Institute of Agricultural and Nutritional Sciences
Martin-Luther-University Halle-Wittenberg, Germany
Animal Breeding

Unravelling the genetic background of Interdigital Hyperplasia of the bovine hoof


©R. Pijl

Sammler S, Scheper C, Wensch-Dorendorf M, Schöpke K,
Brenig B, Swalve HH

svenja.sammler@landw.uni-halle.de

EAAP 2014
Copenhagen, Denmark
25 - 29 August 2014
65th annual meeting of the European Federation of Animal Science

Interdigital Hyperplasia

Clinical Picture

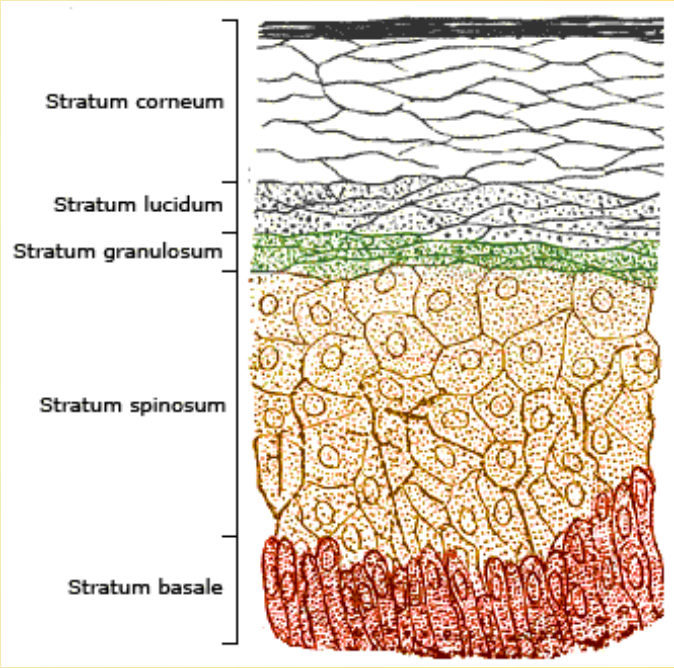
- **firm mass in the interdigital space of the bovine hoof**

medial lateral

Interdigital Hyperplasia

Clinical Picture

- firm mass in the interdigital space of the bovine hoof
- **hyperkeratotic and parakeratotic skin with increased cellularity in the stratum granulosum and s. spinosum (AABP 2014)**



Interdigital Hyperplasia

Clinical Picture

- firm mass in the interdigital space of the bovine hoof
- hyperkeratotic and parakeratotic skin with increased cellularity in the stratum granulosum and s. spinosum (AABP 2014)
- **proliferating**
- **wrinkles/weals already visible in calves for slaughter (Went 1961)**
- **most cattle contract IH between 2-6 years (Böttger 1962)**
- **from 9 years on, no new affections (Böttger 1962)**

Interdigital Hyperplasia

Prevalence

- **< 10 % in recent studies (e.g. Huang & Shanks 2002, Koenig et al. 2005, Smits et al. 1992)**
- **> 20 % in older studies (e.g. Böttger 1962, Comberg et al. 1968)**

depending on:

- **age (Böttger 1962, Comberg et al. 1968)**
- **breed (Huang & Shanks 2002)**
- **farm specific environmental effects (Pijl et al. 2013b)**

Interdigital Hyperplasia

Predisposing Factors

exogenic

- poor hoof trimming
- poor hygiene
- chemical / infectious / mechanical irritation (Hogreve 1964, Borges et al. 2014)

endogenic

- splay toes / flat claw angle
- weak connective tissue
- poor ligament development
- excess interdigital fat (Borges et al. 2014)
- insufficient mineralisation of the bones causing irritation of the periosteum (Chivers 1957)
- high weight

Genetic Background of Interdigital Hyperplasia

Heritability

- **significant correlations to blood group factors (Hogreve 1964)**
- **accumulation in some bull lineages (Hogreve 1964, Pijl et al. 2013a)**

Number of sons within quartiles of high / low EBV for resistance to IH for eight sires

