EXOTIC
Foot-and-mouth disease (native wildlife)
Fact sheet
October 2023

Key points

- Foot-and-mouth disease (FMD) is a highly contagious viral disease of cloven-hoofed animals.
- It is a major issue in international trade in livestock and livestock products.
- **Australia is free of the disease** and it is vital that it remains so.
- Foot-and-mouth disease is a nationally notifiable disease; you must notify animal health authorities if you suspect an animal has FMD (see *Surveillance and management* below).
- Native Australian species are unlikely to be important in the epidemiology of an FMD outbreak, although several species have been experimentally infected with the virus.

This fact sheet summarises what is known about FMD and Australian native wildlife.

WHA also has a fact sheet that briefly summarises information on FMD and feral animals "Foot and Mouth Disease (General Information)". See also the Aug 2022 WHA Information Sheet "Foot and Mouth Disease Information – Australian native species, feral and zoo animals" https://wildlifehealthaustralia.com.au/Portals/0/Incidents/WHA_FMD_Information_V1.2_150822.pdf.

Aetiology and natural hosts

Foot-and-mouth disease is caused by an aphthovirus belonging to the family *Picornaviridae*. It is a single-stranded non enveloped 25 nm RNA virus. There are seven serotypes: A, O, C, SAT 1, SAT 2, SAT 3, and Asia 1.

All cloven-hoofed animals are considered susceptible. Cases have also been reported in elephants, hedgehogs, some rodents and a case was reported in an eastern grey kangaroo (*Macropus giganteus*) held in a zoo in India [1]. Experimental infection was undertaken in a range of Australian native species, in the 1960s (see *Epidemiology*).

One Health implications

Wildlife and the environment: Australian native wildlife are very unlikely to be affected by FMD, and are not considered to be important in the ecology of an FMD outbreak. Feral wildlife have been assessed as a more significant risk to the epidemiology of FMD in Australia than native wildlife, although still low compared to domestic livestock.

Domestic animals: all cloven-hoofed animals can be infected with FMD. Very few animals die from FMD, but it severely affects animal welfare and production.

Humans: human infections are extremely rare. Symptoms, if they occur, include fever and vesicles on the hands or feet or in the mouth. People can mechanically transfer the infection, and may harbour the virus in the nasopharynx for more than 24 hours [2]. Foot-and-mouth disease is not a food safety concern. It cannot be transmitted to humans through consuming commercially produced meat, milk or dairy products. It is not the same as hand, foot and mouth disease of humans.

World distribution and occurrences in Australia

Foot-and-mouth disease is endemic in Africa, the Middle East, Asia and parts of South America. There was an FMD outbreak in cattle in Indonesia in May 2022 and the virus has now spread to Bali [3]. The disease has almost been eradicated from Europe with cases occurring in the UK and Cyprus in 2007 and Bulgaria in 2011 [4]. The 2001 outbreak in the UK resulted in over 10 million cattle and sheep being slaughtered at a cost of over GBP 8 billion in order to eradicate the disease.

Foot-and-mouth disease has **not occurred** in Australia for 130 years, and then only in livestock. Minor outbreaks occurred in 1801, 1804, 1871 and 1872 [2].

Epidemiology

Foot-and-mouth disease is generally transmitted via the respiratory system, orally or through breaks in the skin or mucosa. FMD virus is produced in large quantities by infected animals. Movement of infected animals is an important means of spread for FMD. Other sources of spread include aerosols (over short distances), contaminated products, equipment and people [5]. Long-distance wind-borne movement is also possible under certain conditions [6]. Foot-and-mouth disease virus can remain infective in the environment for several weeks if conditions are favourable [5]

Experimental infection in Australian native animals

Experimental transmission studies in a variety of **Australian native animals** (housed overseas) by Snowdon 1968 [7] were undertaken to determine susceptibility of Australian mammals to FMD (see Appendix 1 for more detail). These studies demonstrated short periods of virus replication, viraemia and shedding of virus in a high proportion of many of the native species tested. A measurable and significant antibody response was also evident in many animals.

