Qualitative assessment for the release of sheep pox virus and lumpy skin disease virus into Great Britain from the European Union

ED1043

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1 Introduction

1.1 Overview of the viruses and diseases
Lumpy skin disease (LSD), sheep pox and goat pox are pox diseases of cattle, sheep and goats, respectively. They are characterised by fever, nodules on the skin, mucous membranes and internal organs, emaciation, enlarged lymph nodes, oedema of the skin, and sometimes death (OIE 2010). The diseases are of economic importance as they can cause a temporary reduction in milk production, temporary or permanent sterility in bulls, damage to hides and death due to secondary bacterial infections (OIE 2010). The World Organisation for Animal Health (OIE) categorize LSD and sheep pox and goat pox as notifiable diseases (Kitching 2004; OIE 2010).

Sheep pox and goat pox are considered to be a single disease by OIE, referred to here as Sheep Pox Goat Pox (SPGP). The viruses causing these diseases are members of the Capripoxvirus genus of pox viruses (family Poxviridae) and are clinically indistinguishable. Strains of sheep pox virus (SPPV), goat pox virus (GTPV) and lumpy skin disease virus (LSDV) cannot be differentiated serologically (Kitching 2004), although distinct host preferences exist with most strains of SPPV and GTPV causing more severe disease in the homologous host (Bowden et al. 2008). There is close genetic relatedness of capripoxvirus isolates, which average no less than 96% nucleotide identity between strains of SPPV, GTPV and LSDV(Bowden et al. 2008).

1.2 Worldwide distribution
LSD is currently present virtually throughout the entire continent of Africa, with only Libya, Algeria, Morocco and Tunisia in the north still considered free (Tuppurainen and Oura 2012). It has spread out of the African continent into the Middle East with the first cases in Israel in 1989 after the disease appeared in Egypt the previous year (Tuppurainen and Oura 2012). LSD outbreaks have been reported in the Middle Eastern region since 1990 including Kuwait, Lebanon, UAE, Israel and Oman. Tuppurainen and Oura (2012) write that there are no geographical or epidemiological reasons why LSD cannot spread further north into Turkey and Europe, or further east into Asia and they cite the impact of climate change on the abundance and distribution of mechanical vector populations as possible reasons for this. Indeed, outbreaks of LSD are ongoing in south eastern Turkey (Figure 1).
Figure 1: Outbreaks of LSD near to the borders of south-eastern Europe 2013. Source: IDM monthly report Feb 2014.

Sheep pox and goat pox are found in Africa north of the equator, the Middle East and Asia including India, Nepal and parts of China (Kitching 2004). These diseases have, however, spread into Europe on several occasions (Kitching 2004), with outbreaks reported in Bulgaria, Greece and Turkey in 2013 (Figure 2). New introductions of sheep pox or goat pox are generally only identified in one of the two animal species concerned (i.e. goats or sheep) depending on the strain introduced, so that goat pox was introduced into Bangladesh in 1984 from India, and sheep pox has caused occasional outbreaks in Italy (1983), Greece (1988, 1995, 1996, 1997, 1998 and 2000) and Bulgaria (1995 and 1996) having spread from Turkey, probably in illegally imported animals (Kitching 2004).
1.3 Imported products and EU Regulations
The products considered here are imported hides and skins of sheep, goats and cattle together with wool from sheep. Imported products may be treated or untreated. Untreated hides and skins are defined in Regulation (EU) No 142/2011 as cutaneous and subcutaneous tissues that have not undergone any treatment, other than cutting, chilling or freezing. There is no requirement for treatment of hides and skins imported to GB from within the EU and therefore all products considered in this risk assessment are assumed to be untreated. However, under Regulation (EU) No 142/2011 fresh hides and skins must comply with the animal health conditions for fresh meat laid down under Council Directive 2002/99/EC. Thus skins and hides must not come from slaughter houses in which animals infected with SPGP virus were present during the slaughtering or production process. This is important because it means that if a positive animal is detected at the farm or slaughter house then the whole batch (including other infected animals which may have been missed) is condemned.

