How much do we need to know about ASF to be able to prevent, control and eradicate?

- Something about the virus
- Something about the clinical course
- Something about diagnosis
- Something about contagiosity, infectiosity, transmission…

- Much about epidemiology

- **Very much about**
  - human - host interactions
- **Very much about**
  - human behaviour
ASF is a human driven disease ("anthropogenic factors")

**Sylvatic cycle**: warthog/bushpig - soft ticks

Infectious period

Chenais et al., 2018

No clinic
**Tick-pig cycle: soft ticks - domestic pigs.**

Chenais et al., 2018

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**Ornithodorus as competent vector**

AFRICA
- *O. Moubata*
- *O. Savignyi*
- *O. Porcinus*

EUROPE:
- *O. Erraticus* (Vector competency is lower)

Domestic cycle: domestic pigs - pig products

1) Sylvatic cycle: the common warthogs; bushpigs and soft ticks.
2) Tick-pig cycle: soft ticks; domestic pigs.
3) Domestic cycle: domestic pigs and pig products.
4) Wild boar-habitat cycle: wild boar; pig- and wild boar products and carcasses; the habitat.

Oral infection!!!
**ASF virus is relatively stable**

- frozen meat: indefinitely
- dry meat and fat: almost one year
- blood, salted meat and offal: more than 3 months
- faeces: over one week

*Temperature plays an important role in decreasing the survival duration of ASF virus in any matrix.*

**ASFV survives the process of putrefaction and carcasses may remain infectious for weeks**
A bit about ASF

- Scientific information available
- Knowledge about ways & routes of transmission
- Diagnostic tools available

If we do not manage ASF, it's not because of lack of knowledge…
1) ASF will fade out rapidly from the affected wild boar population due to the high mortality rate induced by the ASFV (**IMPLOSION**), years later........

Both hypotheses proved to be wrong !!!

2) ASF will spread rapidly westwards since an infected local wild boar population would infect the naïve neighboring populations within a short period of time, initiating an epidemic wave... (**EXPLOSION**)

Textbooks are misleading...

"ASF is a highly contagious disease... causing high mortality up to 100%..."

- Mortality: Dead animals / epidemiological unit
- Case fatality (lethality): Dead animals / infected animals
Contagiousity/Contagiousness

The percentage of animals which get infected after contact with an infectious agent.

*Probability that an animal picks up an infection after contact with a pathogen*

It is NOT an indicator for disease severity and impact!!!
- Low contagious diseases with severe course and high impact
- Highly contagious diseases with mild course and low impact

**Contagiousness**

Probability of infection

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30%</td>
<td>~ 50%</td>
<td>&gt; 60%</td>
</tr>
</tbody>
</table>

**ASF - CSF - FMD**

- **FMD**
  - Prevalence: 100%
  - Mortality: 2%
  - Lethality: 2%
  - Contagiosity: +++
  - 100 infected; 2 dead
- **ASF**
  - P: 10%
  - M: 9%
  - L: 90%
  - Contagiosity: +
  - 10 infected; 9 dead
- **CSF**
  - P: 50%
  - M: 25%
  - L: 50%
  - Contagiosity: ++
  - 50 infected; 25 dead
**ASF - CSF - FMD**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3... weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMD</td>
<td><img src="image1" alt="V. shedding" /></td>
<td><img src="image2" alt="Viraemia" /></td>
<td><img src="image3" alt="C. signs" /></td>
</tr>
<tr>
<td>CSF</td>
<td><img src="image1" alt="V. shedding" /></td>
<td><img src="image2" alt="Viraemia" /></td>
<td><img src="image3" alt="C. signs" /></td>
</tr>
<tr>
<td>ASF</td>
<td><img src="image1" alt="V. shedding" /></td>
<td><img src="image2" alt="Viraemia" /></td>
<td><img src="image3" alt="C. signs" /></td>
</tr>
</tbody>
</table>

- V. shedding
- Viraemia
- C. signs
- Infectious

**Probability of infection**

- **HIGH**
  - within a group (within stable)
  - high virus dose (>1000 HAU)
  - parenteral transmission

- **LOW**
  - between groups (open system...e.g. forest)
  - low virus dose (<100 HAU)
  - oral transmission

**Contagiousity**
## Virus dose & contagiousity

<table>
<thead>
<tr>
<th>Inoculated</th>
<th>Dose</th>
<th>Infected</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 x ASPV Armenia</td>
<td>25 HAU</td>
<td>1</td>
<td>0.08 (1)</td>
</tr>
<tr>
<td>12 x ASPV Armenia</td>
<td>3 HAU</td>
<td>1</td>
<td>0.08 (1)</td>
</tr>
<tr>
<td>6 x ASPV Armenia</td>
<td>1000 HAU</td>
<td>0</td>
<td>0 (0)</td>
</tr>
<tr>
<td>30 x ASPV NL 1986</td>
<td>20,000 HAU</td>
<td>20</td>
<td>0.66 (1)</td>
</tr>
<tr>
<td>10 x ASPV Estland</td>
<td>100,000 HAU</td>
<td>9</td>
<td>0.9 (1)</td>
</tr>
<tr>
<td>5 x ASPV Estland</td>
<td>100,000 HAU</td>
<td>4</td>
<td>0.8 (1)</td>
</tr>
</tbody>
</table>

*(Beer and Blome, FLI-IVD)*

8% - 90%
Characteristics of epidemics in wildlife populations
(and backyards???)

