

Arbovirus infections of animals: congenital deformities, encephalitis, sudden death and blindness



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Viruses from five different taxonomic families have been shown to be the cause of disease outbreaks in either domesticated or wild animals. These include viruses spread by both mosquitoes and biting midges from the genus *Culicoides*, especially *C. brevitarsis*. A number of arboviruses also present significant impediments to the international movement of live animals, semen and embryos.

Alphaviruses

Ross River virus is intermittently incriminated as a cause of fever, lethargy and arthralgia in horses. However, there are few cases supported by convincing laboratory confirmation.

Flaviviruses

Infection of dogs, chickens and horses with Murray Valley encephalitis virus (MVEV) and West Nile Virus (WNV) occurs intermittently in regions where there are large mosquito populations. However, disease is rare and has only been reported in horses. In 2011 there was an outbreak of neurological disease in horses in southern Australia¹, with MVE identified in five horses that died in Victoria². A few MVE cases were also confirmed in NSW and SA. Otherwise there have only been a few sporadic cases confirmed^{3,4} with anecdotal reports of others⁵.

Concurrent with the MVE cases in 2011 in NSW there was an extensive outbreak of encephalitis in horses due to WNV, with approximately 1100 cases observed and a case fatality rate of 11% (A.J. Read *et al.*, unpubl. data). A number of cases were also observed in SA and Victoria. This large outbreak had a number of unusual features. This was the first epidemic of equine neurological

disease due to WNV in Australia. Unlike the 1999 outbreak in the USA, no cases were observed in birds. The NSW 2011 outbreak was due to a variant strain of WNV of Australian origin⁶. The geographic distribution was also unusual. While there were cases throughout the Riverina Region (where the first outbreak of MVE had occurred in people), cases were distributed throughout the Central and Northern Tablelands (extending from Forbes to Narrabri), with a large number of cases in the Hunter Valley, the Sydney Basin and Illawarra region. WNV had never been detected on the eastern side of the Great Divide previously.

Orbiviruses

The *Orbivirus* genus of the family *Reoviridae* contains a large spectrum of viruses that cause disease in livestock and wildlife. Most are transmitted by biting midges but some are spread by mosquitoes and ticks. Viruses belonging to the bluetongue serogroup (BTV) have an extremely high profile globally, either as a cause of disease, mainly in sheep, or through international trade restrictions. Of the 29 serotypes, 12 have been detected in Australia. Most are detected intermittently in the far north of Australia, although serotypes 1 and 21 are widespread along the east coast from Cape York south to the Hunter Valley region, with occasional movement onto the NSW south coast as the distribution of their vector, *Culicoides brevitarsis*, fluctuates.

In northern Australia incursions of novel genotypes of BTV have been detected, with nucleic acid sequencing indicating that these have been introduced by long distance dispersal of vectors from South-East Asia.

Australia has not experienced the severe outbreaks with large scale mortalities as have occurred in Africa, the Mediterranean basin and the USA. Experimental infection studies in sheep have shown that some of the serotypes of BTV found in Australia are asymptomatic while others can produce moderately severe disease. The absence of disease in Australia is largely due to the lack of overlap between the distribution of *C. brevitarsis* and sheep flocks. The presence of BTVs is the greatest impediment to the export of live animals, semen and embryos from ruminant and camelid species. Consequently, because the principal vector has well defined geographical limits determined by seasonal influences,

animal health authorities in Australia have established a 'bluetongue free zone' to support the export of ruminants and germplasm. The National Arbovirus Monitoring Program⁷ (NAMP), based on systematic sampling of sentinel cattle and vectors, underpins this zoning strategy.

Viruses belonging to the epizootic haemorrhagic disease of deer (EHDV) group, which are closely related to BTVs, are also widespread in Australia and mainly infect cattle and deer. Disease has never been observed in Australia.

Between 1994 and 1996 an unusual epidemic was observed in kangaroos, characterised by varying degrees of blindness. The epidemic commenced in western NSW in summer 1994, spread south and west into Vic and SA, and, after interruptions to transmission during winter and spring, eventually reached southern WA in 1996. Disease affected mostly western grey kangaroos, but eastern grey and red kangaroos and even euros were involved. Blindness was shown to be due to chorioretinitis and mild encephalitis⁸. The disease was successfully reproduced after the inoculation of eastern and western grey kangaroos with isolates of Wallal virus⁹. The vector was not proven but this virus has been isolated from several *Culicoides* species.