1.4 Levels of the virus on skins and in wool
*Levels of virus on skins/hides of infected animals*

This risk assessment makes the distinction between skins/hides from infected animals showing clinical symptoms (i.e. lesions, papules or scabs) and those from infected animals...
with normal skin and no symptoms. This distinction is made because most virus is found in the skin papules about six days after their first appearance (Kitching 2004). Bowden et al. (2008) estimated that the normal skin of experimentally infected goats has $10^{2.7}$ to $10^{4.4}$ TCID$_{50}$ per gram while the papules of infected goats have loading ranges over 100-fold higher than the normal skin at $10^{5.2}$ to $>10^{7.2}$ TCID$_{50}$ per gram. Similarly viral genomic copies in normal sheep skin were $4$-log (per 100 ng total DNA) compared to $6.5$-log for the skin nodules (Bowden et al. 2008). In experimentally infected sheep, $10^7$ TCID$_{50}$ per gram of skin (at sites where virus was inoculated) were detected by day 7 to 8 (Plowright et al. 1959). In cattle infected with LSDV, skin lesions contained the highest levels of virus (Babiuk et al. 2008) with $8.1$ and $8.3$ log$_{10}$ plaque forming units per gram at day 12 and 15, respectively, post inoculation (Babiuk et al. 2008). Levels of viral DNA in normal skin of cattle were much lower than in the lesion (Babiuk et al. 2008). It is thus assumed that the titre of virus on a hide/skin is directly proportional to the number of lesions or papules on that hide and the time since infection. The papules and scabs are likely to contain very high levels of virus, while normal skin from infected animals is likely to contain medium levels of virus.

Levels of virus in wool from infected animals

There is little information on levels of SPPV or GPPV in wool. Following experimental intradermal inoculation, the virus replicates in the cells of the dermis and glandular hair cells at the base of the hair follicles (Kitching 2004). Unlike skin, the virus will not be able to replicate within the wool itself, and therefore any virus present will be due to contamination of the wool with skin fragments, including fragments of scab material. In this respect the wool could contain fragments of lesion with high loadings of virus. The macules may cover the whole body or be restricted to the more hairless or woolless parts of the skin (Kitching 2004). In lambs and kids naturally infected in the Duhok area of Iraq, the presence of pox lesions occurs in areas of the hide with less wool and hair (Zangana and Abdullah 2013). Similarly in sheep in Iran, the gross lesions in adults were in certain areas, namely skin denied of wool or sparsely wooled (Khodakaram Tafti and Namdari 2001). However, the gross lesions were all over the skin and in some internal organs in lambs (Khodakaram Tafti and Namdari 2001). It is assumed here that wool from infected adult sheep contains low levels of infectivity while wool from lambs contains medium levels of infectivity. This reflects the fact that in some lambs lesions occur all over the skin rather than in the woolless areas observed in adults.

1.5 Aim and scope of this risk assessment

Given the recent outbreaks of sheep pox and goat pox in south eastern Europe (Figure 2) and the presence of LSDV in Turkey (Figure 1), there is potential for further spread of these capripoxviruses to and/or within Europe. This, together with the fact that GB currently imports cattle hides, sheep skins and wool from European countries without the requirement for treatment prior to export, raises concern that capripoxviruses could be introduced into GB. This report provides a qualitative assessment of the risk of importation of one infected product (i.e. skin/hide or bale of wool) through legal trade into GB. It considers both the

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1 Tissue culture infectious dose 50% as determined by titration on cell monolayers
viruses and products collectively. Trade levels to GB and transmission/spread once within GB are not considered within the scope of the assessment. An infected product is defined as one which contains one or more virus infectious virus particles.

1.6 Risk question
The risk question to be addressed is:

*What is the probability that an individual whole skin/hide or bale of wool imported from the EU is infected with virus at the point of entry into GB?*

2 Assessment of risk

2.1 Risk pathway
The risk pathway is shown in Figure 3 and has four component steps: (i) the herd/flock from which an animal comes is infected (with probability P1), (ii) an individual animal is infected with the virus (with probability P2), given the herd/flock is infected, (iii) the infected animal is not detected on the farm or at slaughter (with probability P3), and (iv) the virus survives packaging and transport of the skin/hide/wool to GB (with probability P4).
2.2 Qualitative probabilities
The approach used was based on the framework set out by the World Organization for Animal Health (OIE 2004). The release assessment describes the probability of entry of the virus into GB through import of one product item from other regions of the European Union. The variables (i.e. probabilities and titres of virus) are expressed qualitatively as negligible, very low, low, medium, high and very high (EFSA 2006; FAO/WHO 2009). The definitions of the probabilities, i.e. the probabilities of an event occurring, were taken from EFSA (2006) namely: negligible, so rare that it does not merit to be considered; very low, very rare but cannot be excluded; low, event is rare but does occur; medium, event occurs regularly; high, event occurs very often; and very high, event occurs almost certainly. To estimate the risk of release, R, the qualitative probabilities are combined as described previously (Gale et al. 2010).

