



Impact of the Friesian *POLLED* Mutation on Milk Production Traits in Holstein Friesian

EAAP 2016

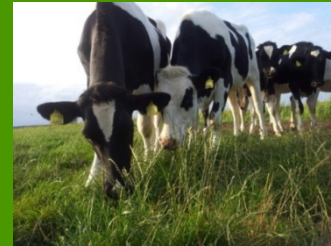
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Background



- Horns are a typical feature of the *Bovidae*

- 3 known phenotypes: horned (A), scurred (B) and polled cattle (C)



- The gene for polledness is present in most of the European cattle breeds albeit in a low frequency
→ on many dairy farms calves are routinely dehorned

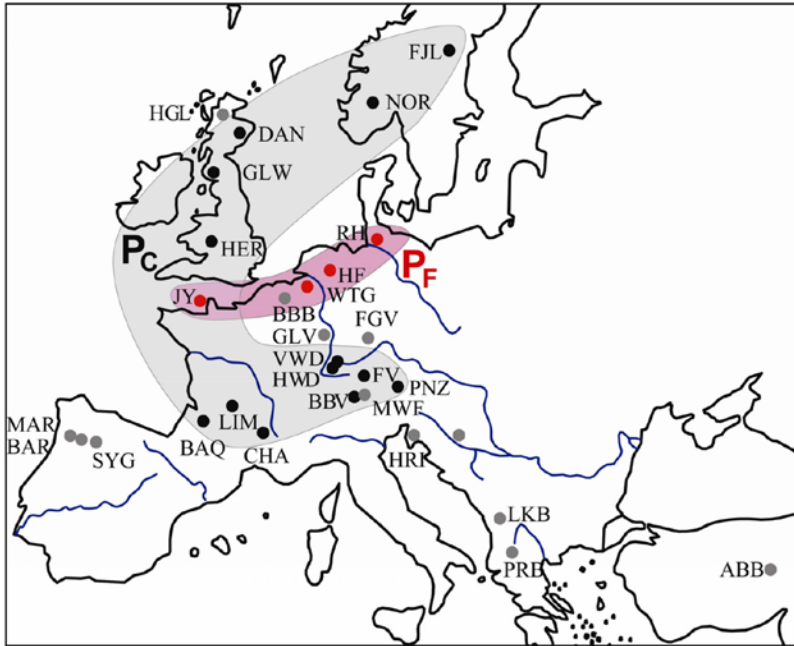
- Dehorning is raising animal welfare issues



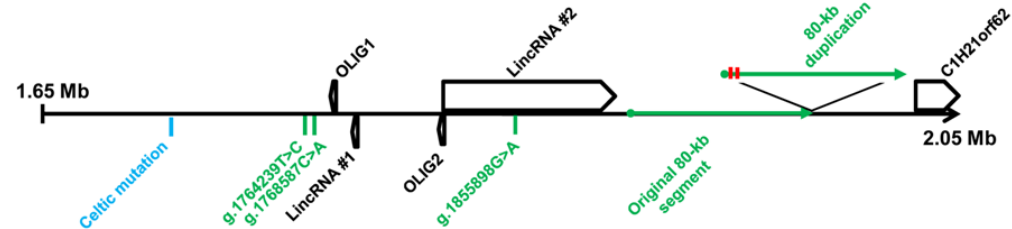
- Interest in breeding genetically hornless cattle increased in the last decades

