Scientific Opinion on sheep pox and goat pox - first part –

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Sheep pox and goat pox (SPP/GTP) are endemic in Africa north of the Equator, the Middle East, Turkey, and some parts of Asia.

Exotic to the EU, but outbreaks occurred in the past in Greece and Bulgaria, and lastly in 2013 (August 2013 - current)

Included in the OIE list - compulsory notification to OIE

EC need: assessment of the risk of introduction and spread of SPP/GTP and to determine if further measures are justified
May 2014

- Disease characterisation and distribution (ToR 1).
- Identification of pathways of introduction of SPP/GTP into the EU (ToR 3).
- Assess the speed of propagation of SPP/GTP (ToR 4).
- Review effectiveness and feasibility of prevention and control measures (ToR 7).

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- Mapping of identified or likely live animal trade routes (ToR 2).
- Ranking pathways of introduction of SPP/GTP into the EU (ToR 3).
- Assess the risk of endemicity of SPP/GTP (ToR 5).
- Assess the impact and consequences of SPP/GTP (ToR 6).
SPP/GTP are diseases of domestic small ruminants caused by viruses of the genus *Capripoxvirus*.

- Severe clinical signs and losses especially in naive and young animals.
- Morbidity up to 90% and case fatality up to 100%.
- No evidence to date that SGP viruses can infect wildlife.
- Capripoxviruses are not considered to be zoonotic agents.
- Recurrent incursions of sheep pox into Greece and Bulgaria, the most recent ones causing 91 outbreaks in Greece and 4 in Bulgaria from August 2013 until April 2014.
- Virus can be detected in animal secretions up to two months after infection.
the virus can survive in scabs if protected from sunlight, and in the environment for up to 6 months, and in wool, hairs or skin of infected animal for up to 3 months

The virus is susceptible to high temperatures and common disinfectants

The main mode of transmission of SPP/GTP is direct contact between infectious and susceptible animals

Indirect transmission: dissemination from animal secretions and products from infected animals or human movements and/or fomites acting as mechanical carriers of virus
Pathways identified

- **ANIMAL MOVEMENTS**
  - legal or illegal trade of live animals
  - legal or illegal trade of animal products
  - movement or proximity of animals to contaminated areas/pastures shared by flocks from infected countries.

- **HUMAN MOVEMENTS**
  - visitors, tourists
  - animal workers
  - immigrants

- **FOMITES OR MECHANICAL CARRIERS**
  - movement of vehicles
  - Birds, wildlife and insects
Methodology

- A model to evaluate the spread of SPPV over space (data 2013/14 outbreaks in EU and European Turkey)

- The continental-scale spread resolution: NUTS3

- Different models and assumptions tested

- Three scenarios for the spread of SPP in the EU after 1, 6, 12 months and after 5 years:
  - Incursion in the regions of Bulgaria and Greece
  - Incursion in Croatia and Hungary, over Balkans
  - Incursion in southern Spain, from northern Africa.
RISK AND SPEED OF SPREAD OF SPP

4 models for dependence of the force of infection on host demography:

- (i) no dependence (i.e. $D_i=1$)
- (ii) proportional to the number of holdings with sheep, $N_i$ (i.e. $D_i= N_i$)
- (iii) proportional to the number of sheep, $S_i$ (i.e. $D_i=S_i$)
- (iv) proportional to mean holding size (i.e. $D_i=S_i/N_i$)

The best fitting model: transmission between regions proportional to the number of sheep per NUTS3
Predicted spatial spread of sheep pox virus in Europe under different incursion scenarios.
Simulation of SPP/GTP spread over EU after incursion in Greece and Bulgaria

- Probability of an area becoming infected, the force of infection between regions is proportional to the number of sheep / NUTS3 and given the control measures as applied in Greece and Bulgaria.
Simulation of SPP/GTP spread over EU after incursion in Croatia and Hungary, over Balkans

- probability of an area becoming infected, the force of infection between regions is proportional to the number of sheep /NUTS3 and given the control measures as applied in Greece and Bulgaria.
Simulation of SPP/GTP spread over EU after incursion in southern Spain

- probability of an area becoming infected, the force of infection between regions is proportional to the number of sheep /NUTS3 and given the control measures as applied in Greece and Bulgaria.
ASSUMPTIONS & LIMITATIONS

- the contact patterns within Europe are similar to those in Bulgaria and Greece.