2.3 Estimation of P1: The probability that a herd or flock is infected.
Data on the recent outbreaks in Greece are used to estimate this probability. Hadjigeorgiou et al. (1998) reported that there are 9,200,000 sheep and 5,600,000 goats in Greece on about 300,000 farm units. Even counting the units with more than 10 adult female animals, this number is about 155,000 farms. Between Aug 2013 and January 2014 (six months), a total of 82 outbreaks of sheep pox virus (no goat pox cases) were reported in Greece (OIE, 2014). Over a period of one year, therefore, double that number, i.e. 164 outbreaks might be expected. This would represent about one in a thousand of the 155,000 goat and sheep farms in Greece.

It is therefore concluded that the probability P1 is low. Although this estimate is based on data for sheep pox in Greece, the risk assessment here is treating SPGP and LSD as one and the same disease (even though LSDV and goat pox are not currently present in the EU).

2.4 Estimation of P2: The probability that an individual animal within a positive flock is infected.
Again, data from the recent outbreaks in Greece and Bulgaria are used to estimate this probability. Between Aug 2013 and January 2014, a total of 1,472 cases (250 deaths) of sheep pox virus were reported in Greece in 17,735 susceptible sheep. Of 1,008 susceptible goats, no cases were detected. The case prevalence in sheep therefore was therefore 1,472/17,735 = 0.083. In Bulgaria there were three outbreaks, with 37 cases in 558 susceptible sheep. The case prevalence was thus 37/558 = 0.066. The reported outbreaks from Greece and Bulgaria give estimates of the within herd/flock prevalences (P2) to be between 6.6% and 8.3%. However, only 50% of infected cows in the case of LSD are likely to show clinical signs, and the majority of experimentally infected cows become viraemic (Tuppurainen and Oura 2012). The observed within herd prevalence is therefore multiplied by factor of 2 for the purpose of this risk assessment (assuming SPGP to be similar to LSD).
Thus the estimated within-herd/flock prevalence for a positive herd is thus around 13.2% to 16.6%. It is therefore concluded that the probability P2 is *medium*.

### 2.5 Estimation of P3: Probability that infected animal/skin/wool is not detected on farm or at approved slaughter house

Within Europe, in the 82 reported outbreaks of SPPV in sheep in Greece, flocks with as few as one case in 284 sheep were reported (OIE 2014). This suggests that farmer/slaughter house operators are good at spotting clinical cases, and that the probability of missing an infected animal with clinical symptoms is relatively low. To estimate the probability of an infected animal skin/wool not being detected it is thus assumed that the probability of detection of an infected animal at an approved slaughter house or on a farm is directly proportional to the number of lesions on that animal (i.e. the more papules the greater the chance that the farmer or slaughterhouse worker will see one). Therefore, those animals with high titre hides/skin/wool have a high probability of being detected, while the lower titre animal hides from infected animals without lesions are likely to be missed. Based on data from Merza and Mushi (1990) that the clinical signs develop a few days after the rise in body temperature, it is assumed that for every clinical case detected there will be several infected animals without symptoms which are missed. Taking this into account and the different detection probabilities for clinical and non-clinical animals, it is concluded that the probability that an infected skin/hide is not detected is *medium*.

The probability P3 is also related to the number of clinical cases in the flock. Thus the more clinical cases, the greater the chance that at least one is detected and that all animals in that flock and thus their products are condemned according to EU 142/2011. On the basis of the outbreak data for SPPV in sheep in Greece (OIE, 2014) the distribution for the number of clinical cases per flock is skewed with most having a few cases and a few having large numbers of cases. For those with larger numbers of cases, P3 for an individual case is negligible, while for those flocks with lower numbers of cases, P3 is medium. Since many flocks have just a few cases, P3 is assumed here to be *medium* for every case.

About 110 fleeces may go into a bale of wool (Anon 2014). The shearing process on the farm may expose skin lesions and allow detection of infected animals at an earlier stage. However, although many animals contribute wool to a bale, many infected flocks have few cases and the probability, P3, that an infected bale of wool is not detected is judged here to be *medium* as for an individual skin/hide.

