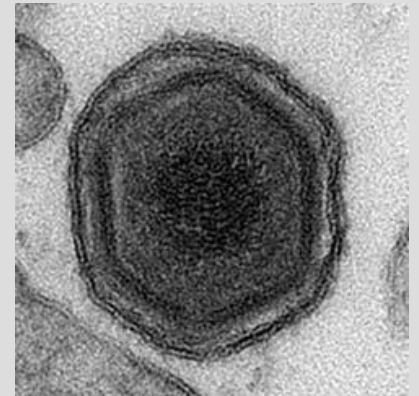
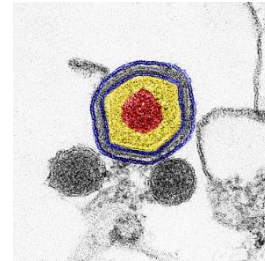


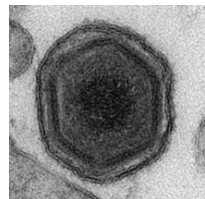
African swine fever - between the poles of textbook, history and current situation



- Large, complex, enveloped DNA-Virus, replicates primarily in macrophages
 - Why is this important?
 - Large and complex: Multiple factors that help the virus to modulate and evade the host immune system → one of the difficulties in vaccine production
 - Replication in macrophages: antibodies can be detrimental, replication in designated phagocytes
 - Enveloped: important for the choice of disinfectants
 - DNA: stable, rather slow evolution (in general)
- ASFV is the only known ARBO virus with a DNA genome
 - ARBO: arthropod borne virus
 - ASFV has a soft tick vector (replication in the vector, transmission)
 - So far no relevance of soft ticks for Central Europe
 - Vector has to be included in control measures
- For the completeness:
 - Genus *Asfivirus* in the *Asfarviridae* family



„ASFAR“
African
Swine
Fever
And
Related viruses



Tenacity:

- 3 h at 50°C
- Up to 10 days in feces, even longer periods mentioned in old publications (>3 month under favourable conditions)
- **Up to 70 days in blood at room temperature**
- Up to 15 weeks in cooled pork
- Up to 6 months in conserved ham
- **Up to 18 months in cooled blood (fridge)**
- **Years or even decades in frozen carcasses and pork**

pH stability:

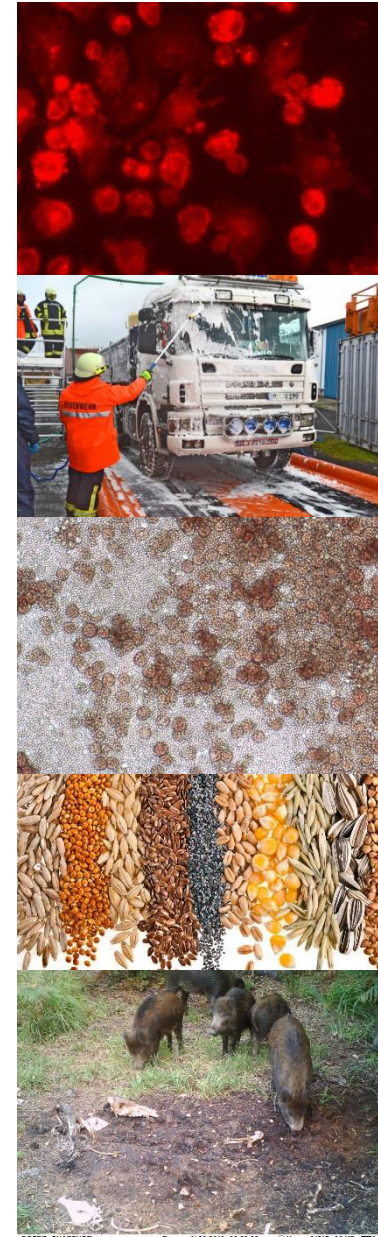
Inactivation at pH <3,9 and >11.5

Serum (proteins) has a strong stabilizing effect: 21 h at pH 13,4!

Disinfection:

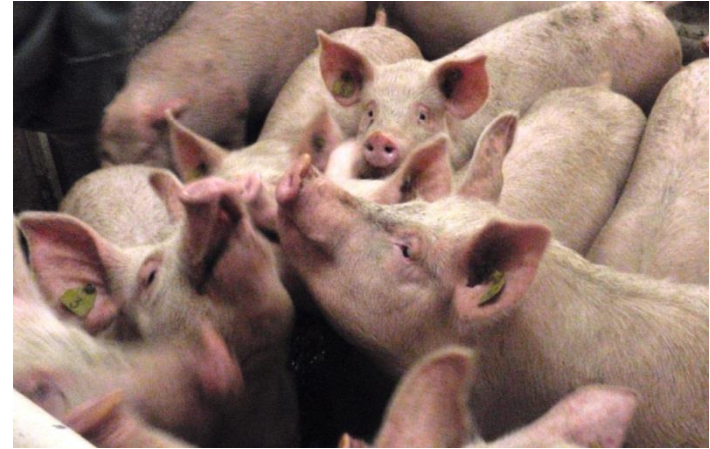
- Commercial disinfectants for enveloped viruses, e.g. Vennovet
- Peracetic acid, formic acid
- Hypochlorite, iodine, quarternary ammonium compounds
- Lime slurry, (caustic lime)

Heat treatment: 70°C für 20 min; 60°C 30 min...



Host species

- Domestic pigs
- Wild pigs, e.g. European wild boar
- Warthogs
- Soft ticks of the *Ornithodoros* genus



Ornithodoros moubata
Picture: R. Klein



© Stefan Diehl, www.koerperpflege.com

ASF is not a zoonosis...