Natural transmission from infected cattle to red kangaroos and wombats occurred, when species were held in close confinement. However, spread from naturally infected red kangaroos to other red kangaroos or cattle did **not** occur under close confinement (although artificially inoculated kangaroos could transmit FMD to cattle through contact).

The author concluded that **native Australian species were unlikely to play an important role in the epidemiology of an FMD outbreak**. This is because the risk of transmission within and between native species, from native species to cattle and from domestic species to native species was considered low under normal field conditions, although the author noted that an outbreak might

occur under adverse conditions such as drought (when many species are in close contact at water sources).

Experimental infection does not always provide a good indication of the likelihood of infection under field conditions, however Australian native species are thought to pose minimal risk to livestock during a potential outbreak and it is very unlikely that they would become infected and transmit the disease [8].

Feral wildlife have been assessed as a more significant risk to the epidemiology of FMD in Australia than native wildlife, although still low compared to domestic livestock [9]. See also WHA Fact Sheet "Foot-and-mouth disease (General Information) and WHA Information Sheet "Foot and Mouth Disease Information – Australian native species, feral and zoo animals".

Clinical signs

A naturally infected eastern grey kangaroo in the Indian zoo developed lameness and sloughing of the foot pads, while experimentally infected grey kangaroos showed no clinical signs. One out of 24 experimentally infected red kangaroos developed irregular circular ulcers on the feet 14 days after inoculation, with no lesions prior to this time. The tree kangaroo developed a vesicle on the tongue three days after inoculation, which had healed by day 11. It also developed vesicles on the feet four days after inoculation. Four of five water rats developed white circular tongue lesions, although these did not appear vesicular. Two of 13 echidnas developed vesicles on the hind feet and ulceration on the posterior third of the tongue. The Bennett's wallabies, wombats, possums, potoroos, bandicoots, and antechinus developed no clinical signs post inoculation [1, 7].

Diagnosis and differential diagnosis

A diagnosis of FMD is based on a combination of clinical signs and laboratory tests. Differential diagnoses include other vesicular diseases such as vesicular stomatitis (antibodies to VS have been found in opossums; *Didelphis virginianus*) [10], traumatic lesions of the mouth or feet or chemical irritants and scalding.

Laboratory diagnostic specimens and laboratory procedures

Vesicular fluid, epithelial flaps and blood in EDTA or heparin should be collected. A necropsy should be performed, and a complete set of tissues collected fresh and in formalin. It is important to include sections of soft palate and pharynx, as these seem to contain the highest concentrations of virus in marsupials [2, 7]. Diagnosis can be made by ELISA, PCR and viral culture.

Pathology

The naturally infected eastern grey kangaroo from the zoo in India had areas of myocardial necrosis with an inflammatory cell infiltrate [1]. Pancreatic lesions were seen in the experimentally infected antechinus and water rats [7].

Treatment, prevention and control

Treatment is not an option as the disease is exotic to Australia. Australia has stringent quarantine measures in place to prevent the introduction of FMD, so the risk of Australian native mammals contracting the disease is extremely low.

Surveillance and management

Foot-and-mouth disease is a nationally notifiable disease (see www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/notifiable). By law you must notify animal health authorities in your jurisdiction if you know or suspect that an animal has a notifiable pest or disease. Refer to advice in your jurisdiction (www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/state-notifiable) and on outbreak.gov.au on how to report.

Australia's approach to managing an incursion of FMD is described in the AUSVETPLAN foot-and-mouth disease strategy, version 5.2, 2023. Wildlife considerations as part of response are addressed in the WARS AUSVETPLAN. Both can be found at: https://animalhealthaustralia.com.au/ausvetplan.

The role of native species in an FMD outbreak is likely to be minor as it is very unlikely that they will become infected and transmit the disease under normal field conditions. However, in the event of an outbreak of FMD it may be valuable to conduct some surveillance in native species. It may also be necessary to demonstrate to trading partners that there is no persistence of FMD in native species. This type of surveillance would be conducted as part of proving freedom, and would be targeted to previously-infected areas where native and domestic animals are in high concentrations and contact was likely to have occurred.