**Complex situation:** interaction of many factors
(infected animals, animal density, hunting activities, agriculture, etc.)

**Obscure situation:** not all important parameters are known (e.g. animal density, animal movements, etc...)

**Dynamic situation:** permanent change of parameters
(e.g. seasonal influences, fluctuation in animal number)

Influencing one factor can cause unpredicted side-effects

The 4 phases of a transmissible disease

<table>
<thead>
<tr>
<th>N. cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>28</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>32</td>
</tr>
</tbody>
</table>

**Introduction**

**Invasion**

**Epidemic**

**Endemic**

**Fade out**
Summary

Endemic situation, slow spread, does not fade out
Fades out after reducing susceptibles by vaccination
Fades out spontaneously

Two of three parameters should be low/medium for the epidemic to fade out

Persistency triangle (ASF)

- **High tenacity** ensures long term virus persistence in the environment
- **High case fatality** rate makes the virus largely available in the form of many carcasses.

The relatively **low contagiousity** prevents the complete depletion of the host population and may hamper early detection.

The interaction of these three parameters maximize local persistence and limits fast geographical spread of the virus within an affected population. ASF is maintained locally, with a low but steady presence, making its eradication a challenge.

*Chenais et al. 2019*
Exposure opportunity

- If carcasses will be removed, exposure opportunity will decrease -> less contacts
- If carcasses will NOT be removed, exposure opportunity will increase -> more contacts

Passive surveillance for DP and WB

*5/95 surveillance concept is not purposeful*

Active surveillance gives a false sense of security
Early detection of ASF in wild boar

Passive surveillance vs. active surveillance

<table>
<thead>
<tr>
<th></th>
<th>tested</th>
<th>positive</th>
<th>% positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive (found dead)</td>
<td>245</td>
<td>177</td>
<td><strong>72.24</strong></td>
</tr>
<tr>
<td>Active (hunted)</td>
<td>2765</td>
<td>40</td>
<td><strong>1.45</strong></td>
</tr>
</tbody>
</table>

**Passive / Active: 72.24 / 1.45 = 49,82**

The probability to detect an ASF positive case is 50 times higher in dead animals than in hunted animals.

81 out of 100 positive cases are likely to be detected in dead wild boar

(177 / 217 x 100 = 81)

Biosecurity

the most effective control tool

The only potent tool we have...

- Africa - double fencing
- Three golden rules of biosecurity
"... the precautions now being exercised beneficially show that under the conditions at present existing the disease is one which can in large measure be avoided“

E. Montgomery 1921
**Good news (domestic pigs):** no (rapid) spread of the disease

*ASF in domestic pigs can be controlled effectively by good biosecurity!!!*

**Bad news (wild boar):** no (rapid) spread of the disease

*ASF in wild boar survives locally over months or years in wild boar populations (a habitat disease)*

**ASF control and eradication**

**Key characteristics of ASF:**
- low contagiousity, slow spread, few secondary infections
- no transmission by wind or insects,
- **site fidelity** (stable disease / habitat disease)

**DP: stable disease**

**Measures:**
1. Standstill
2. Culling
3. C&D

**WB: habitat disease**

**Measures:**
1. Standstill (no disturbance of WB, no hunting, electrical fence, (feeding))
2. (Trapping)
3. Disposal of carcasses

**Successful approach!!**

“**Virtual stable**” in forest
### Freedom of disease vs. Presence of disease

<table>
<thead>
<tr>
<th>Freedom of disease</th>
<th>Presence of disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild boar management measures</td>
<td>Disease control measures</td>
</tr>
<tr>
<td><em>e.g.</em> population reduction to avoid agricultural damage</td>
<td><em>not wild boar management measures!!</em></td>
</tr>
<tr>
<td><em>e.g.</em> Intensive hunting</td>
<td>Movement restriction</td>
</tr>
<tr>
<td></td>
<td>Ban of feeding</td>
</tr>
<tr>
<td></td>
<td>Prohibition of hunting</td>
</tr>
<tr>
<td></td>
<td>Intensive hunting</td>
</tr>
</tbody>
</table>

**Hunting/Slaughtering ↔ Culling**

### Measures based on ASF biology

- **CA:** defined by carcasses found within 1-2 months
- **BA:** defined by home range, ~ 6 km
- **IA:** “legal area” >200km²
  - 400 - 1000 WB

**Slow disease => be very patient in CA + BA!!**

**Avoid any activity which disturb WB**
### Lessons learned in recent years

- ASF is in the field not a highly contagious disease
- ASF in WB is a habitat disease
- ASF is a “slow” disease
  - ASF did not fade out: NO implosion
  - ASF did not spread rapidly (Rabies-like...) NO explosion
  - Lethality high (>90%)
  - Starting mortality low (<5%)
  - Prevalence low (<5%)
  - Not necessarily a density dependent process

**Endemic in the region, slow spread**

It changed the understanding of ASF

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**...identify the essentials, spot the disease characteristics important for epidemiological understanding...**