Transmission pathways



Sylvatic cycle in Africa



Persistently infected adult warthogs do not show high level viremia but may carry infected ticks

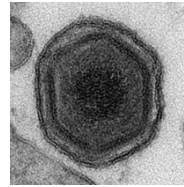


Trans-stadial and trans-ovary transmission



Young warthogs in the burrow - High viremia, source of infection for soft ticks (*Ornithodoros moubata*)

Introduction into the domestic pig population



Direct contact, swill feeding



Indirect contact



Cycle in domestic pigs and wild boar



O. erraticus played a role as vector on the Iberian peninsula



European wild boar are as susceptible as domestic pigs and played a role on Sardinia and in the Caucasus/Russia

Clinical signs in domestic pigs

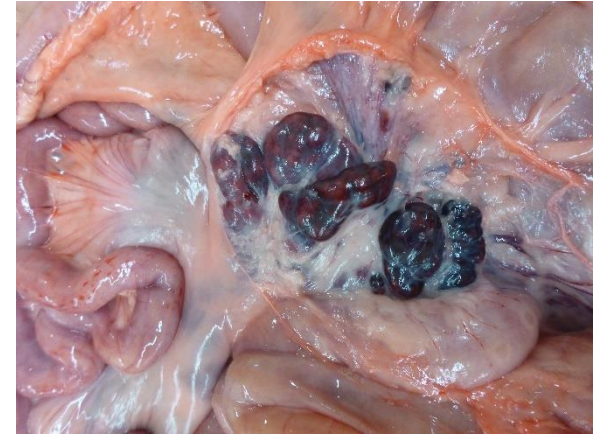
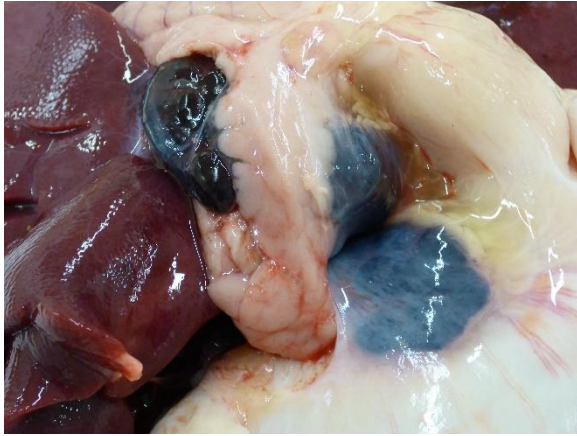


- First signs are observed app. four days post infection: High fever, reluctance to move, inappetence, huddling, it is „too quiet“ when you enter the stable
- Some animals develop conjunctivitis and gastro-intestinal signs (vomiting, diarrhea)
- With progression of the disease, animals become somnolent, appear desorientated, and show dyspnea
- In the final phase, affected animals may show petechiae or map-like bleedings and cyanoses as well as seizures and haemorrhages (epistaxis, bleedings from the anus)

Clinical signs in wild boar

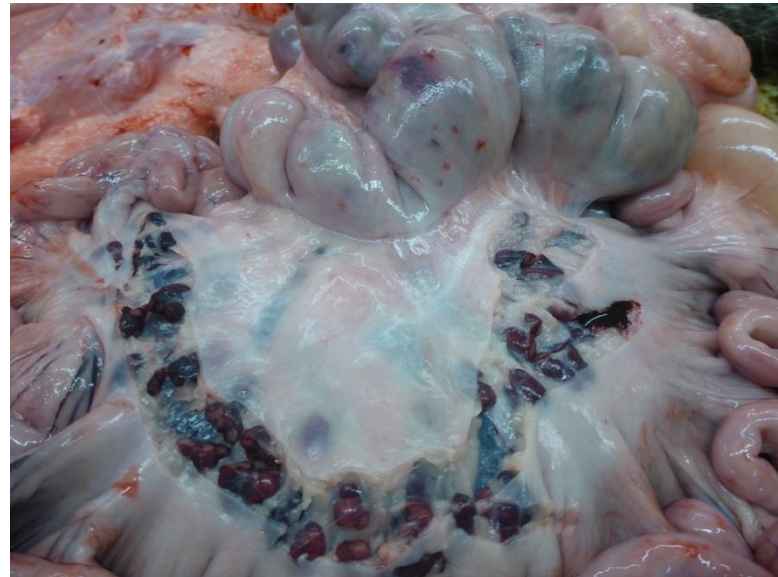
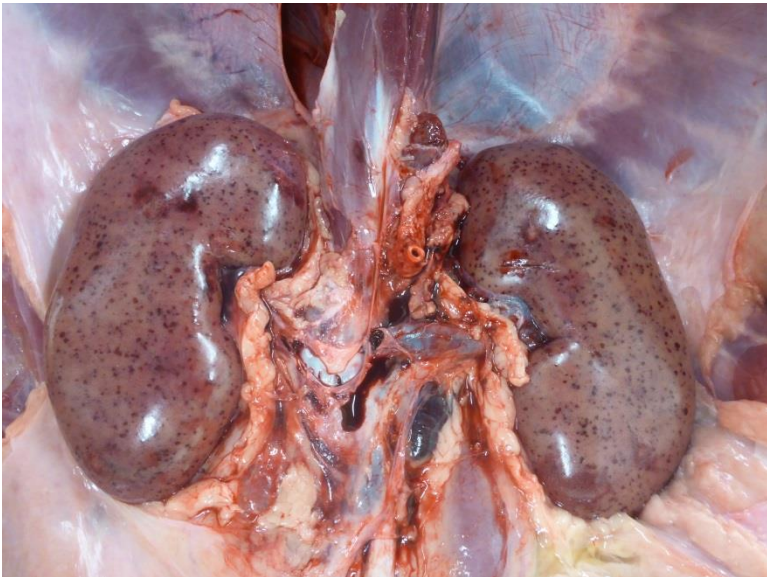
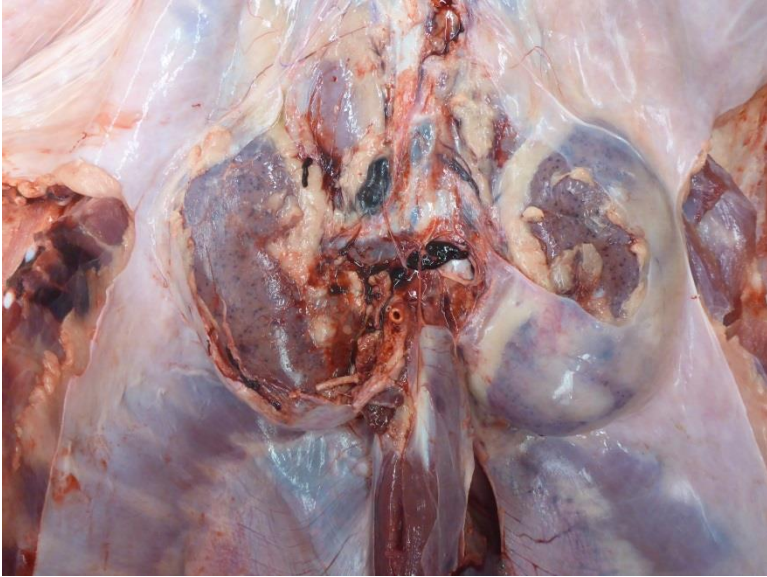


- In general no differences observed between domestic pigs and wild boar (skin lesions cannot be seen)
- No age dependence of clinical signs with highly virulent strains
- General observation from lab and field: young animals survive more often