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information https://wildlifehealthaustralia.com.au/Our-Work/Surveillance and https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System.

No cases of FMD have been reported from native Australian wildlife in Australia.

Appendix 1: Additional information on experimental transmission of FMD in Australian native wildlife

Experimental transmission studies were undertaken in a variety of Australian mammals: (red kangaroos (*Macropus rufus*), a Matschie's tree kangaroo (*Dendrolagus matschiei*), eastern grey kangaroos, Bennett's wallabies (*M. rufogriseus*), common wombats (*Vombatus ursinus*), brush-tailed possums (*Trichosurus vulpecula*), long-nosed bandicoots (*Perameles nasuta*), long-nosed potoroos (*Potorous tridactylus*), water rats (*Hydromys chrysogaster*), echidnas (*Tachyglossus aculeatus),* and brown antechinus (*Antechinus stuartii*), and resulted in viraemia for varying periods of time (Snowdon 1968), as shown in the table below, with number of animals viraemic shown against number of animals tested.

	Days post infection										
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**14**	**21**	**35**
Red kangaroo	21/31	26/37	16/33	5/25	1/14	0/2	0/8				
EG kangaroo	1/4	1/6	0/6	0/6	0/2		0/2				
M tree kangaroo	1/1	1/1	1/1	1/1	1/1						
Bennett's wallaby	1/6	6/10	2/10	3/10	0/4		1/6				
Common wombat	4/8	9/14	8/14	8/11	0/3	0/3	¼				
Brush-tailed possum			3/6				0/6				
Long-nosed potoroo			1/5				0/5				
Long-nosed bandicoot			0/5				¼				
Water rat			2/8				0/8				
Brown antechinus			2/4								
Echidna			11/13				8/12	4/11	1/6	0/6	0/6
Rabbit	1/16	10/16	3/16	0/16	0/10						

Virus was generally recoverable from oral and cloacal swabs in viraemic animals, and was also recovered from one oral swab in a grey kangaroo, one oral swab in a wallaby, two cloacal swabs in grey kangaroos and four cloacal swabs in wallabies that were not viraemic.

Antibody titres in inoculated red kangaroos, the tree kangaroo and wombats peaked 14 days after inoculation and then gradually declined. Antibodies developed in only one out of four wombats despite all four becoming viraemic. Inoculated echidnas had no detectable antibody titres 21 days after inoculation but had considerable titres when tested at day 35.

When four red kangaroos and four wombats were held in contact with an infected steer, three kangaroos and all wombats developed a low grade viraemia. Three kangaroos and no wombats seroconverted. When seven red kangaroos were inoculated with the virus and placed in contact with six steers, one steer developed FMD seven days after contact and one developed FMD 15 days after contact. When three inoculated kangaroos were placed in contact with other kangaroos, none of the contact kangaroos became viraemic.

Four inoculated steers developed FMD and were placed in contact with 13 kangaroos. After 48 hours, seven of the kangaroos were placed in contact with six cattle and six kangaroos were placed in contact with six kangaroos. Viraemia was not detected in any of the in-contact kangaroos and none of the cattle developed FMD. None of the contact cattle or kangaroos seroconverted.

Four red kangaroos and three wombats were inoculated with the virus. All kangaroos became viraemic with one animal developing clinical lesions in the hind feet. Only one wombat became viraemic and none developed clinical signs. Two red kangaroos, one grey kangaroo and two wombats were held in contact with the inoculated animals. None of the contact animals seroconverted or developed clinical signs of FMD.

A red kangaroo was inoculated with virus and blood was collected while it was viraemic. This blood was inoculated into another kangaroo. No clinical signs developed, and virus could not be recovered from this kangaroo.

The mode of transmission to the kangaroo infected in the Indian zoo is unknown but infection was speculated to have come from muntjac deer (*Muntiacus muntjac*) within the zoo that were showing clinical signs at the time [1].

Acknowledgements

We are extremely grateful to the many people who had input into this fact sheet. Without their ongoing support production of these fact sheets would not be possible.

Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

Updated: Oct 2023

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