		B	P	L1	A	S	R	L2	J
number of sons		30	27	19	20	24	27	23	23
number of granddaughters		803	658	849	500	470	632	442	657
number of observations		2988	2727	3154	1746	1538	2177	1403	1474
Best Quarter	N	**6**	**26**	**15**	**6**	**16**	**4**	**2**	**1**
Medium Half	N	**15**	**1**	**3**	**11**	**7**	**17**	**13**	**12**
Worst Quarter	N	**9**	**0**	**1**	**3**	**1**	**6**	**8**	**10**

Half-sibs Half-sibs, sons of sire to their left

Genetic Background of Interdigital Hyperplasia

Heritability

- significant correlations to blood group factors (Hogreve 1964)
- accumulation in some bull lineages (Hogreve 1964, Pijl et al. 2013a)

- **h^2: 0.115 (Koenig et al. 2005) – 0.43 (van der Spek et al. 2013)**
- **highest estimated heritabilities in comparison to other claw diseases**
- **higher when more than one foot is affected and the animal is young**

Genetic Background of Interdigital Hyperplasia

Study Design

- **assessment of IH status of 1,962 first lactation cows at time of hoof trimming**
- **differentiation between one-sided and pairwise affected rear legs**

→ 107 IH positive (71 one-sided and 36 pairwise affected)

1. searching for bull lineages passing on IH predisposition

n daughters	affected daughters	%	bull*	bull sire	mgs
5	2	40.0	A1	A	J
6	2	33.3	J1	J	T
6	2	33.3	B1	B	R
8	2	25.0	F1	F	N
8	2	25.0	G1	G	O
8	2	25.0	C1	C	P
25	4	16.0	J2	J	Q
21	3	14.3	E1	E	U
15	2	13.3	W1	W	V
33	4	12.1	J3	J	X
59	7	11.9	D1	D	Y
34	4	11.8	H1	H	AA
29	3	10.3	I1	I	S
20	2	10.0	K1	K	AB
54	5	9.3	J4	J	AC
33	3	9.1	M1	M	AD
32	2	6.3	J5	J	X
124	4	3.2	L1	L	Z

* ≥ 5 daughters, ≥ 2 affected daughters

Genetic Background of Interdigital Hyperplasia

bull sire	n sons*	n granddaughters	affected granddaughters	%
J	6	180	17	9.44
L	2	179	6	3.35
AE	3	145	0	0.00
D	1	62	7	11.29

J: high heredity of IH

L: medium heredity of IH

AE: low heredity of IH

* ≥ 5 daughters

Genetic Background of Interdigital Hyperplasia

Study Design

- assessment of IH status of 1,962 first lactation cows at time of hoof trimming
- differentiation between one-sided and pairwise affected rear legs

→ 107 IH positive (71 one-sided and 36 pairwise affected)

1. searching for bull lineages passing on IH predisposition
2. **genotyping of 192 selected cows with Illumina BovineSNP50 BeadChip**

selection basis: herd visits with highest IH prevalence rates (6.67-19.51%)