Animals that die from ASF show lesions in lymphnodes, lungs, kidney, and spleen:

- Ebony-colored, bloody and enlarged lymphnodes, especially in the gastro-hepatic area, throat, and kidney
- Froth in lungs and trachea (lung edema), lung haemorrhages
- Petechia in the kidneys, kidney infarctions
- Haemorrhages in other organs



„Group dynamics“ of ASF



- Oral infection is rather inefficient (remember that the virus is optimized for tick transmission)
- In the majority of cases, rather high virus doses are needed for oral infection and not all inoculations result in infection (~10.000 HAU)
- An infected animal dies with high probability, but not all animals in a stable/pen have to be infected
- The virus is found in high amounts in blood of diseased animals, much less in feces and saliva
- Contagiosity can be moderate or even low if no blood shedding occurs!
- Even with close contact, some animals may go uninfected (see pictures above)
- In units with separate pens, the disease may stop after one or some pens
- Transmission after an isolated introduction can be sluggish
- Fulminant courses are seen in breeding farms where abortions and thus blood contact is frequent



The main target: carcasses...

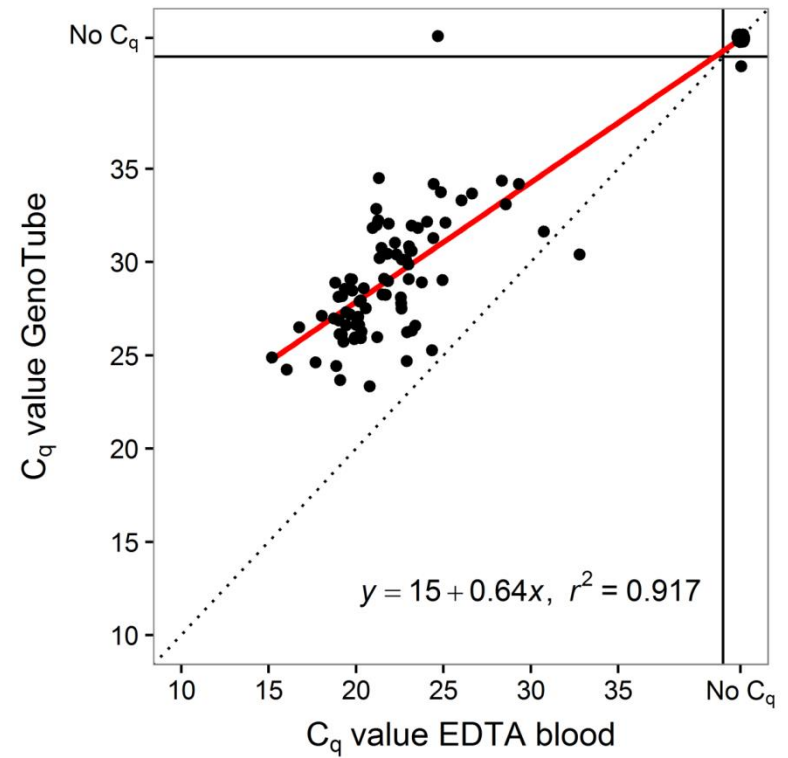
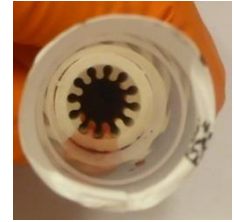
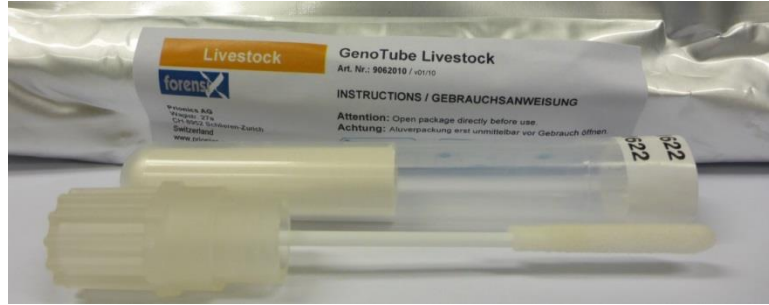


Source: Food and Veterinary Service of Latvia

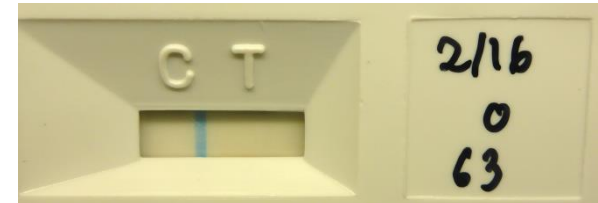
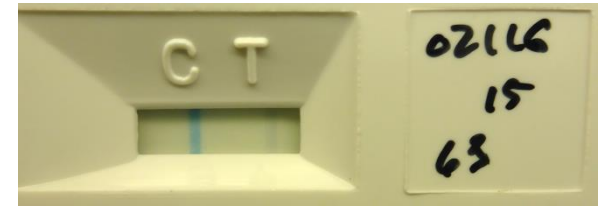
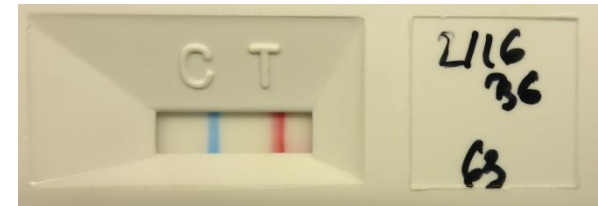
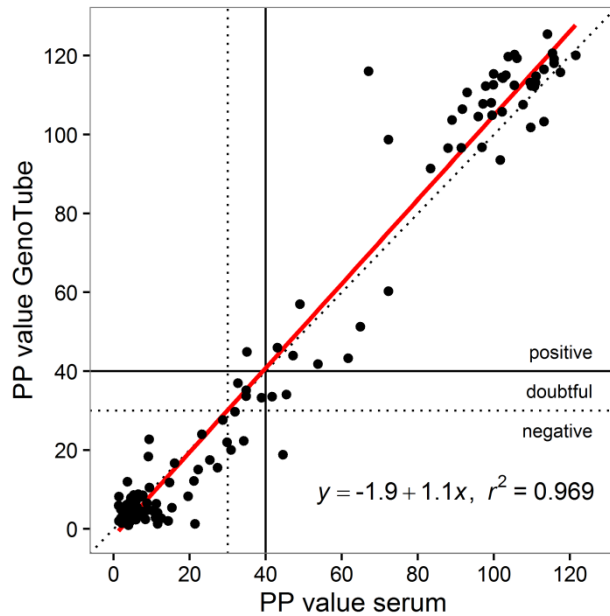
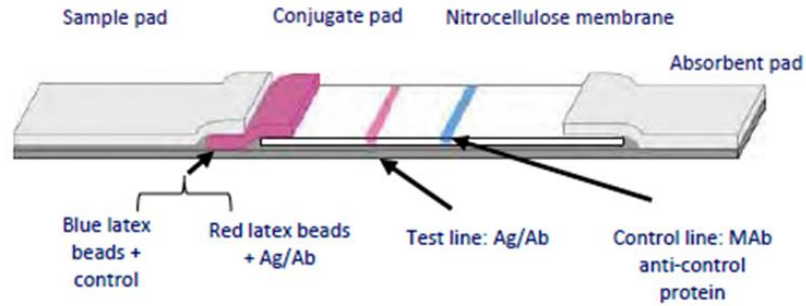
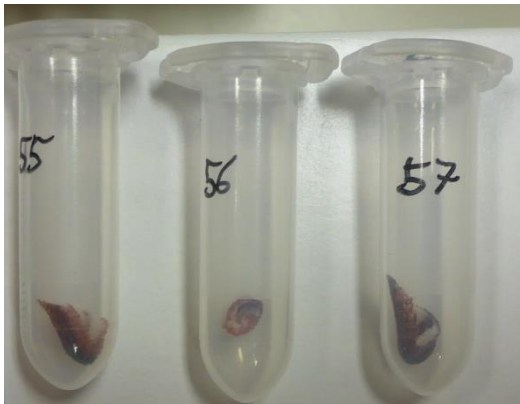
- Sampling is not easy
- Rotten carcasses are smelly and disgusting...
- Some organs are not available anymore
- Blood (decent fluid) is not available
- Some carcasses are just skeletons



