Examinations on the genetics of digital dermatitis based on improved definitions of clinical status

Session 27. New sources of phenotypes in cattle production – Part 1 (with ICAR)
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Bovine digital dermatitis (BDD)


Zinpro corporation 2014

= Mortellaro‘s disease

= Hairy heel warts

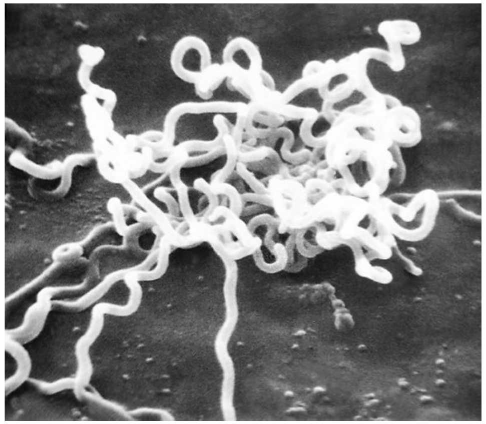
- increasing problem in europe (S -> N) and worldwide
- wide range for herd prevalence level
- infectious disease
- multiple risk factors

BDD – a multifactorial disease

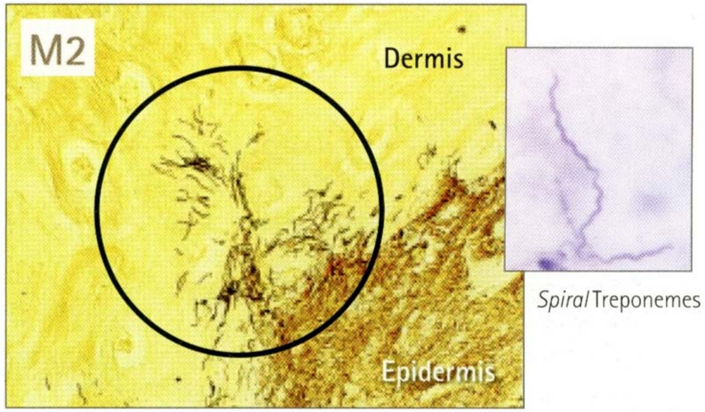
… with significant bacterial contribution

Treponema spp.

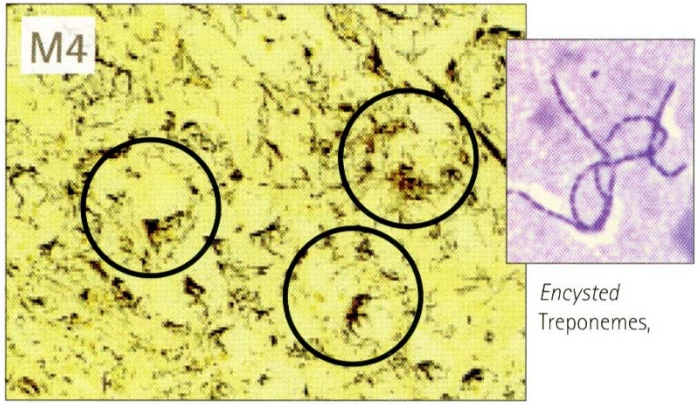
motile, with corkscrew motion



Treponema pallidum



Spiral Treponemes



Encysted Treponemes,

Genetic background of BDD

So far:

- heritability estimates range bewegen 0.05 (König et al. 2008)
and 0.14 (Schöpke et al. 2013)

predominantly based on:

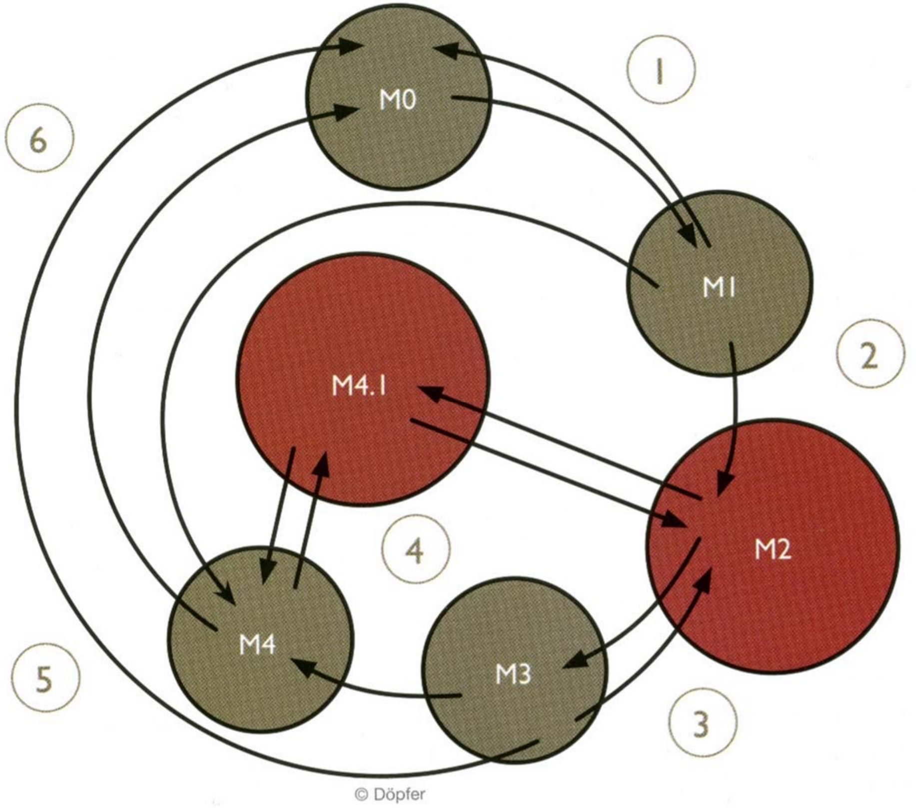
-> single or repeated observations per animal

-> simple trait definition for BDD-status =>healthy/ diseased (0/1)

-> consideration of clinical stages — Holzhauer et al. 2008

-> macroscopic classification of BDD — Döpfer et al. 1997
Berry et al. 2012

Classification scheme for BDD stages

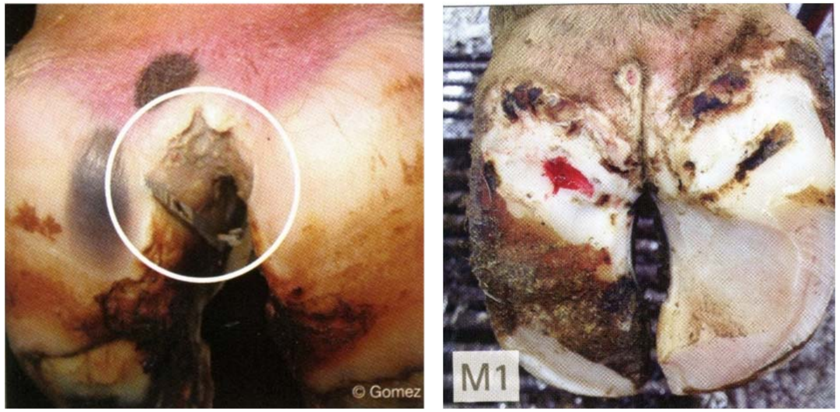


M0=0	healthy
M1=1	early stage, small
M2=2	acute, painful, active state
M3=3	curative/healing stage, dry
M4=4	chronic
M4.1=5	chronic, active stage

➔ Rapid dynamics of BDD !

Döpfer et al. 1997, 2012

BDD - stages



M1
early stage

M2
acute stage

Aim of the study

⇒ application of a more detailed scoring system for BDD stages and definition of new phenotypes for BDD

⇒ identification of factors associated with these traits

⇒ estimation of genetic parameters

⇒ improved assessment of the genetic background for BDD

Data

- commercial Holstein dairy herd in Wisconsin, USA (~2,000 animals)
- 729 pregnant heifers (6,444 observations)
- July 2011 – September 2012
- 120 visits (Ø 54 heifer/visit)
- at least 3 evaluations per heifer (Ø 4; [3-14])

Incidence for BDD

- 68 % of all observations were negative (M0) => “healthy”
- 55 % of the positive observations showed chronic stages (M4 or M4.1)
- 35 % of positive observations showed infectious stages (M2 or M4.1)

- 48 % of cows were consistently not affected
- 6 % of cows were permanently suffering from BDD