Background

The *POLLED* Locus



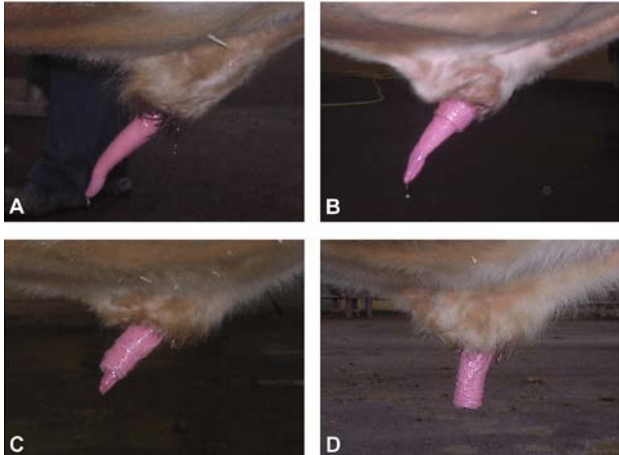
1. Friesian mutation P_F : 80kb duplication
→ esp. Holstein Friesian and Jersey
 2. Celtic mutation P_C : 202 bp InDel
→ esp. beef and dual purpose breeds
- Both mutations are not located within known coding sequences, regulatory elements or splice sites (Medugorac et al. 2012)





Background

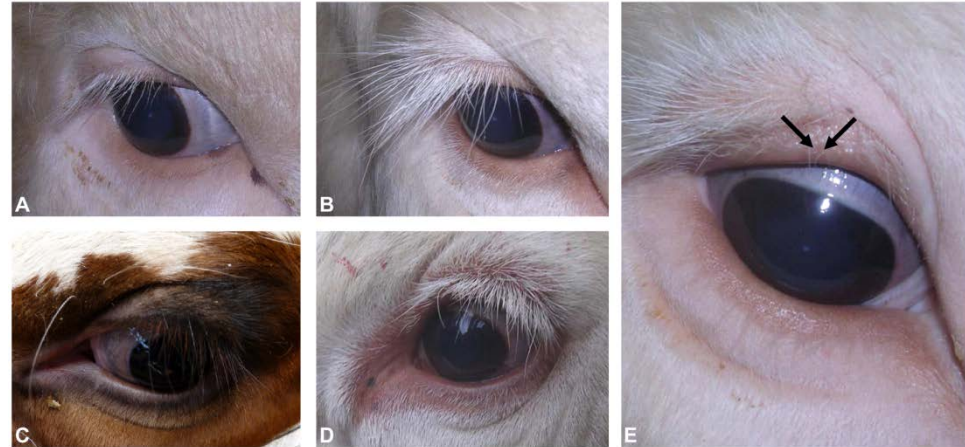
Associated Phenotypes



Allais-Bonnet et al. (2013) doi:10.1371/journal.pone.0063512

Defects of the genital tract
'preputial eversion', 'pending prepuce',
'abnormal preputial withdrawal'

➤ **Linked to P_C in Charolais bulls**



Allais-Bonnet et al. (2013) doi:10.1371/journal.pone.0063512

Atypical eyelashes
'bushy eyelashes', 'double rows of eyelashes', 'hair growing on
the inner part of the eyelid'

➤ **Perfect association to P_C and P_F**

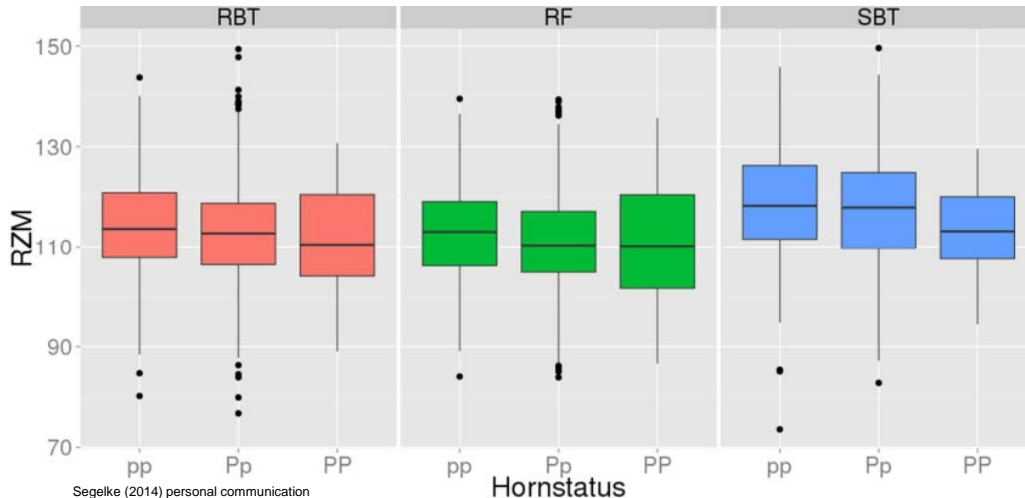


Background

Comparison of EBVs of polled and horned bulls (Lamminger et al. (2000))