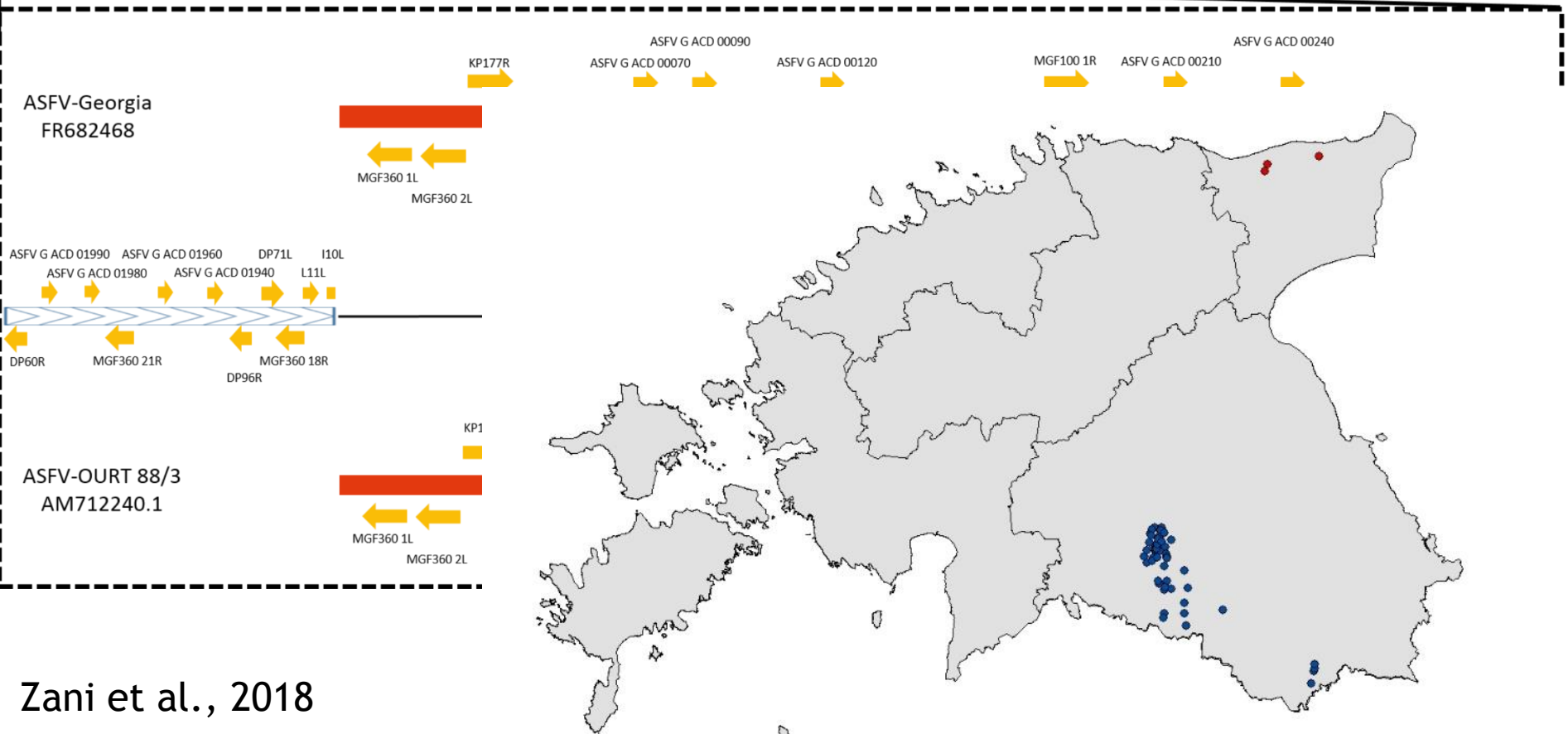
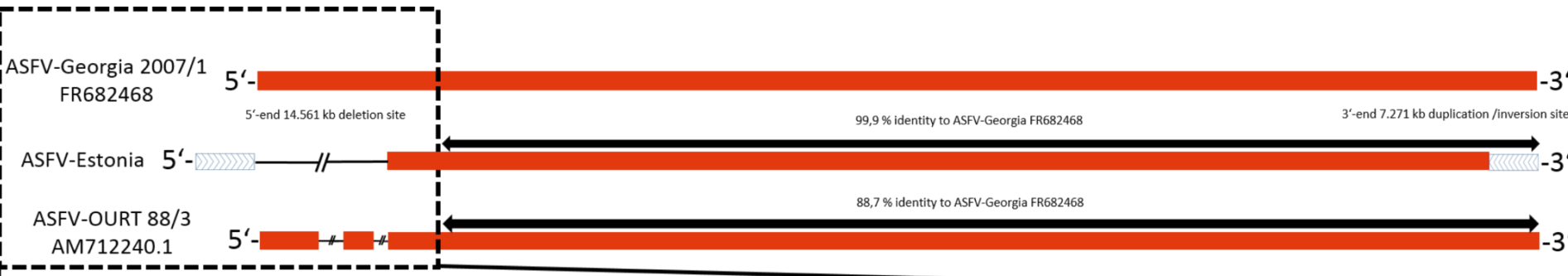
Alternative Sampling



„Point-of-care“ Diagnostics



A variant virus...