### 2.6 Estimation of P4: Virus on wool/hide/skin survives transport to GB.

According to Kitching (2004) and Davies (1981) the sheep pox and goat pox virus is very susceptible to direct sunlight. Kitching (2004) adds that in dark conditions, such as contaminated animal sheds, the virus can persist for months. Indeed Davies (1981) writes that there is considerable evidence for prolonged survival, especially when the virus is contained in scab material (obtained from animals which have recovered from the virus) which has been shown to be infective for periods of at least 3 months. LSDV is stable between pH 6.6 and 8.6 and will show no significant reduction in titre after 5 days at 37°C over this pH range (Weiss 1968). For LSDV, in the skin lesions of infected animals, the virus can persist for at least 33 days
even through the necrotic portions of skin have completely dried out (Weiss 1968). Skin/hides and wool are likely to be transported to GB via trucks and ships. Various travel blogs report that the drive from England to Greece requires 4 - 7 days. With temperatures below 37°C and in the dark, it is assumed that little or no inactivation of the virus would occur during this time for transport. It is thus concluded that the probability P4 is high.

### 2.7 Summary

On the basis of data for Greece and taking into account the number of sheep/goat farms in Greece it is concluded that the probability, P1, that a herd or flock is infected is low.

Assuming that the data for Greece and Bulgaria (OIE 2014) give a reasonable description of likely within herd prevalence for capripoxviruses in any EU country which could potentially have outbreaks, it is concluded that the estimated level of P2 is medium.

The assessment considers infected animals with clinical symptoms, as well as those without. Infected animals showing clinical signs (and thus having lesions with high viral titres) are unlikely to be missed at the slaughter house or farm while infected animals without clinical symptoms (and hence with medium levels of infectivity) could easily be missed. As the skin lesions take a few days to develop those animals without obvious clinical signs (i.e. macules) could be slaughtered and thus, overall, it is concluded that P3 is medium.

Given that there is going to be little decay of the virus within the travel time to GB, it is concluded that the estimated probability of virus survival, P4, is high.

The individual probabilities and the overall probability R are given in Table 1. The probability R is derived by combining the probabilities P1 to P4 using the method described previously (Gale et al. 2010). In effect, this uses the lowest probability in the chain of conditional probabilities. The lowest probability is for P1 (low). Thus by combining the probabilities in Table 1 it is estimated that the overall risk of release R of importing one raw hide/skin or bale of wool infected with SPGP/LSD virus into GB from the EU through legal trade, is low.

Table 1: Estimated qualitative probabilities

<table>
<thead>
<tr>
<th>Probability</th>
<th>Qualitative probability</th>
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<tbody>
<tr>
<td>Herd/flock infected (P1)</td>
<td>Low</td>
</tr>
<tr>
<td>Animal infected (P2)</td>
<td>Medium</td>
</tr>
<tr>
<td>Infected animal/skin not detected (P3)</td>
<td>Medium</td>
</tr>
<tr>
<td>Virus survival (P4)</td>
<td>High</td>
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<tr>
<td>Risk of release for one product item (R)</td>
<td>Low</td>
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</table>

### 3 Discussion

Sheep pox and goat pox virus have emerged in sheep and goats in Greece and Bulgaria. Lumpy skin disease virus outbreaks have occurred in south-eastern Turkey and there is no reason to assume that LSDV will not spread into south-eastern Europe in the near future.
The risk question is defined in terms of importation of one infected product, contaminated with one or more virus particle. Viral load has been considered to some extent within this assessment although it is not explicitly stated in the final risk estimate. The available data suggests that any imported product infected with the virus would most likely have come from an animal which had not yet developed clinical signs. The viral load on the hide/skin/wool of such an animal is likely to be at a medium level. Further work, out of the scope of this assessment, would need to be undertaken to determine whether or not this level would be important for transmission within GB. It should be noted that sheep and goats that recover from sheep pox and goat pox virus are immune for life, and there is no virus carrier state (Kitching 2004). In addition, the virus can only survive by constant transmission from infected to susceptible animals, and therefore requires a certain minimum size of susceptible population.

The assessment does not consider the volume of trade and thus has not estimated the risk per year or per batch. There are currently no data available to determine the volume of trade. Should these data become available, the assessment could be extended to derive such estimates.

4 Conclusion

Based on the current situation in EU countries, this assessment has concluded that the risk of release of SPGP or LSD virus into GB via the importation of one untreated animal skin/hide/wool bale from the EU is low. This estimate is highly dependent on P1, the probability that a herd/flock is infected within the EU; should this increase, the overall risk of release will increase.

5 References


