(Limited) transmission of Foot-and-Mouth Disease virus from infected sheep to calves

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Outline

- **Aim:**
  - To quantify FMDV transmission from infected sheep to cattle
- **Why:**
  - The proximity of sheep and cattle in the field
  - The high susceptibility of cattle
- **How:**
  - Two infected sheep in contact with one calf
  - Laboratory tests and quantification of transmission
- **Conclusion:**
  - Transmission from infected sheep to cattle occurred (R_0 >1)

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Interspecies transmission of FMD

Factors of risk

- Sheep may not manifest clear clinical signs
- Sheep secrete and excrete considerable amounts of FMDV
- Sheep secrete and excrete FMDV for a long period
- Sheep and cattle are brought into close proximity
- Cattle are high susceptible to FMD

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Material and methods

- Animals:
  - 20 sheep inoculated with FMDV Asia1 Tur/11/2000
  - 10 contact exposed calves
- Samples and laboratory tests:
  - OPF and blood were analysed by Virus titration
  - Probang (29, 30 and 31 dpi) and OPF were analysed by RT-PCR
  - Serum were analysed by NS ELISA and VNT
- Quantification of transmission
  - The next-generation matrix

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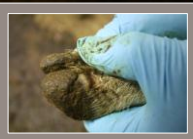
Results

Laboratory tests



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#	Sp.	VI OPF	VI Blood	PCR OPF	PCR Probang	NS-ELISA	VNT	C.S.	Infected
1	Cattle	-	-	-	-	-	-	-	NO
	Sheep	+	+	+	+	+	+	+	YES
	Sheep	+	+	+	-	+	+	+	YES
2	Cattle	-	-	-	+	+	+	-	YES
	Sheep	+	+	+	-	+	+	+	YES
	Sheep	+	-	+	+	+	+	-	YES
3	Cattle	-	-	-	-	-	-	-	NO
	Sheep	+							YES
	Sheep	+							YES
4	Cattle	-							NO
	Sheep	+							YES
	Sheep	+							YES
5	Cattle	-							NO
	Sheep	+							YES
	Sheep	+							YES
6	Cattle	-							NO
	Sheep	+							YES
	Sheep	+							YES
7	Cattle	+							YES
	Sheep	+							YES
	Sheep	+	+	+	-	+	+	+	YES
8	Cattle	-	-	-	-	-	-	-	NO
	Sheep	+	+	+	-	+	+	+	YES
	Sheep	+	+	+	-	+	+	+	YES
9	Cattle	-	-	+	-	+	+	-	YES
	Sheep	+	+	+	+	+	+	+	YES
	Sheep	+	-	+	+	+	+	-	YES
10	Cattle	-	-	-	-	+	+	-	YES
	Sheep	+	+	+	-	+	+	+	YES
	Sheep	+	+	+	+	+	+	+	YES

Test	Sheep	Calves
Clinical infected	16/20	1/10
Subclinical infected	4/20	3/10
FMDV detection	20/20	2/10
Serology	20/20	4/10
Carriers	9/20	1/10

Conclusions

Laboratory tests

- 100% of the sheep (N=20) shed FMDV and became serological positive
- 80% showed clinical signs and 45% became carriers

How infectious are sheep compared to cattle?

- Only 1 or 2 calves (N=10) shed FMDV and 4 calves became serological positive
- 1 calf showed clinical signs and 1 calf became carrier

How susceptible are sheep compared to cattle?

- In average 2 calves get infected by 1 infected sheep

Would subclinical infected calves transmit FMD?

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Quantification of transmission

- We need to quantify transmission in heterologous populations
- We used the Next-generation matrix

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Quantification of transmission

- R_0 is the average number of new cases caused by one typical infected individual in a susceptible population
- Previously R_0 has been quantified in homologous populations (i.e. sheep to sheep, cattle to cattle):

R_0 = 1.14

R_0 = 14

- In our experiment a partial R_0 was quantified:

R = 2

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Quantification of transmission

The Next-Generation Matrix (NGM)

- R_0 is the dominant eigenvalue of the next-generation matrix (Diekmann et al, 1990) wherein the typical infected individual is in the eigenvector

$$\begin{pmatrix} R \to F_s & R \to F_s \\ R \to (1-F_s) & R \to (1-F_s) \end{pmatrix}$$

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Results

Quantification of transmission

$$\begin{pmatrix} 0.57 & 3.99 \\ 1 & 7 \end{pmatrix}$$

R_0 = dominant eigenvalue of this matrix = 7.57

- In a 50% cattle and 50% sheep population.
- We used Final Size estimates from experiments with Asia1 Tur/11/2000

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Final conclusions

- Transmission occurred between infected sheep and naive calves (partial R_0 = 2; R_0 = 7.57 in a 50%s-50%c population)
- Considering that cattle are highly susceptible to FMD, we found an unexpected "limited" transmission
- We estimated that sheep are 7 times less infectious than cattle
- And that sheep are 0.57 times less susceptible than cattle
- It is unclear if subclinical animals could transmit the disease

Thank you for your attention

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