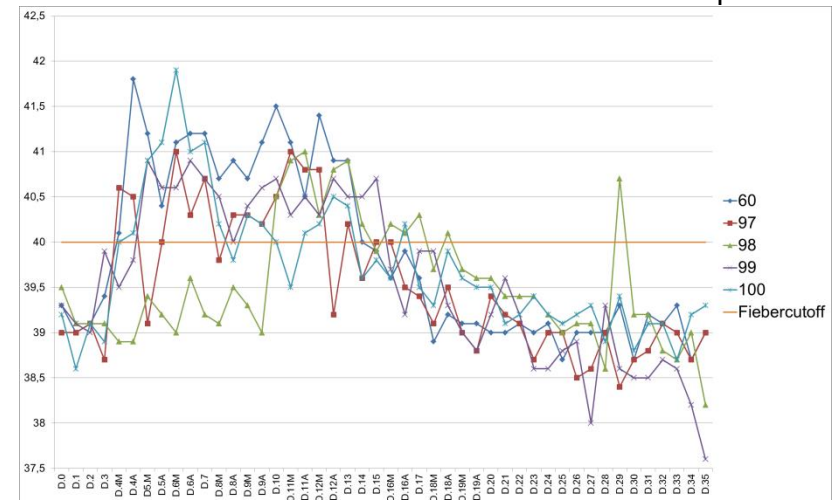


Biological characterization of the variant

Moderate/rather low virulence in potbelly mini pigs and domestic pigs



18 dpi



No transmission to fetuses of infected sows

Dr. Jekyll and Mr. Hyde?

The plan: use the variant to answer the question whether the variant can protect against the co-circulating virulent virus strains



Studien Design:

- Inokulation of five wild boar of different age classes with the variant ASFV „Estonia P2“
- Challenge with ASFV „Armenia08“ (the „Killer“)

Infection with the attenuated phenotype

Challenge with ASPV Armenia

Necropsy



0 dpi

7 dpi

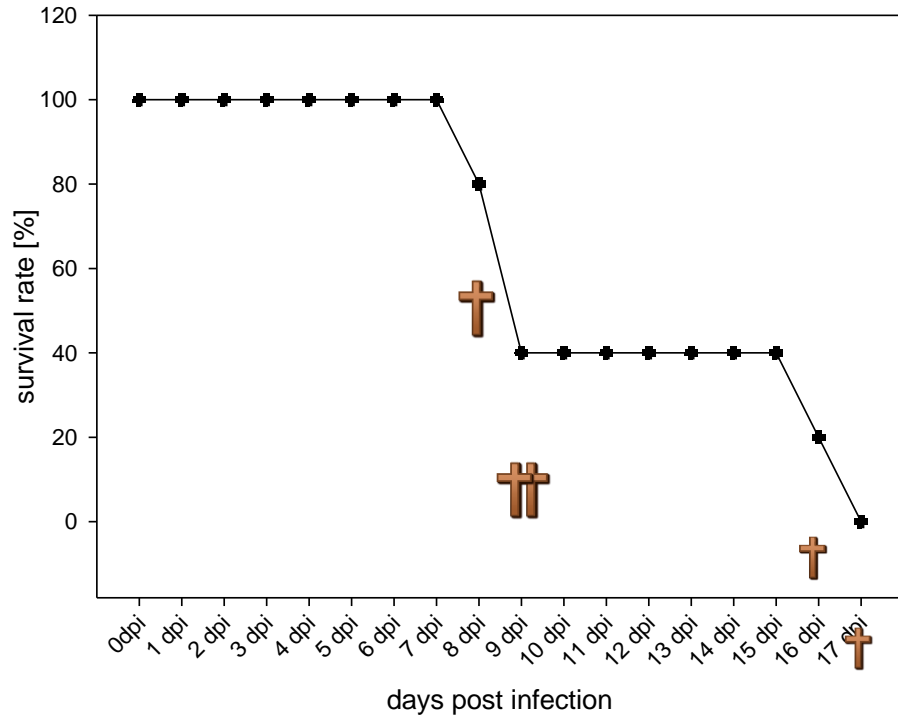
28 dpi

35 dpi (7 dpo)

56 dpi (28 dpo)



Plans can be changed...



- Highly virulent phenotype with severe clinical signs already in the first week

- Typical lesions...

What is the moral of the story? → we still do not know the virus...

Myths and Facts - Carcasses...

Opinion: It is impossible to detect carcasses
→ We are looking for the **increased** (!!!) occurrence of carcasses



Myths and Facts - Carcasses II

- Opinion: Wild boar is canibalistic
- Opinion: Carcasses are gone within 48 h



16.12.2015 (day 8)



02.01.2016 (day 25)



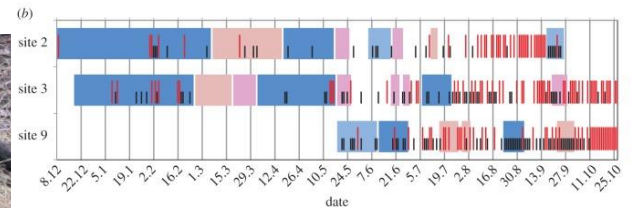
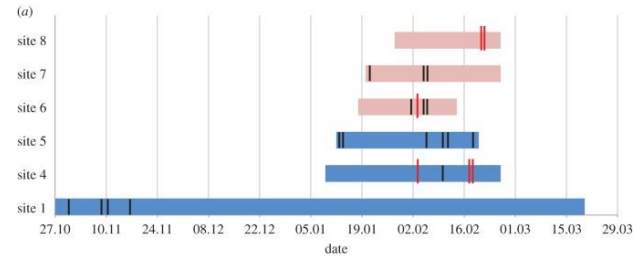
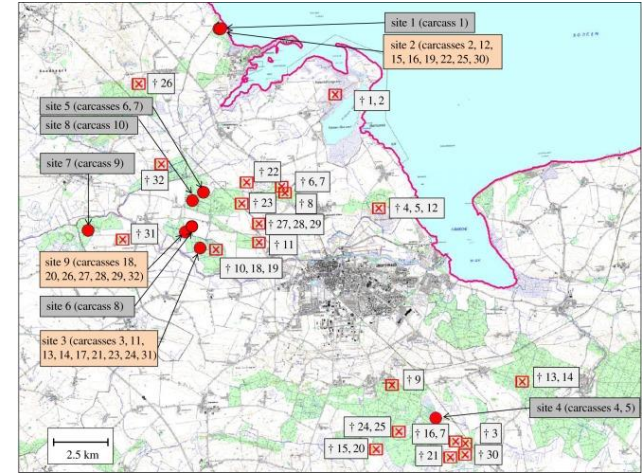
12.01.2016 (day 35)



08.02.2016 (day 54)



→ Not so easy!!!