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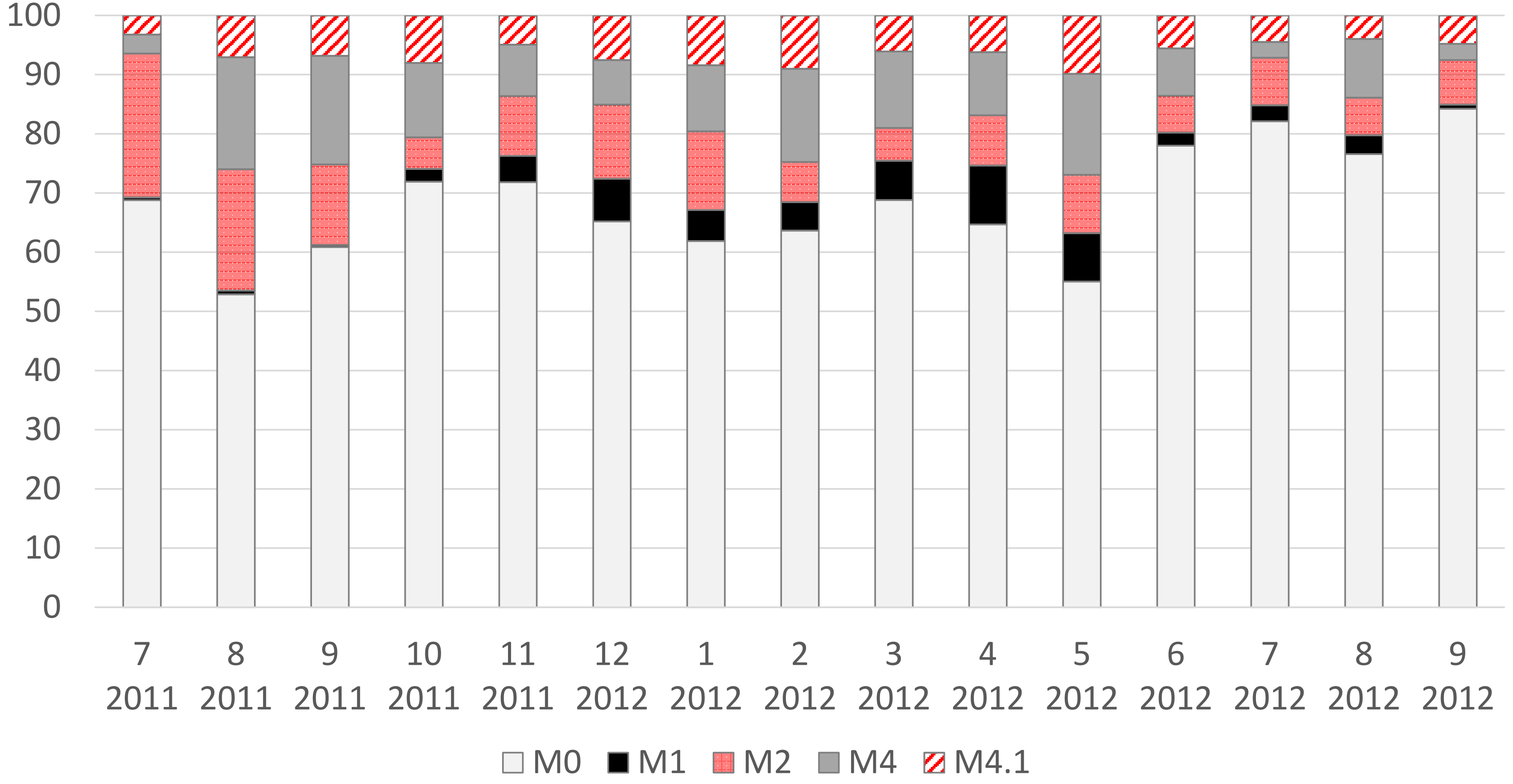
- 3.222 observations, although
  - 58 % completely healthy
  - 22 % both hind legs affected
  - 20 % one hind leg affected

Monthly frequencies for clinical status of BDD



M0 for unaffected animals; M1 for infected heifers with early, small, non-active lesions; M2 for infected heifers with a classic active lesion; M4 for late and chronic stages without lesion; M4.1 for late and chronic stages with small M1 lesion

Trait definition I

-> using previously described M-stages

➔ trait „TBIN“

- differentiates between consistently not DD affected cows (0) and cows with at least one observation with a DD lesion (1)

