Preliminary Outbreak Assessment #1

Rift Valley fever in Mayotte (Indian Ocean)

23 April 2019

Ref: VITT/1200 RVF in Mayotte

Disease report

Periodic outbreaks of Rift Valley Fever (RVF) in livestock have been reported in Mayotte, a French overseas Department since 2007 (Chevalier et al, 2019). However, in March, there were 46 outbreaks of RVF reported in cattle and goats in Mayotte, and 20 more in April, to date taking the total to 100 official reports of RVF in small ruminants since January (ADNS). Mayotte is an island located in the northern Mozambique Channel in the Indian Ocean, between north-western Madagascar and north-eastern Mozambique (see map). The outbreak has affected sheep, goats, cattle and camels (ADNS & OIE, 2019). The disease has also been reported in humans. Between the end of November 2018 and March 2019, regional authorities reported 82 human Rift Valley fever (RVF) cases across Mayotte (ECDC, 2019).
RVF is a viral disease within the genus *Phlebovirus* (family Bunyaviridae). The disease causes high mortality in young animals and abortion in ruminants. It affects cattle, sheep, goats, camels, wild ruminants, including buffaloes, gnus (wildebeest) and antelopes while African monkeys and domestic dogs and cats may get short-lived infections (OIE, 2019). The virus has also been found in rodents (Pretorius et al, 1997) and bats (Fontanille et al, 1998). The virus is transmitted to susceptible species by arthropod vectors (various mosquito genera, mainly *Aedes*, *Culex* and *Mansonia* spp.), but has also been found in ticks and sandflies that have fed on the blood of infected animals.

RVFV persistence and transmission in Africa involves two stages, namely maintenance of the virus between epizootics and transmission during the epizootic. Both involve different mosquito populations. The maintenance of RVFV between epizootics in Africa is by transovarial (vertical) transmission of virus from infected mosquitoes to progeny via the egg (Lumley et al. 2017). Thus, floodwater *Aedes* mosquitoes act as maintenance vectors, ovipositing in low lying grasslands predisposed to seasonal flooding. Infected *Aedes* eggs can withstand desiccation and may remain dormant in the dried mud of surface pools for several years until persistent rain causes flooding and the eggs to hatch. For example, Californian encephalitis virus (an Orthobunyavirus) remained viable for 19 months within *Aedes melanimon* eggs (Lumley et al. 2017). Floods persisting for weeks create a semi-permanent habitat for secondary amplifying vectors (usually *Culex* spp.), leading to a shift from enzootic to epizootic cycling. These mosquitoes oviposit egg rafts on the water’s surface, superseding the *Aedes* spp., feeding on viraemic hosts in the area. It is during this stage that disease is usually identified in mammals by which point control and prevention are challenging (Lumley et al. 2017). While the disease is usually associated with heavy rains or flooding followed by the emergence of high numbers of the mosquito vectors, some localised areas of Kenya, South Africa, West Africa and Zimbabwe have a low level of virus transmission to ruminants in most years (OIE, 2019; Fontanille et al, 1998; Geering et al, 1995).

The global distribution of RVF is almost exclusively in Africa but also extends into the Arabian Peninsula. RVFV was first isolated in Kenya in 1930, with subsequent major outbreaks in South Africa in 1950–1951, Egypt in 1977–1979, Mauritania in 1987 and Madagascar in 1990. The first outbreak outside of Africa, in the Arabian Peninsula in 2000, resulted in a predicted economic burden of US$90 million. Therefore potential spread to, and establishment in, non-endemic regions such as Europe and the USA would severely impact the health of humans, livestock, and the economy, particularly as vaccination is not available in many areas (Lumley et al. 2017).

**RVFV in Mayotte**

It should be stressed that RVFV has been in Mayotte since early 2007 at least, and was probably introduced there by illegal importation of live infected ruminants from the (nearby) Comoros islands (Chevalier et al. 2010). The RVFV was probably introduced to the Comoros islands by the trade of live ruminants imported from Kenya or Tanzania during the 2006-2007 epidemics. However, the recent official reports of diseases in 2019 (in ADNS) suggest that the current outbreak was due to the introduction of the virus on the
island following illegal imports in preparation for the celebration of Eid al Adha in 2018. Recent cases in ruminants have been identified through abortion surveillance.

**Routes of transmission of RVFV**

Spread of RVFV out of Africa has raised concerns that it could emerge in Europe or the USA (Lumley et al. 2017). The potential routes of entry of the RVFV into the EU and the UK are via infected products of animal origin (POAO), typically meat, infected livestock, and infected mosquito life cycle stages including dessicated eggs, free-flying adults and even larvae in transported water. Humans are mainly infected by contact with body fluids and tissues of infected animals (live or dead) and dietary exposure is also suspected (e.g. raw or unpasteurised milk). Humans can also be infected by mosquito bites.