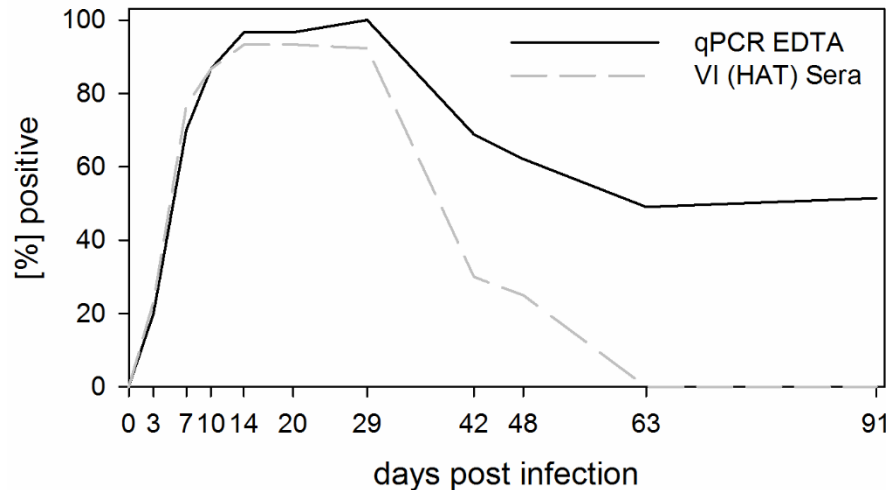
Probst et al., 2017

Are all survivors carriers?

Not in our hands... survivors did not transmit to sentinels and virus was not found in the surviving animals



Are all convalescent animals carriers and if so, for life?



Observations from long-term animal studies:

- Survivors carry the virus for a long time and viral genome even longer
- However, virus detection ends roughly at day 50
- No transmission after day 50 from survivors to commingled sentinels
- Survivors were negative in all organs after 165 days
- Percentage of true carriers is probably rather low
- Biological impact?



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journal homepage: www.elsevier.com/locate/vetmic



Received: 20 October 2017

DOI: 10.1111/tbed.12837

ORIGINAL ARTICLE

Short time window for transmissibility of African swine fever virus from a contaminated environment

A. S. Olesen¹ | L. Lohse¹ | T. B. Rasmussen¹ | A. M. ...

Survival and localization of African swine fever virus in stable flies (*Stomoxys calcitrans*) after feeding on viremic blood using a membrane feeder

Ann Sofie Olesen^a, Mette Frimodt Hansen^b, Thomas Bruun Rasmussen^a, Graham J. Belsham^a, Rene Bødker^b, Anette Bøtner^{a,*}

^a DTU National Veterinary Institute, Technical University of Denmark, Lindholm, DK-4771 Kalvehave, Denmark

^b DTU National Veterinary Institute, Technical University of Denmark, Kemtorvet, building 202, DK-2800 Kgs. Lyngby, Denmark

SHORT COMMUNICATION

Evaluation of blowfly larvae (Diptera: Calliphoridae) as possible reservoirs and mechanical vectors of African swine fever virus

J. H. Forth¹ | J. Amendt² | S. Blome¹ | K. De ...

Arch Virol (2015) 160:1657–1667
DOI 10.1007/s00705-015-2430-3

ORIGINAL

Courtesy of domestic animals: low-dose infection with a Caucasian African swine fever virus

Jana Pietschmann¹, Anja Globig¹, Valery Pronin², Kerstin Taucher¹, Anja Globig¹, Anja Keil⁴, Sandra Blome¹

Water? Predators? Unknown vectors? Soil? Movements? Carcasses? Contaminated grass? Grain? Hay? Straw?

Krzysztof Śmietanka²

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rsos.royalsocietypublishing.org

Research



Cite this article: Probst C, Globig A, Knoll B, Conraths FJ, Depner K. 2017 Behaviour of free ranging wild boar towards their dead fellows: potential implications for the transmission of African swine fever. *R. Soc. open sci.* 4: 170054. <http://dx.doi.org/10.1098/rsos.170054>

Behaviour of free ranging wild boar towards their dead fellows: potential implications for the transmission of African swine fever

Carolina Probst¹, Anja Globig¹, Bent Knoll², Franz J. Conraths¹ and Klaus Depner¹

¹Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health, Institute of Epidemiology, Südufer 10, 17493 Greifswald-Insel Riems, Germany

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CP, 0000-0003-0763-3604

Received: 19 January 2017

Accepted: 27 April 2017

RESEARCH ARTICLE

Survival of viral pathogens in animal feed ingredients under transboundary shipping models

Scott A. Dee^{1*}, Fernando V. Bauermann², Megan C. Niederwerder^{3,4}, Aaron Singrey², Travis Clement², Marcelo de Lima^{2,5}, Craig Long², Gilbert Patterson⁶, Maureen A. Sheahan³, Ana M. M. Stoian³, Vlad Petrovan³, Cassandra K. Jones⁷, Jon De Jong¹, Ju Ji⁸, Gordon D. Spronk¹, Luke Minion¹, Jane Christopher-Hennings², Jeff J. Zimmerman⁹, Raymond R. R. Rowland³, Eric Nelson², Paul Sundberg¹⁰, Diego G. Diel²

schen Untersuchungen ist es, herauszufinden, mit welchen Instrumenten bzw. durch welche Maßnahmen sich das Risiko einer Virusinfektion weiter senken lässt.

(Quelle: topagrar.com ; 16.04.2018)

Five grams of gamma-irradiated ingredients (in 50 mL mini bioreactor tubes) were spiked with 100 µL of MEM (minimum essential media, Gibco, ThermoFisher Scientific, Waltham, MA, US) containing 1×10^5 tissue culture infectious dose 50 (TCID₅₀) of each virus [12].