A syndrome of sudden death almost always without any prior signs, has occurred on several occasions in captive populations of Tammar wallabies, held mainly in research institutions in eastern NSW and southern Qld. The first outbreak in 1998 decimated research populations in the Sydney region with more than 230 animals affected¹⁰. The gross pathology was very similar to severe acute bluetongue where vascular damage results in extensive congestion and haemorrhage. Eubenangee virus, a close relative of BTV, was isolated from these animals. However, the vector involved remains unclear.

In the Northern Territory between 1999 and 2004, a similar syndrome of acute death in northern black wallaroos was associated with infection with a Wallal group virus, blindness in agile wallabies with a Eubenangee group virus and death in red kangaroos with a Wongorr group virus (L. Melville *et al.*, unpubl. obs.).

Finally, the equine population is not spared from infections with orbiviruses. In Australia, Elsey virus is a mosquito-borne orbivirus that has been associated with encephalitis in several horses in the NT and Qld¹¹.

Bunyaviruses

The Bunyaviruses (Family *Peribunyaviridae*, genus *Orthobunyavirus*) comprise the largest group of vector-borne viruses with members transmitted by mosquitoes, biting midges, sandflies and

ticks. Akabane virus is the most prominent to infect animals in Australia and was the cause of a large outbreak of congenital deformities in calves in 1974, with approximately 8000 cases in NSW. Outbreaks occur at intervals of about 15–20 years. Climatic variations have a profound impact on the distribution of the principal midge vector, *C. brevitarsis*, either as an outcome of higher rainfall and mild winters resulting in greater dispersal of midges and virus, or temporary reductions in population immunity in times of drought as a result of restricted midge and virus distribution¹². The major epidemics have been mostly confirmed in regions of NSW that adjoin the endemic North and Central Coast regions¹³. The impact of the virus is greatest in cattle due to their long (9 month) gestation but sheep and goats can also suffer losses. The type of defect depends on the stage of gestation at which the dam was infected¹⁴. In cattle infected late in gestation calves can be born with encephalitis. Infection in the fifth and sixth months of gestation results in arthrogryposis and scoliosis, with the severity and incidence of abnormalities greater in earlier stages of pregnancy. The most severe defects follow infection in the third and fourth months of gestation and affected calves are born with hydranencephaly. The most severe cases have almost complete destruction of the cerebral hemispheres although the brain stem and cerebellum are generally unaffected. When cattle are infected at the most susceptible stages of gestation, up to 50% of calves can be born with defects¹⁵. In small ruminants, with a much shorter pregnancy, severe hydranencephaly and arthrogryposis occur concurrently and animals are usually still born¹⁶.

Aino virus has been associated with an outbreak of congenital defects reported about 40 years ago¹⁷, but no further outbreaks have occurred.

Rhabdoviruses

Also known as 'Three Day Sickness' by farmers due to the spectacular acute but transient illness, bovine ephemeral fever (BEF) virus (Family *Rhabdoviridae*, genus *Ephemerovirus*) had attracted attention because of the large scale epidemics that had spread from Northern Australia through most of NSW and sometimes into Vic. and SA between 1930–1970¹⁸. BEFV only infects cattle and buffalo, causing a severe but short febrile disease, often associated with recumbency, locomotor difficulties, shifting lameness and difficulties in swallowing¹⁹ – signs similar to rabies in cattle. There is a high morbidity but generally low mortality and the majority of animals recover rapidly (typically in about three days, hence the colloquial name). In the endemic coastal regions of NSW north of Sydney and in Qld and the NT, infection is restricted to younger animals born since the last occasion that the virus was spread²⁰. Beyond the endemic areas, cattle of all ages are affected²¹.

The disease can have a severe impact in dairy herds because there is almost complete cessation of milk production in infected cows²². In beef herds, the decline in milk availability can severely impact on calf health and growth. The severe fever often induces a temporary infertility in males that lasts for several months but can be permanent. Although the epidemiological patterns and association of outbreaks with high rainfall suggest a mosquito vector, there remains a dearth of supporting evidence. There is some evidence to incriminate *Culex annulirostris* as the most likely vector^{23,24}.

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Biography

Dr Peter Kirkland is the Head of the Virology Laboratory at the state government Elizabeth Macarthur Agriculture Institute at Menangle NSW. Dr Kirkland has had a long career in diagnostic and research projects in animal health. He has been instrumental in the identification of several new viruses, including Menangle virus that was transmitted from flying foxes to pigs, a novel pestivirus that was responsible for a major disease outbreak in pigs and viruses that have caused blindness and sudden deaths in macropods. In 2007 he led the EMAI team during the diagnosis and response to the equine influenza outbreak and in 2011 the investigation of the large West Nile virus outbreak in horses in NSW. His research interests include vector borne viruses and the development and evaluation of rapid diagnostic assays for viral diseases of animals.



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