→ 87 IH positive (56 one-sided and 31 pairwise affected) + 105 controls

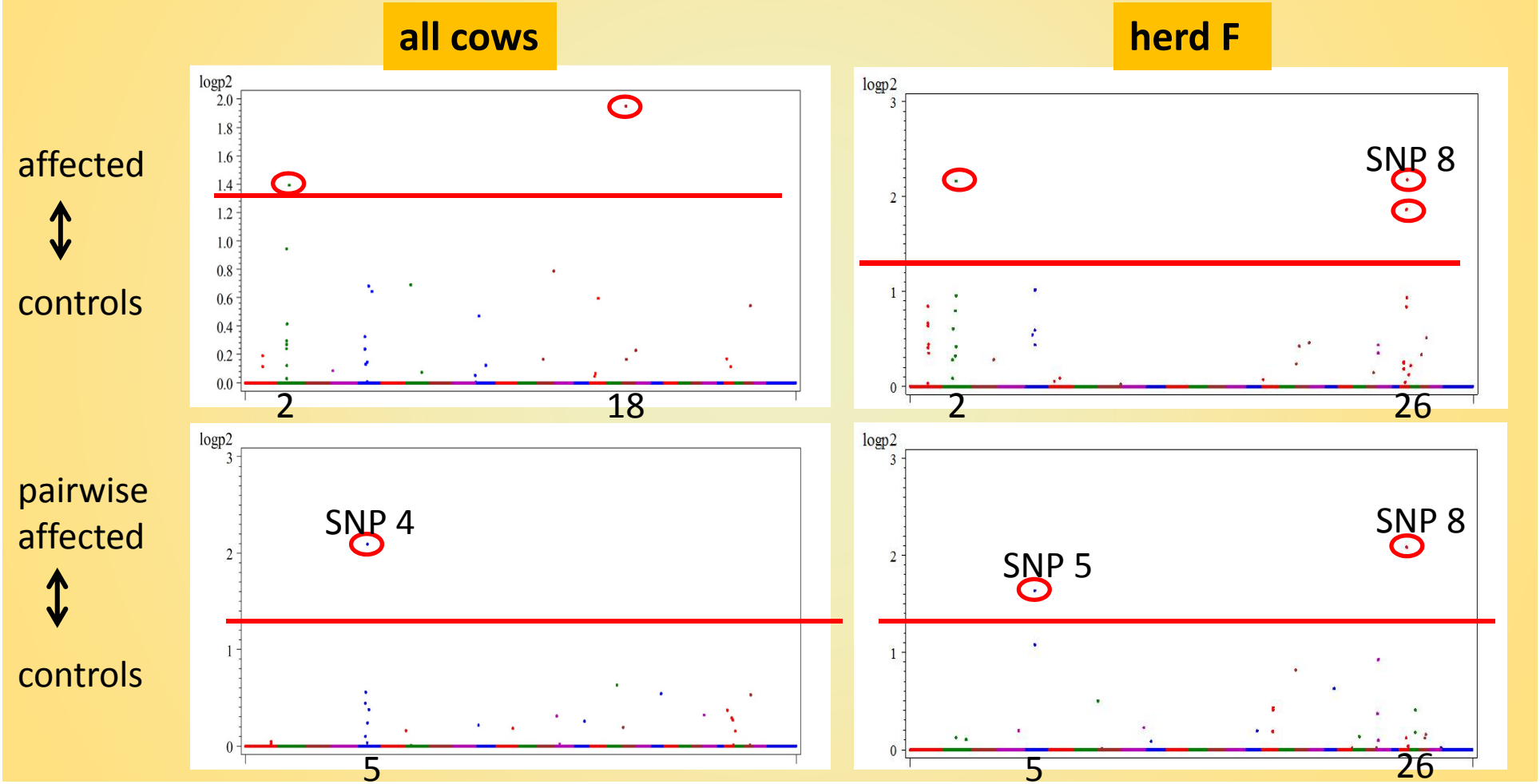
Genetic Background of Interdigital Hyperplasia

Statistical Analyses

- **GWAS in 6 cohort-case variants**
- **PLINK software (mixed threshold model)**

	Cohort 1 (all 192 cows)	Cohort 2 (F_1-F_5)
Case A affected against controls	87 / 105	49 / 67
Case B one-sided affected against controls	56 / 105	29 / 67
Case C pairwise affected against controls	31 / 105	20 / 67

Genetic Background of Interdigital Hyperplasia



Summary and Outlook

- **confirmation of the existence of IH susceptible bull lineages**
- **detection of IH associated SNPs**

→ detailed study of the promising regions

→ sequence candidate genes

→ identify causative genes

→ facilitate genetic selection for an improved resistance to IH

Institute of Agricultural and Nutritional Sciences
Martin-Luther-University Halle-Wittenberg, Germany
Animal Breeding

Thank you for your attention!

EAAP 2014
Copenhagen, Denmark
25 - 29 August 2014
65th annual meeting of the European Federation of Animal Science

Institute of Agricultural and Nutritional Sciences
Martin-Luther-University Halle-Wittenberg, Germany
Animal Breeding

Unravelling the genetic background of Interdigital Hyperplasia of the bovine hoof

Sammler S, Scheper C, Wensch-Dorendorf M, Schöpke K,
Brenig B, Swalve HH

EAAP 2014
Copenhagen, Denmark
25 - 29 August 2014
65th annual meeting of the European Federation of Animal Science

References

AABP. 2014. AABP fact sheet – interdigital hyperplasia (corn).

