TICKS AND TICK-BORNE DISEASES IN SOUTHWEST GERMANY

Monika Schaeffer, Trevor Petney, Nina Littwin, Senta Muders, Miriam Pfäffle, Rainer Oehme
WHY TICKS?

- Transmit a greater variety of pathogenic microorganisms, protozoa, bacteria and viruses than any other arthropod vector group
- Substantial impact on public health in the northern hemisphere
- Evidence of an increase in distribution and abundance of ticks in Europe due for example to climate change
TICKS IN SOUTHWEST GERMANY

- Almost 900 tick species described, 19 present in Germany, 9 in Rhineland-Palatinate, 10 in Baden-Württemberg
- All ticks are obligate temporary parasites of vertebrate animals
- It is common for immatures (larvae and nymphs) to feed on small animals
- While adults may feed on large carnivores and ungulates
- At each blood meal ticks can become integrated into the chain of pathogen transmission
WHAT MAKES TICKS TICK?

“A humidity rate of $> 85\%$, air temperatures of more than $6^\circ C$ to $7^\circ C$ and a large number of blood-delivering hosts are the basic requirements to make ticks “happy“. (Süss 2008)
“Ticks are very finicky, like one of those brats who will only eat cookies”. D.E. Sonenshine (2000)
PATHOGEN TRANSMISSION
PATHOGEN TRANSMISSION

Horizontal (tick by another tick)

\[ \rightarrow \text{reservoir host} \]
\[ \rightarrow \text{co-feeding} \]

Vertical (different life stages)

\[ \rightarrow \text{transstadial} \]
\[ \rightarrow \text{transovarial} \]
Co-feeding

- *Babesia* spp, *Borrelia burgdorferi* sensu lato, *Candidatus Neoehrlichia mikurensis* (CNM), *Rickettsia* spp. and TBE-V can be transmitted horizontally (via saliva of a feeding tick)
- Bbsl and TBE-V infected ticks rarely transmit pathogens transovarially, more likely to occur for *Rickettsia* spp
- CNM mainly a rodent-associated pathogen
PATHOGEN TRANSMISSION

TICKS AND TBD IN SOUTHWEST GERMANY

Lyme-Borreliosis (LB)

- most frequent vector-borne disease in Germany
- 50,000-100,000 cases per year estimated
- 18 species described in the sensu lato complex, 5 species pathogenic for humans
- prevalence: 1% in larvae, 10% in nymphs and 20% in adults

Tick-borne-encephalitis (TBE)

- most common vector-borne viral pathogen in Germany
- 250-400 cases per year, recently tenfold higher risk than in the 1980s

Images: [http://textbookofbacteriology.net/borrelia.jpg](http://textbookofbacteriology.net/borrelia.jpg) and [http://ars.els-cdn.com/content/image/1-s2.0-S1877959X14000351-gr4.jpg](http://ars.els-cdn.com/content/image/1-s2.0-S1877959X14000351-gr4.jpg)
TICKS AND TBD IN SOUTHWEST GERMANY

Rickettsiosis

- Rickettsiaceae
- 6 species described in Germany, 5 transmitted by ticks
- most common species *R. helvetica*

Neoehrlichichiosis

- mainly described in immuno-compromised patients
- *Candidatus* Neoehrlichia mikurensis (CNM)
- mainly rodent-associated pathogen
- Exposure of people to infected ticks is expected to be on the rise

http://itg.author-e.eu/Generated/pubx/173/mm_files/do_3160/co_68355/cd_1002_015c.jpg

https://microbewiki.kenyon.edu/images/thumb/1/1e/Neoehrlichiamikurensis.jpg/180px-Neoehrlichiamikurensis.jpg
PROJECTS

Ticks on big game

Ticks on small mammals
STUDY AREAS – SMALL MAMMAL PROJECTS

STUDY AREAS

- in Rhineland-Palatinate mixed forest (oak, beech, pine)
- medium soil wetness
- little difference in height, 136 - 156m (a.s.l.)

- in Baden-Württemberg hardwood alluvial forest and mixed forest (pine and beech)
- moderately damp till dry soil
- height differing from 100 up to 610m (a.s.l.)
METHODS – SMALL MAMMAL PROJECTS

Small Mammal Trapping

- March - October
- two consecutive days and nights / month
- patches of 1600/2500m²
- 5x5/6x12 Longworth life traps per grid

Examination

- determination of individual host characteristics
- individual foot tattoo (least invasive)
- tick collection and determination
- analysis of infection with *Borrelia burgdorferi* s.l., *Rickettsia* spec., CNM, using PCR

Drag-Sampling of 100m² at each habitat

Images: G. Wagner-Vogel, N. Littwin, L. Kratzer
RESULTS – SMALL MAMMAL PROJECTS

SMALL MAMMAL COMMUNITY IN 2014
- all habitats house 4 species: *Apodemus flavicollis*, *Myodes glareolus*, *Sorex araneus*, *Sorex minutus*
- while *A. flavicollis* and *M. glareolus* represent the dominant species

<table>
<thead>
<tr>
<th>Location</th>
<th><em>Apodemus flavicollis</em></th>
<th><em>Myodes glareolus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yellow-necked mouse</td>
<td>Bank vole</td>
</tr>
<tr>
<td>Eichelgarten</td>
<td>37</td>
<td>26</td>
</tr>
<tr>
<td>Porbelsee</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Viehunger Allee</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>all</td>
<td>80 (57.9%)</td>
<td>58 (42%)</td>
</tr>
</tbody>
</table>