- Polled bulls were inferior in breeding values for milk, fat and protein.
- But they were superior in the paternal component for fertility, type and muscularity

Comparison of horned and polled sons of Pp Bulls



Genomic combined relative breeding value for milk (RZM)

Average RZM (no considerations of different breeds):

pp: 114,11

Pp: 112,76 *

PP: 111,51 *

* sign. differences to pp



Objective

Are the *POLLED* mutations causative for the stated differences in milk performance?

Hypothesis:

There is a pleiotropic effect of the *POLLED* mutations acting in different epidermal tissues, e.g. mammary gland.



Experimental Design

Basic idea:

Comparison of milk production traits of horned and polled daughters of heterozygous polled Holstein Friesian bulls.

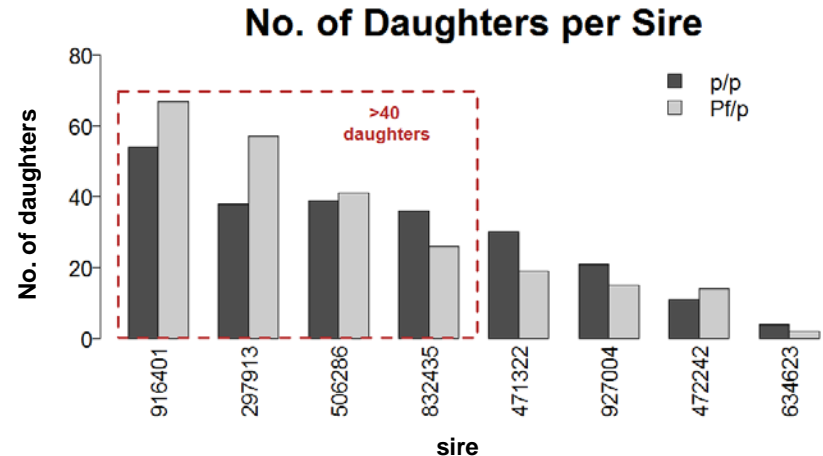
Data

- 478 daughters of 8 heterozygous polled sires
- Born between 2009-2012
- 323 Black Holstein Friesian
- 155 Red Holstein Friesian

Hypotheses:

There is a significant difference in milk production traits

1. Between polled and horned cows
2. Between polled and horned daughters of one sire





Methods

Statistical Analysis (R 3.2.2):

- Independent two sample t-test
- ANOVA for multiple factors:

$$y_{ijklmn} = \mu + GENO_i + BREED_j + SIRE_k + BIRTH_l + FARM_m + e_{ijklmn}$$

y_{ijklmn} : observation on the n^{th} animal of i^{th} genotype, j^{th} breed, k^{th} sire, l^{th} year of birth and the m^{th} farm

μ : mean

$GENO_i$: effect of the i^{th} genotype (i = horned and polled)

$BREED_j$: effect of the j^{th} breed (j = Black Holstein and Red Holstein)

$SIRE_k$: effect of the k^{th} sire (k = 1, ..., 8)

$BIRTH_l$: year of birth of the l^{th} animal (l =2009, ..., 2012)

$FARM_m$: effect of the m^{th} farm (m =1, ..., 132)

e_{ijklmn} : random error associated with the measurement on the n^{th} animal of the i^{th} genotype, j^{th} breed, k^{th} sire, l^{th} year of birth and the m^{th} farm



Results I

ANOVA for multiple factors across sires

Trait	Lactation No.	n	Estimator of the group polled	Std. error	p-value
YD milk, kg	1	472	-89.29	45.15	0.049
YD protein, kg	1	472	-2.51	1.28	0.051
YD fat, kg	1	472	-3.79	1.74	0.029
RZD*		467	0.67	0.29	0.025

* RZD: relative breeding value for milking speed

Significant differences between polled and horned cows for the traits, milk yield, protein yield fat yield of the first lactation and for the relative breeding value for milking speed.