Borges JRJ, Garcia M, da Cunha PHJ. 2014. Cattle Lameness Bayer's Guide. http://www.mgar.com.br/podologia/aspTexto.asp?posicao=124&lang=2&texto=Hiperplas.

Chivers WH. 1957. An investigation of bovine interdigital overgrowth. Vet. Med. 52: 579-580.

Comberg G, Meyer H, Weferling KG. 1968. Untersuchungen zur Erblichkeit und Pathogenese des Zwischenklauenwulstes beim Rind. 1. Mitteilung. Vergleichende Untersuchungen über Häufigkeit von Zwischenklauenwulst und Stellungsanomalien der Gliedmaßenspitze in verschiedenen Rinderrassen. Z. Tierz. und Züchtungsbiol. 85: 1-13.

Hogreve F. 1964. Untersuchungen über Beziehungen zwischen Limaxbildung und Blutgruppenfaktoren beim schwarzbunten Niederungsrind. Tierärztl. Umschau 9: 453-457.

Huang YC, Shanks RD. 2002. Genetic aspect of foot abscess, heel warts and Interdigital Hyperplasia in dairy cattle_(1). J. Chin. Soc. Anim. Sci. 31(2): 141-155.

Koenig S, Sharifi AR, Wentrot H, Landmann D, Eise M, Simianer H. 2005. Genetic Parameters of Claw and Foot Disorders Estimated with Logistic Models. J. Dairy Sci. 88: 3316-3325.

Pijl R, Alkhoder H, Swalve HH. 2013a. Genetische Auswüchse. DLZ Primus Rind 05/13.

Pijl R, Alkhoder H, Swalve HH. 2013b. Environmental effects and a genetic predisposition influence Interdigital Hyperplasia. 9th International Conference on Lameness in Ruminants, Bristol.

van der Spek D, van Arendonk JAM, Vallée AAA, Bovenhuis H. 2013. Genetic parameters for claw disorders and the effect of preselecting cows for trimming. J. Dairy Sci. 96: 6070-6078.

Szalay G. 1962. Zum Vorkommen, zur Pathologie und zur Pathogenese des Zwischenklauenwulstes beim Rind. Vet. Diss., Gießen.

Went E. 1961. Über Limaxbildung beim Rind. Vet. Diss., Hannover.

Interdigital Hyperplasia

Prevalence

- < 10 % in recent studys (Huang & Shanks 2002, Koenig et al. 2005, Smits et al. 1992)
- > 20 % in older studys (Böttger 1962, Comberg et al. 1968)

depending on:

- age (Böttger 1962, Comberg et al. 1968)
- breed (Huang & Shanks 2002)
- farm specific environmental effects

Pijl et al. 2013a

%	number of farms	number of observations
0	3	942
1-10	56	38004
11-20	33	33371
21-29	7	7971
30	4	3231

n daughters	affected daughters	%	bilateral	one-sided	bull*	bull sire	mgs
5	2	40.0	0	2	A1	A	J
6	2	33.3	2	0	J1	J	T
6	2	33.3	0	2	B1	B	R
8	2	25.0	0	2	F1	F	N
8	2	25.0	0	2	G1	G	O
8	2	25.0	0	2	C1	C	P
25	4	16.0	1	3	J2	J	Q
21	3	14.3	1	2	E1	E	U
15	2	13.3	0	2	W1	W	V
33	4	12.1	1	3	J3	J	X
59	7	11.9	2	5	D1	D	Y
34	4	11.8	2	2	H1	H	AA
29	3	10.3	0	3	I1	I	S
20	2	10.0	0	2	K1	K	AB
54	5	9.3	4	1	J4	J	AC
33	3	9.1	0	3	M1	M	AD
32	2	6.3	0	2	J5	J	X
124	4	3.2	2	2	L1	L	Z

* ≥ 5 daughters, ≥ 2 affected daughters

Genetic Background of Interdigital Hyperplasia

bull sire	n sons*	n granddaughters	affected granddaughters	%	bilateral	one-sided
J	6	180	17	9.44	8	9
L	2	179	6	3.35	3	3
AE	3	145	0	0.00	0	0
D	1	62	7	11.29	2	5

J: high heredity of IH

L: middle heredity of IH

AE: low heredity of IH

* ≥ 5 daughters