Wolf als Überträger

Hier kommt der Wolf als Überträger ins Spiel: Dieser trägt den Virus, sofern er ein infiziertes Stück aufgenommen hat, bis zu drei Monate in sich und verbreitet ihn durch Ausscheidungen und Bisse. Meist tötet der Wolf seine Beute nicht, bevor er mit dem Fressen beginnt. Der Blutkreislauf ist intakt und der Erreger verteilt sich im Wildkörper, so werden die Überbleibsel infiziert und das Virus verbreit-



Gary Kramer - National Digital Library of the United States Fish and Wildlife Service

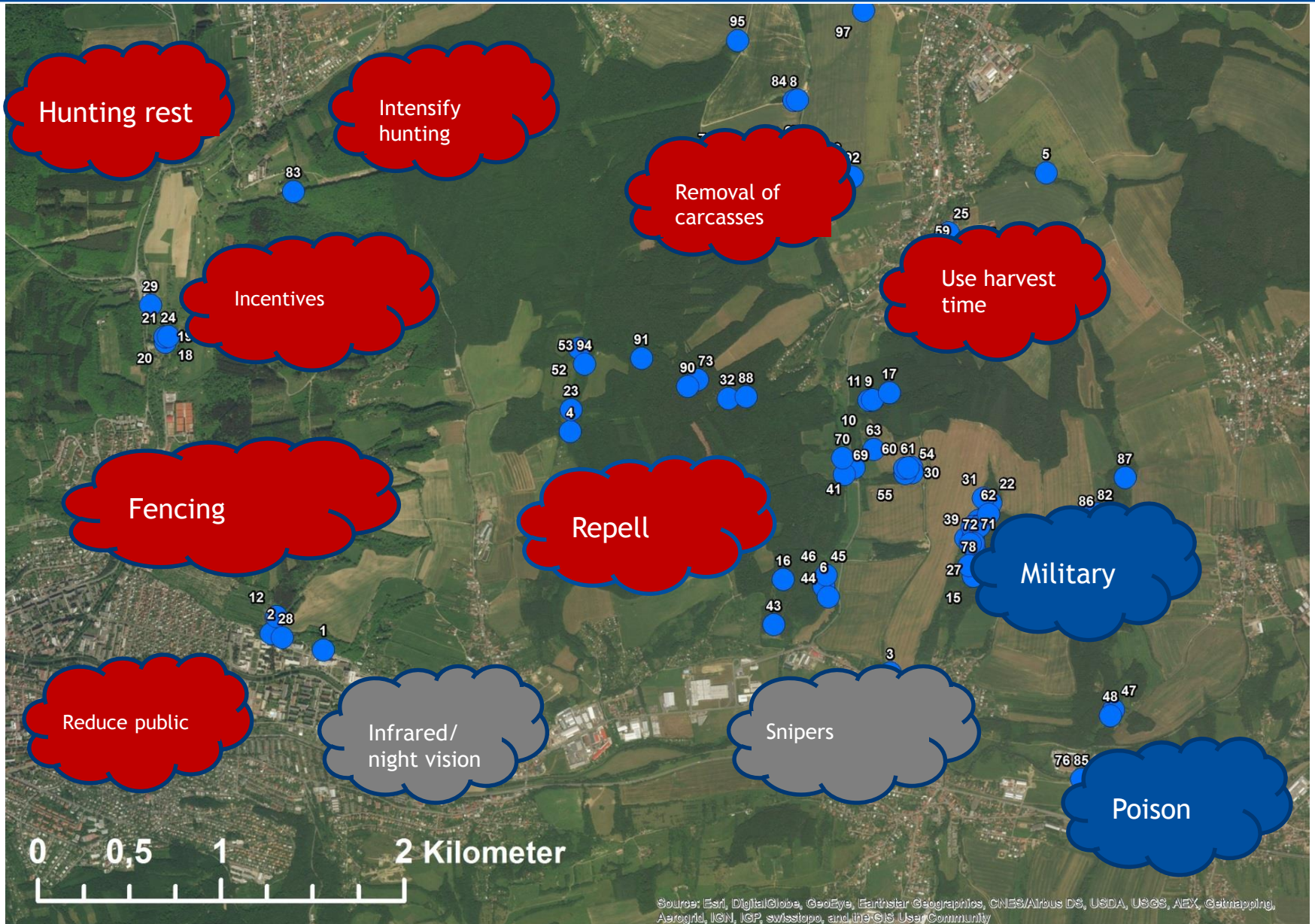
DÄNEMARKS GRENZZAUN

Wildschweinzaun hilft nicht: Fliegen übertragen Afrikanische Schweinepest

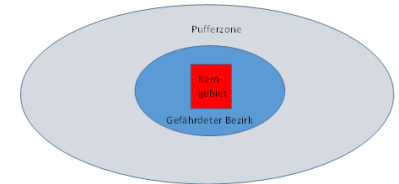
Die Afrikanische Schweinepest kann durch Stechfliegen übertragen werden. Fliegensichere Ställe wären extrem teuer.



Control options...



How can we control the disease and is there a „gold standard“?



Zone			Maßnahme	Vorteile	Nachteile	Kommentare
1	2	3				
			Jagdruhe	<ul style="list-style-type: none"> Tiere in der Kernzone halten, Ausbreitung der ASP verhindern, durchseuchen lassen 	<ul style="list-style-type: none"> Andere Tierarten müssen u.U. zur Erfüllung der Abschusspläne gejagt werden Steht im Gegensatz zur intensiv Fallwildsuche 	
			Ansitzjagd auf andere Wildarten	<ul style="list-style-type: none"> Erfüllung der Abschusspläne 	<ul style="list-style-type: none"> u.U. Beunruhigung des Schwarz 	
			Drückjagd	<ul style="list-style-type: none"> Gezielte Beunruhigung und Bejagung, damit Reduzierung der Schwarzwildpopulation 	<ul style="list-style-type: none"> Gefahr der Seuchenverschleppung der Kernzone heraus Drückrichtung ist mit der Bewegungsrichtung des Schwarz nicht immer identisch, windabhängig Muss revierübergreifend erfolgen, Absprachen sind notwendig 	
			Einsatz von Drohnen	<ul style="list-style-type: none"> Aufspüren von Kadavern Aufspüren von Rotten in großen Schlägen, die nicht einsehbar sind 	<ul style="list-style-type: none"> Kosten Sachkenntnisse notwendig 	
			Einsatz von Wärmebildkameras	<ul style="list-style-type: none"> Aufspüren von Rotten Charakterisierung der Population Gezielte Bejagung 	<ul style="list-style-type: none"> Waren bei KSP nicht zielführend (Wildschweine im Winter weniger zu sehen aufgrund dicker Isolierung) Sehr hohe Kosten für geeignete Kameras 	
			Einsatz von Hubschraubern	<ul style="list-style-type: none"> Aufspüren von Rotten in unwegsamen Gebieten (z.B. Schilfgürtel), Charakterisierung der Population, gezielte Bejagung 	<ul style="list-style-type: none"> Kosten Starke Beunruhigung des Wildes, unkontrollierte Flucht 	



ASP-Früherkennung

Was ist zu tun, wenn Fallwild gefunden wird?