**Routes of RVFV from Mayotte to EU and the UK**

The importation of RVFV-infected ruminants poses the highest risk for RVF introduction to the EU (Chevalier et al. 2010) although this reflected livestock from endemic regions in Africa. Official RVF-free status is required for a country to export livestock and livestock meat to the EU. However, Mayotte is a French Department and therefore part of the EU and free movement of goods between Mayotte and mainland France can occur, presenting a route of entry from Mayotte into France, and from France into other countries in Europe including the UK. Thus, a potential route of entry of RVFV to the UK is through legal importation of RVFV-infected live ruminants into France with subsequent infection of French mosquito vectors and transmission to French livestock which could then be imported to the UK.

**Vector transmission of RVFV within France**

Once a viraemic livestock animal enters France, transmission of RVFV to local livestock in France could occur through native mosquitoes. Mosquitoes of the genus *Aedes* and *Culex* are considered to be the most competent vectors to transmit RVFV (Tong et al, 2019). Chevalier et al. (2010) list *Aedes vexans vexans*, *Ochlerotatus caspius*, *Culex theileri* and *Culex pipiens* as competent mosquito vectors of RVFV present in mainland France and Corsica and conclude that there is almost no doubt that several of the mosquito species in the EU, e.g. *Cx. pipiens*, would be competent vectors for RVFV. Moreover, the introduction and spread of new vector species represents a further risk. For example, *Aedes albopictus* can transmit RVFV, and many epidemiological concerns arise from this species’ current distribution in Europe. Consequently, given a viraemic livestock animal entered France there is a high probability during the vector season that infection is passed on to French cattle. According to Chevalier et al. (2010), clinical signs of RVF may not be observed rapidly in livestock living in remote, humid areas such as the Camargue region in France or the Danube delta in Romania. Such a scenario, Chevalier et al. (2010) argue, would allow RVFV to amplify and endemic foci to develop, if suitable ecological and entomological conditions were met. According to ECDC (2019), should the virus be introduced into continental EU/EEA countries through imported infected livestock animals from an RVF endemic area in Africa, the likelihood of further vector-borne transmission among animals remains very low during the winter season due to the low-level abundance
and activity of competent mosquito vector populations in continental EU/EEA countries, although it cannot be excluded.

Legal importation of livestock and products of animal origin

According to World Integrated Trade Solution (2019), of the $3,605,230 of exports from Mayotte to Europe, $3,552,680 went to France in 2009. $756,000 of this value was animal product to France in 2009. Overall ECDC (2019) conclude that the risk of RVFV entry to EU countries (presumably applicable to the UK too) through legal exports of livestock and POAO is currently very low. This is because according to ECDC (2019) imports into the continental part of the EU of live animals and their meat and milk from Mayotte are probably very rare, due to the distance. Further information is provided by PAFF (2019). Thus:

• There is a shortage of beef and sheep meat in Mayotte such that legal export of POAO does not occur to a great degree (PAFF, 2019);
• There are no live animals or POAO exchanges from Mayotte to La Réunion or EU territory (PAFF, 2019). Between 2018–February 2019, there were no official movements of cattle, sheep or goats towards the EU/EEA from the region of the Comoros Islands (Comoros and Mayotte) and Madagascar (ECDC, 2019); and,
• In recent months, the French authorities have prohibited the export of live ruminants and products (meat and milk) from Mayotte (PAFF, 2019).

Based on this PAFF (2019) information is it concluded the risk of entry of RVFV into France and hence other EU Member States through legal routes is negligible.

Illegal ruminant and POAO importations

According to ECDC (2019), another risk that cannot be excluded is the illegal transport of fresh meat, POAO and unpasteurised milk from infected ruminants in personal luggage. RVFV-infected POAO may present a non-negligible risk to humans (given exposure) but would present a negligible risk of transmission to livestock and a negligible risk to mosquitoes and can therefore be ignored from the point of view of UK livestock/vectors. Any illegal movement of livestock from Mayotte to France would most likely occur through shipping and in view of the long journey and economic returns is considered to be small in volume. It is concluded the risk to the UK from illegally-imported livestock, fresh meat, POAO and unpasteurised milk entering France and infecting French livestock through vector transmission is negligible, although there is high uncertainty in this estimate.