Results II

Comparison of polled and horned daughters within sires

Independent two sample t-test for the trait yield deviations of milk yield of the first lactation

sire	t	DF	p value	Ø p/p	Ø Pf/p
297913	93	-0.142	0.887	758.098	769.640
471322	47	1.185	0.242	1115.064	959.200
506286	78	1.461	0.148	1291.759	1170.663
832435	60	0.482	0.632	642.392	592.926
916401	119	0.712	0.478	794.299	737.315

- Only sires with > 40 daughters were regarded
- The same tendency of the horned group having a higher average milk production can be observed
- This tendency is substantial in three out of five sires



Discussion and Perspective

Theories

1. The *POLLED* mutation is causative for the lower milk production. It leads to a modification of epidermal tissues, e.g. in the horn area and in the mammary gland
2. The mutation is linked to an unknown QTL for milk production

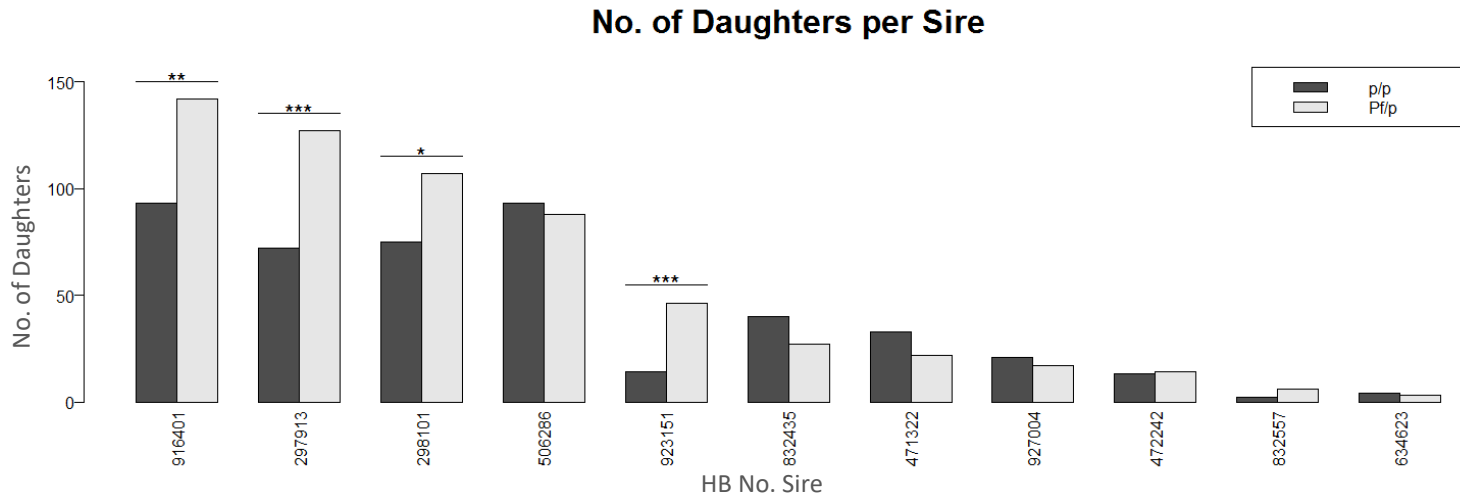


Perspective

- Extension of the sample (more daughters per sire, more sires)
- Incorporate additional traits



Inclusion of SNP-Genotyped Daughters



Comparison of the RZM of the original data set and the data set including all SNP-genotyped daughters

trait	lactation no.	<u>Old Data Set</u>			<u>New Data Set</u>		
		n	mean	sd	n	mean	sd
RZM	--	478	100.40	10.43	1059	105.09	10.7



Acknowledgements

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H. WILHELM SCHAUMANN STIFTUNG



Thank you for your attention!