-> M0 vs. M1, M2, M4, M4.1

TBIN	N	%
0	354	48.29
1	379	51.71

➔ trait „TBINA“

- differentiates between cows that never (0) / at least once (1) experience an active stage of DD lesion

-> M0, M1, M4 vs. M2 + M4.1

TBINA	N	%
0	441	60.16
1	292	39.84

➔ trait „TSEVCAT41“

- differentiates between three severity categories of DD lesions: consistently not affected (1), at least once M1 or M4 (2), at least once active stage M2 or M4.1 (3)

TSEVCAT41	N	%
1	354	48.29
2	87	11.87
3	292	39.84

Trait definition II

-> using previously described M-stages

➔ trait „TTRANS“

- generation of “*Transition scores*” for each cow

-> classification and weighting of the single transitions between DD stages: staying not affected (1), improving, healing (2), staying affected (3), aggravating (4)

Trait	**N**	**Mean**	**Std Dev**	**Min**	**Max**
T-score	729	17.9	9.0	10.0	42.0

➔ trait „TCTM2“

- differentiate between three DD cow types concerning the number of M2 events

➔ type I: never M2 vs. Typ II: 1x M2 vs. Typ III: ≥2x M2

TCTM2	**N**	**%**
1	427	61.79
2	133	19.25
3	130	18.81

-> without using M-stages

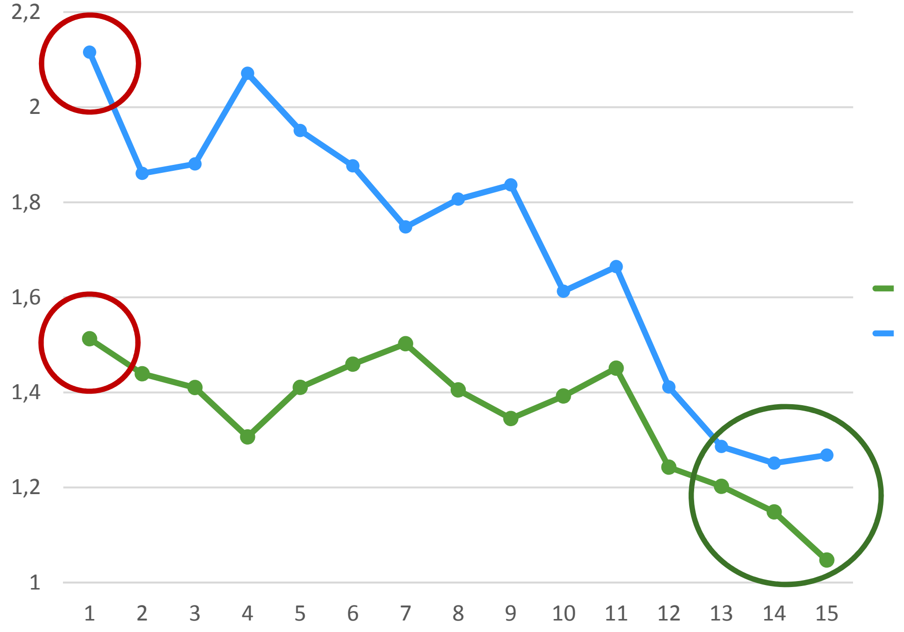
➔ Trait „TREF“

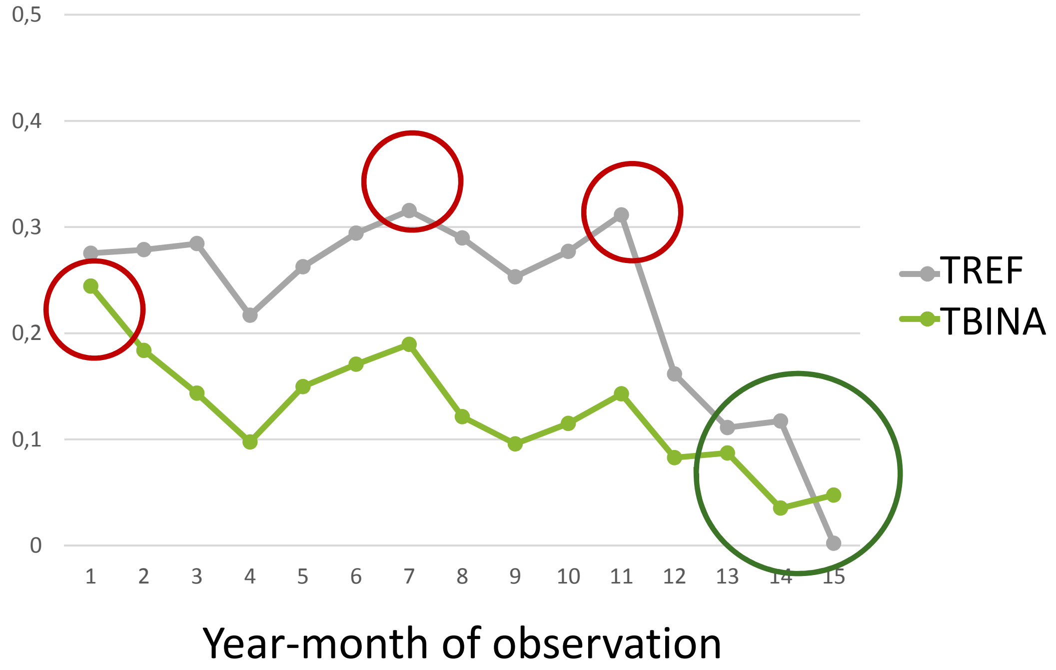
- reference scenario

➔differentiate the first observation of the cow into not affected (0) or affected (1)

TREF	**N**	**%**
0	640	87.79
1	89	12.21

LSMeans for different BDD traits in the course of observation months





Genetic analyses

Estimates of heritabilities (h^2) with standard errors (SE), additive (σ_a^2) and residual variance (σ_e^2) for different BDD traits in the linear univariate model

Trait	**No of observations (no. of cows)**	σ_a^2	σ_e^2	**h^2 (± SE)**
TBIN	729 (729)	0.043	0.179	0.194 ± 0.106