- limited availability of data > uncertainty:
  - 8 infected EU regions and 4 in Turkey
  - probability of SPPV transmission \( f(Nr \text{ number of herds or sheep in a region}) \)
  - This model does not distinguish between possible transmission routes

- Different degree of effectiveness in implementing control measure in different countries

- the model predictions to be considered as an example of the options when assessing risk of SPP epidemics in EU
Diagnostic tools

- Under field conditions the clinical diagnosis performed by trained veterinary staff is effective for the early detection of outbreaks and the consequent prompt implementation of measures.

- The high variability of reported studies on diagnostic test and vaccine performance makes their comparison difficult, and conclusions on test and vaccine performance should be made with caution.

- Among the test for detection of virus and its nucleic acid PCR assays (including different real time PCR and gel-based PCR assays) are considered the most sensitive and specific.

  **Sequencing** of virus nucleic acid can be used to determine the virus strain for molecular epidemiology purposes.

  **Virus isolation** is not suitable for primary diagnostics but is needed to confirm the infectivity of the virus.
Serological tests

- the performance of **ELISA** assays for SPP/GTP ranges from 70% to 100% for the sensitivity and from 84 to 100% for the specificity. Novel recombinant ELISAs are at experimental stage.

  - **Serum/virus neutralization test**: very specific but not sufficiently sensitive and not suitable as a primary assay or for testing large numbers of samples.

  - **Agar gel immune diffusion test**: a very simple test, requires minimum laboratory facilities, but it lacks sensitivity and specificity.

  - **Western blotting** cannot be used as primary assay but it can be used if an inconclusive or positive SNT/ELISA results need to be confirmed.
vaccines

- commercially available vaccines for sheep and goat pox
  - live attenuated vaccines
  - prepared with a limited number of strains.
  - None of these are licensed within the EU
  - the use of these vaccines would inflict immediate restrictions for the international trade of live sheep and goats.

- None of the available vaccines support the DIVA concept.

- Where applied, live attenuated SPP/GTP vaccines provide good protection if a minimal coverage of 75% is created and maintained.
CONTROL MEASURES (TOR 7) - OUTPUTS

vaccines

- Although capripoxviruses are considered to be cross-protective, the use of homologous vaccine is more effective.

- Sufficiently attenuated and tested vaccines are safe and effective, also for use in pregnant animals providing three months of immunity to lambs.

- However some vaccines may have unacceptably high levels of residual pathogenicity.

- Inactivated vaccines are not commercially available, the immunity provided by those is not long-lasting (up to 6 months).

- The use of inactivated vaccines could be considered only in case of an immediate threat of an outbreak, as an emergency vaccine and as a safer option than the use live attenuated vaccine in non-endemic countries.
Movement restrictions, biosecurity

- Movement restriction of animals appears to be an effective measure to prevent direct contact between animals.

- Culling of the affected herds on the basis of the clinical signs and lesions is an effective and time-saving measure to reduce the risk of spread.
RECOMMENDATIONS

- Awareness raising campaigns and training for farmers and veterinary staff

- Molecular typing of SPPV/GTPV strains isolated during an outbreak

- Extending the duration of setting the surveillance and protection zone beyond 21 and 42 days

- Potential risk posed by skin and hides coming from affected regions

- Diagnostic test validation studies should be done according to OIE guidelines
Recommendations

- Development of inactivated vaccines with DIVA principle
- Safety of live attenuated vaccines should be further investigated
- More stringent control measures after introduction into areas with high number of sheep.
- Harmonised data collection of outbreaks from MSs and neighbouring countries is recommended
Thank you for your attention!

Acknowledgements to the team!

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- EFSA staff (AHAW and AMU)
PREDICTED RATE OF SPREAD OF SHEEP POX VIRUS IN EUROPE
PREDICTED NUMBER OF REGIONS AND HOLDINGS AFFECTED BY SHEEP POX VIRUS IN EU
The choice of kernel had limited impact on the predictions of spread: for the same demographic models and incursion scenario, the predicted outbreaks are similar in terms of time-course, spatial spread and outbreak size.

The model for the duration of virus circulation in a region had a minor impact on predictions of spread.

The choice of demographic model used in the force of infection between regions has a large impact on the model predictions, though the magnitude of the impact also depends on the incursion scenario.
SENSITIVITY ANALYSIS

- all possible combinations (96) of models for the force of infection between regions (six kernels and four demographic models and duration of virus circulation were considered.

- For each model component, the maximum likelihood estimates were used to parameterise the model (i.e. no parameter uncertainty was included)