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<td></td>
<td>Yellow-necked mouse</td>
<td>Bank vole</td>
</tr>
<tr>
<td>Auwald</td>
<td>284</td>
<td>266</td>
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<tr>
<td>Hardtwald</td>
<td>107</td>
<td>64</td>
</tr>
<tr>
<td>Michaelsberg</td>
<td>152</td>
<td>117</td>
</tr>
<tr>
<td>Schwarzwald</td>
<td>80</td>
<td>13</td>
</tr>
<tr>
<td>all</td>
<td>623 (57.5%)</td>
<td>460 (42.4%)</td>
</tr>
</tbody>
</table>
I. RICINUS ON HOSTS IN BW

![Graph showing mean abundance of I. ricinus larvae and small mammal density](image-url)

**Mean abundance of I. ricinus larvae**

- Small mammal density (JS)
- A. flavicollis
- M. glareolus

**Small mammal density (JS)**

- 2012
- 2013
- 2014
- 2012
- 2013
- 2014
- 2012
- 2013
- 2014

**Wilcoxon-Mann-Whitney***: p < 0.001  *: p < 0.05
TICK-BORNE PATHOGENS IN BW

- TBE virus in two larval samples from *S. araneus*
- No detection of *Babesia spp.*
- Overall presence of *Candidatus Neoehrlichia mikurensis*

**viruses**
- TBE V

**bacteria**
- *Borrelia burgdorferi s.l.*
- *Candidatus Neoehrlichia mikurensis*
- *Rickettsia spp.*

**protozoans**
- *Babesia spp.*
**BORRELIA BURGDORFERI S.L. IN TICKS ON HOSTS, BW**

- High spatio-temporal and species variability
- Absence of pathogen at SW
- Highest larval prevalence in 2013

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**B. burgdorferi s.l. in A. flavicollis**

- Prevalence (%)
- Years: 2012-2014
- Hosts: AW, HW, MB, SW

**B. burgdorferi s.l. in M. glareolus**

- Prevalence (%)
- Years: 2012-2014
- Hosts: AW, HW, MB, SW
**Rickettsia spp. in ticks on hosts, BW**

- Larval prevalence steadily increasing
- No influence of host species or abundance detectable

![Graphs showing prevalence of Rickettsia spp. in A. flavicollis and M. glareolus](image)

*I. ricinus LL*  *I. ricinus NN*
TICKS ON BIG GAME, RP

- Sampling during annual hunting
  - Hunting from a hide (January till October)
  - Driven hunt (November till January)

- Tick collection as soon as possible after shooting
- Organs removed on opening the animal
### SAMPLED ANIMALS AND TICKS

<table>
<thead>
<tr>
<th></th>
<th>Adults</th>
<th>Males</th>
<th>Females</th>
<th>Nymphs</th>
<th>Larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roe deer</td>
<td>247</td>
<td>212</td>
<td>789</td>
<td>429</td>
<td>154</td>
</tr>
<tr>
<td>Adult</td>
<td>1001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild boar</td>
<td>344</td>
<td>4</td>
<td>37</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Adult</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sampled Animals:**
- Roe deer: 247 adults, 212 males, 789 females, 429 nymphs, 154 larvae
- Wild boar: 344 adults, 4 males, 37 females, 5 nymphs, 0 larvae
# OVERVIEW – *RICKETTSIA AND BORRELIA*

<table>
<thead>
<tr>
<th>Ticks from roe deer</th>
<th>Ticks</th>
<th>Rickettsia</th>
<th>Borrelia</th>
<th>Mixed infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>male ticks</td>
<td>48</td>
<td>26</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>female ticks</td>
<td>216</td>
<td>98</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ticks from wild boar*</th>
<th>Ticks</th>
<th>Rickettsia</th>
<th>Borrelia</th>
<th>Mixed infections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*all ticks were female

### Summary

- *Rickettsia* prevalence: 40-55%
- *Borrelia* prevalence: 0-7%
- Concurrent infections: 0-5%
ROE DEER – BORRELIA PREVALENCE

- Host age
  - Yearlings 5.13 %
  - Fawns 2.63 %
  - Adults 1.83 %

- Engorgement
  - loose unengorged 10.98 %
  - attached 0.00 %

→ roe deer are dilution hosts
**ROE DEER – RICKETTSIA PREVALENCE**

- **Host sex**
  - Ticks from female deer 53.64 %
  - Ticks from male deer 42.21 %

- **Tick engorgement**
  - loose unengorged 68.29%
  - attached unengorged 46.00%
  - little engorged 36.73%
  - medium engorged 34.62%
  - fully engorged 29.03%

Decreasing prevalence with higher engorgement!
TO SUM IT UP

- Results of own working group show high prevalence of *Rickettsia* in ticks from roe deer (47,0%) and wild boar (41,7%) in contrast to overall low *Borrelia* prevalence (3,4%, no positive tested tick from wild boar) in the Bienwald, Rhineland-Palatinate
- Roe deer is confirmed in our project as dilution host for *Borrelia burgdorferi* s.l.

- Overall presence of *Candidatus* Neoehrlichia mikurensis in ticks on small mammals
- High spatio-temporal and species variability of *Borrelia burgdorferi* s.l. in ticks on small mammal hosts in Baden-Württemberg
- Larval prevalence of *Rickettsia* in ticks on small mammals is steadily increasing while there is no influence of host species or abundance detectable
FORGET ABOUT MOSQUITOS WATCH OUT FOR TICKS!

DID YOU KNOW THAT RODENTS ARE THE PRIMARY RESERVOIR HOSTS FOR LYME DISEASE?

THANK YOU FOR YOUR ATTENTION!
ACKNOWLEDGMENTS

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