TBINA	729 (729)	0.041	0.162	0.203 ± 0.108
TSEVCAT41	729 (729)	0.175	0.574	0.234 ± 0.115
TCTM2	691 (691)	0.280	0.258	0.521 ± 0.171
TTRANS	729 (729)	30.522	41.726	0.423 ± 0.149
TREF	729 (729)	0.019	0.080	0.193 ± 0.109

Ranking (acc. breeding values) of bulls with at least 5 daughters

sire	N daughters	Rank ***TBIN***	Rank ***TBINA***	Rank ***TSEVCAT41***	Rank ***TTRANS***	Rank ***TCTM2***	Rank **TREF**
1	18	2	4	1	1	4	5
2	19	7	2	4	2	1	4
3	9	4	3	3	3	3	1
4	11	5	1	2	4	2	7
5	15	12↓	5	7	5	6	2
6	8	3	9↓	5	6	10 ↓	3
7	12	10↓	7	8	7	5	17 ↓↓
8	14	15↓	8	11 ↓	8	8	8
9	8	9	11	9	9	13	11
10	42	6	6	6	10	9	23
11	5	8	15	12	11	11	6
12	41	11	10	10	12	14	26
13	7	13	13	13	13	15	25
14	26	14	16	14	14	16	19
15	11	16	12	15	15	7	22
16	47	19	14	16	16	12	30
17	7	18	20	18	17	18	27
18	13	20	30	28	18	29	13
19	24	17	18	17	19	25	21
20	5	23	19	19	20	20	20
21	8	27	17	20	21	17	29
22	30	21	22	21	22	23	12
23	15	24	23	24	23	22	18
24	16	30	29	29	24	24	16 ↑
25	25	28	25	25	25	27	9 ↑↑
26	5	22 ↑	26	23 ↑	26	26	28
27	15	26	27	27	27	28	24
28	5	29	28	30	28	30	15 ↑↑
29	20	31	24	26	29	19↑	14 ↑↑
30	22	25	21↑	22 ↑	30	21↑	10 ↑↑
31	42	32	31	31	31	31	31

Conclusion

M-scale system allows for improved trait definition of BDD

-> traits accounting for different clinical stages can serve as an alert tool and thus can help to control BDD in cattle production systems

-> some of the traits not only enable the detection of BDD pre-disposition but also for chronicity

-> new traits showed higher heritability estimates

➔ pre-disposition for DD is higher than previously assumed

➔ new trait definition allows for improved strategies for genetic selection and for management strategies

Thank you !

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