Entry of RVFV-infected humans

According to IATA data, there were almost 40 000 travellers from Mayotte to continental Europe in 2017, the vast majority of them to France (97%) (ECDC, 2019). Therefore, the importation of human cases from Mayotte to Europe cannot be excluded. Humans may be infected through direct contact with livestock body fluids animals (at slaughter, veterinary inspections) so livestock keepers and veterinarians are particularly at risk of infection.
However, should infected humans enter the EU, then the likelihood of further spread by direct human-to-human transmission is very low as sustained direct human-to-human transmission has not been described for RVFV (ECDC, 2019). Indeed, although not resolved, humans are considered dead end hosts for RVFV in that viral titres in the blood are not sufficient to infect mosquitoes (Lumley et al. 2017). RVFV has been imported into Europe through human cases, travelling from RVFV-endemic parts of Africa e.g. Mali (Tong et al. 2019). Indeed, RVFV RNA was detected by PCR in whole blood of two military personnel up to 67 days after onset of symptoms (Tong et al 2019) raising issue of the risk of transmission to competent mosquito vectors in Europe. As Mayotte is endemic for Malaria, passengers are unable to donate blood for an extended period of time, thereby also preventing onwards infection of RVFV to humans.

**Human-mediated importations of RVFV-infected mosquitoes from Mayotte**

Human activities enable transportation of mosquitoes from one continent to another within a matter of hours to a few days. In theory, an individual infected adult mosquito, or its larvae or eggs could enter the UK from Mayotte via France through (unintentional) human-mediated transportation, resulting in a release of RVFV into the UK. This would not occur directly but through France. The main potential routes of entry of exotic mosquito life cycle stages into the UK are:-

- Direct flight or wind carriage (adult mosquitoes only) – negligible even from France.
- Aeroplanes - cabins, cargo holds, luggage – no direct flights to UK from Mayotte.
- Shipping including containerised cargos and insects “on board” – no exports to UK.
- Cars – luggage, interiors (adult mosquitoes only) – negligible from Mayotte.
- Car tyres (desiccated eggs only) – negligible from Mayotte.
- Packed cut-flowers (adults and possibly larvae) – negligible from Mayotte.
- Water in ornamental plants “lucky bamboo” (larvae only) – negligible from Mayotte.

All these routes can be considered as **negligible** for RVFV-infected mosquitoes from Mayotte to the UK via France. Although adult mosquitoes can fly into aircraft cabins, cargo holds, and even be packed in passengers’ luggage, there are no direct flights from Mayotte, and the chance of a mosquito flying from France to the UK is negligible. Due to high humidity and cool air, the refrigerated transoceanic containers offer ideal conditions suitable for the transport of living insects. The entry of mosquitoes to cargo holds and luggage could occur through importation of cut flowers and lucky bamboo, for example. Cut flowers are often packed under lighting at night and would therefore have much higher adult mosquito loadings. However, we are not aware of any commercial cut flower exports from Mayotte, and lucky bamboo is from Asia. Three species of exotic mosquito (*Aedes aegypti*, *Ae. albopictus* and *Ochlerotatus japonicus japonicus*) have been imported into Europe via used car tyres that have been stored outdoors providing a container for stagnant water to collect into which eggs are laid by the female mosquito (Becker *et al.* 2011). It is unlikely that used car tyres are imported into the UK from Africa or the Middle East, let alone from Mayotte, and indeed they are more likely come to Europe from Japan and China. The African continent is one of the fastest growing markets for importing used car tyres which are needed to supply the boom in car ownership and transport (African
Consequently, Africa let alone nearby Mayotte, is not likely to export its used tyres to Europe. It is concluded therefore that the number of car tyres entering the UK per year from RVFV-endemic regions in African or the Arabian Peninsula is very small and that from Mayotte itself is probably approaching zero.

Conclusion

The main route of RVFV entry into the UK from Mayotte would be through (legal or illegal) entry into France of a RVFV-infected livestock animal from Mayotte which then leads to undetected infection of French livestock through vector transmission in the vector season with some of those infected livestock then being legally imported into the UK without detection. The French authorities remain vigilant to the epidemiological situation in Mayotte and measures are being applied accordingly to the local conditions, including human and livestock epidemiological surveillance, biosecurity, and vector control. In view of the presence of RVFV in livestock in Mayotte, France no longer allows legal movement of livestock, meat and milk from Mayotte to mainland France. Thus it is concluded that there is a negligible risk of entry of RVFV to the UK by legal trade. It is concluded that the risk to the UK from illegally-imported livestock entering France is also negligible because of the large distances and small numbers, although there is high uncertainty in this estimate. The risk of entry of RVFV through human-mediated (unintentional) importation of infected mosquitoes is also negligible. Any RVFV-infected POAO illegally imported to the EU would present negligible risk to UK livestock or vectors. The trans-Saharan highway to North Africa may present a higher risk to the UK through illegal entry of RVFV into livestock in southern Europe than the risk from Mayotte. As there are uncertainties around certain pathways, some of which such as entry of infected humans and illegal importation of livestock from Mayotte into France have been described here, we may undertake a more in depth risk assessment in the light of new evidence.

We will continue to monitor developments and will re-assess the situation as new information becomes available.

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References

All disease reports are available from the OIE WAHIS database.


