA

There is no evidence of besnoitiosis in Australian livestock. Nasir et al (2011) surveyed 51 beef herds and 131 dairy herds in South Australia for *Neospora caninum* and *B. besnoiti*. They found no serological evidence of *Besnoitia*. However, *Besnoitia spp* have been isolated from western grey kangaroos (*Macropus fulginosus*). Most recently, in July 2011, western grey kangaroos from a South Australian property presented with epistaxis, with a presumptive laboratory diagnosis of besnoitiosis. *B. wallacei* has been isolated from rats (*Rattus norvegicus*), with cats the final host. (Mason 1980).

SIGNIFICANCE OF BOVINE BESNOITIOSIS TO AUSTRALIA

In Europe, infected cattle are considered the main source of new infections. While clinical cases are easily diagnosed, sub-clinical cases are more difficult to detect and so may act as reservoirs for the disease (European Food Safety Authority 2010). Australian quarantine restrictions, that prevent the entry of live animals, should exclude cattle infected with *B. besnoiti* but as the final hosts are not known, it is difficult to ensure that they will be excluded from importation. Should the parasite enter Australia, surveillance, tracing and knowledge of the definitive host(s) would be important in its eradication.

An Australian veterinarian, confronted with animals acutely infected with *B. besnoiti*, showing a fever, anasarca, depression, lymphadenopathy and weight loss, might not suspect besnoitiosis initially. The list of differential diagnoses would include a range of infectious diseases (such as malignant catarrhal fever, ephemeral fever, sporadic bovine encephalitis and histophilosis), degenerative diseases (such as cardiomyopathy), toxins (such as *Pimelea*) and neoplasms (such as lymphosarcoma).

The chronic phase is more characteristic with alopecia and scleroderma. Differential diagnoses include skin diseases such as (exotic) lumpy skin disease, uncommon but endemic pseudo lumpy skin disease (Allerton virus infection), vetch toxicosis, pediculosis, buffalo fly worry, generalised dermatomycosis and the various forms of mange. However, an Australian veterinarian, conducting a routine clinical examination, should notice pinhead sized cysts within the dermis or conjunctival or vaginal mucosa and therefore should suspect besnoitiosis. The diagnosis could be confirmed by smear examination or histopathology.

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Case Report: Protein-energy malnutrition in late pregnant dairy cattle

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A case of protein-energy malnutrition was investigated on a dairy farm near Maffra, Victoria in August 2013. The farmer sought veterinary advice following the recumbency and death or euthanasia of four cows in a group of 50 late-pregnant dry dairy cows within a week. The cows had been grazing a 150 acre property with minimal dry standing feed for the past 3-4 weeks. They were being supplemented with an 8 x 4 x 3 bale of wheaten straw, approximately 300kg of almond hulls every second day and had ad lib access to 7% urea lick blocks. A further two recumbent cows were examined by the attending veterinarian and were found to be in reasonable body condition (3.5-4/8), bright, good appetite and had no abnormalities on clinical examination. Both cows were on the point of calving with large fetuses palpable rectally. An analysis of the diet based on mid-range published values for the supplementary feeds revealed a total intake of approximately 80-90 MJ ME/cow/day and a dietary crude protein of approximately 7%. It was concluded that the deaths were attributable to a severe protein deficiency and moderate energy deficiency despite the farmer's best efforts to maintain his cattle through the feed shortage of winter 2013. 2.5-3kg of dry distillers grain (CP ~20-24%) was immediately introduced into the ration and in the preceding month the farmer experienced no further losses. This case highlights the importance of a basic understanding of dairy cattle nutrition for new and recent graduates embarking on a career in dairy practice and the usefulness of back-of-the-envelope nutritional analyses in assisting farmers through tight times.

A cow with protein-energy malnutrition (not from this case)