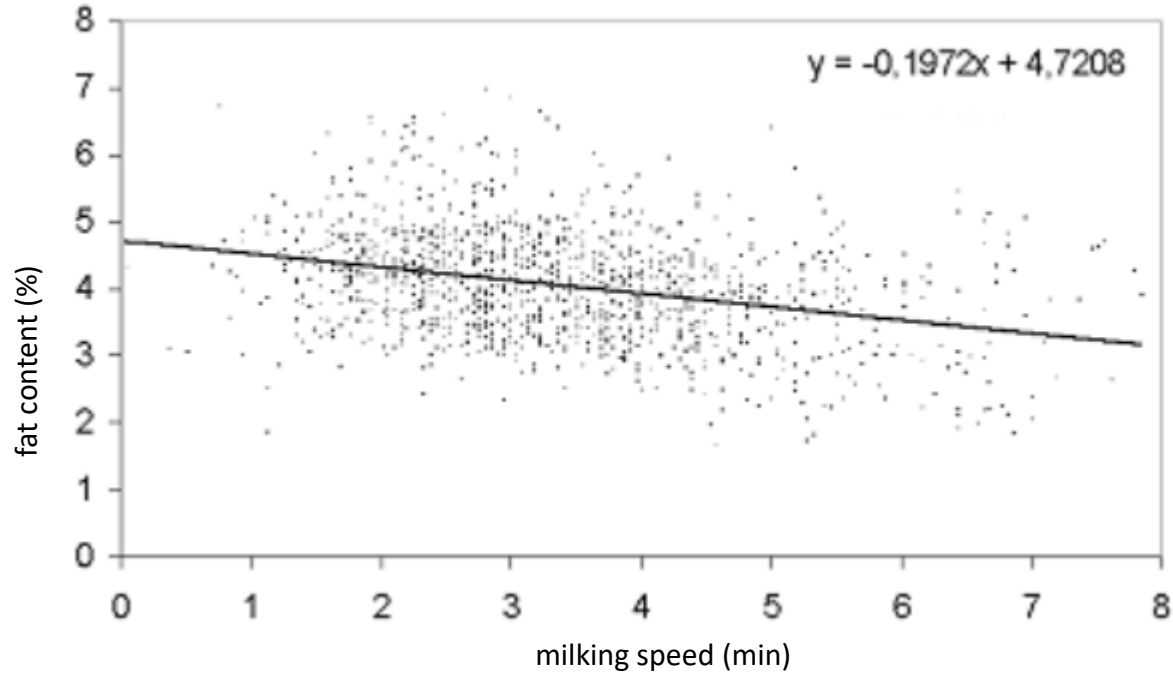


Summary statistics

Trait	Lactation No.	n	mean	sd	min	max
YD milk, kg	1	474	847	458	-579.47	2379.12
YD protein, kg	1	474	25.6	13.5	-10.81	66.55
YD fat, kg	1	474	19.0	18.5	-38.44	75.30
RZD	--	469	99.2	2.9	87	111



Milking Speed vs Fat Content





Means of the horned and polled group

Complete data set

trait	lactation	n	mean in p/p	mean in Pf/p
YD milk, kg	1	472	878	816
YD protein, kg	1	472	26.6	24.6
YD fat, kg	1	472	20.3	17.8

Animals with missing data for the second lactation

trait	lactation	n	mean in p/p	mean in Pf/p
YD milk, kg	1	30	1043	777
YD protein, kg	1	30	32.9	24.7
YD fat, kg	1	30	24.9	20.6