Ein Eintrag der Afrikanischen Schweinepest (ASP) führt aufgrund der hohen Sterblichkeit (ca. 90 %) in allen Altersklassen zu einem vermehrten Auftreten von Fallwild. Die Untersuchung tot aufgefundener Wildschweine ist somit eine wichtige Säule der Früherkennung.



(Fotos: Edvins Oļševskis, Lettland)

Was ist zu tun, wenn Fallwild gefunden wird?

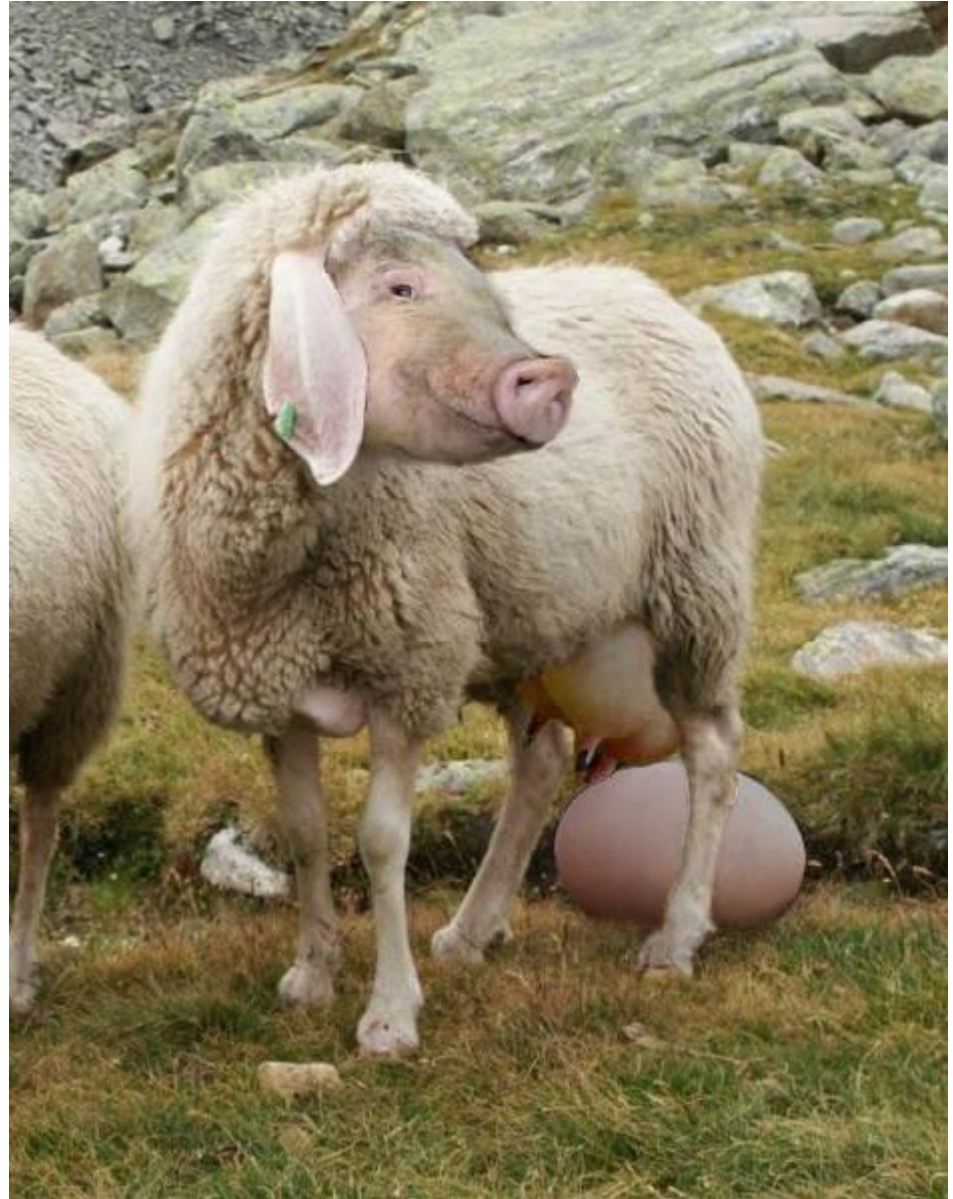
- Der Fund von Fallwild ist der zuständigen Behörde (**Veterinäramt**) **anzuzeigen**. Dies sollte im Regelfall durch einen Anruf erfolgen. Über die Erweiterung der Tierfund-App sollte diskutiert werden. Die Markierung und Georeferenzierung der Fundstelle erleichtert das weitere Vorgehen. Ggf. Foto der Fundstelle und des Tierkörpers (ggf. über die App übermitteln).

ASF vaccines



Von unbekannt - BSB München, cgm 19, f. 50v, Ausschnitt, Bild-PD-alt,
<https://de.wikipedia.org/w/index.php?curid=615232>

Jack of all trades device?
Grail of control measures?

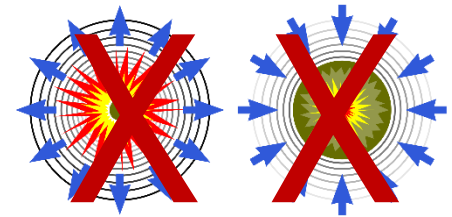


What ASF did not do after its re-introduction into the EU:

- No explosive spread to the West
- No self-termination of outbreaks

Lessons learned:

- Contagiosity was overestimated
- Endemic cycles were established in the wild boar population, independently from domestic pigs
- The contaminated habitat plays a crucial role
- Transmission routes are often „golden bullet events“ with very low probability but high impact, risk assessments and predictions are most difficult (would you have guessed that grass is an important factor?)
- Lethality is still high but mortality can be low, especially at the beginning of an epidemic
- There are some virus variants with lower (moderate) virulence; these viruses seem to have a disadvantage in wild boar (disappeared quickly)
- Surviving animals carry the virus for a long time and genome even longer; however, the percentage of animals that do not eliminate the virus in the end is very low (not existent in our long-term experimental studies), no transmission from true convalescent animals to sentinels
- Antibody detection does not have a predictive value towards the outcome of the infection





Global African Swine Fever
Research Alliance

Thanks for your attention!

