Mastitis in sows – current knowledge and opinions

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FUGATO

62nd Annual Meeting of the European Federation of Animal Science
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„The importance of animal production for foód supply, food quality and environment“

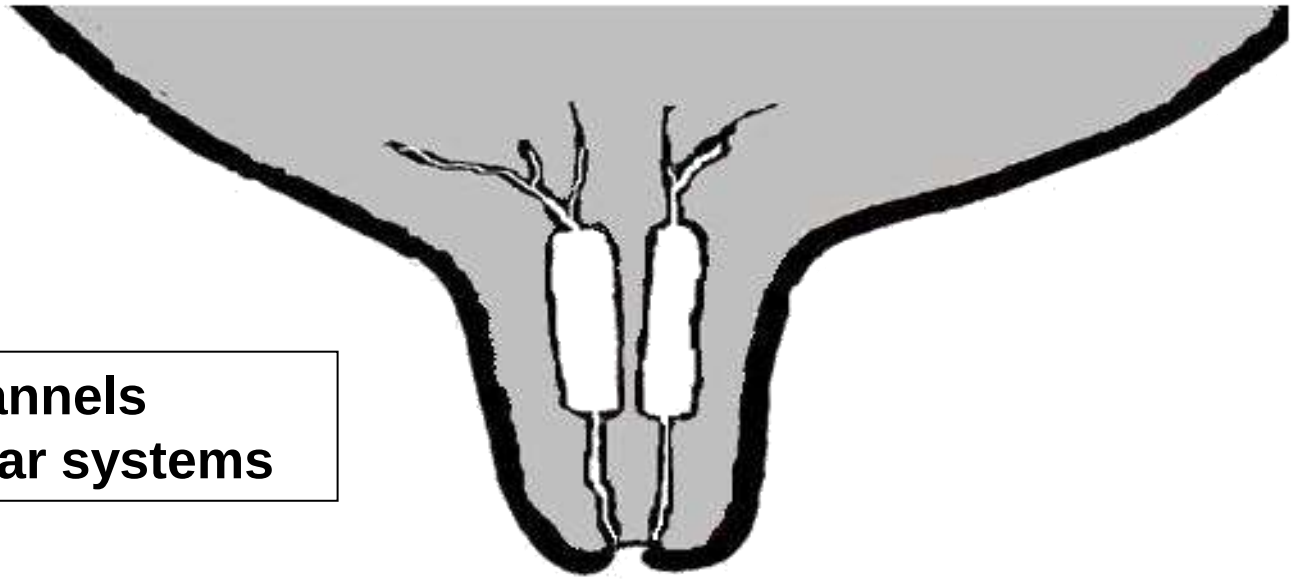
OUTLINE

- ⇨ introduction
  - ⇨ synonyms *et cetera*
  - ⇨ clinical and economic importance
- ⇨ „geMMA“-project
  - ⇨ material und methods
  - ⇨ results and discussion
- ⇨ summary

INTRODUCTION

⇨ **physiological conditions in lactation**

tubulo-alveolar gland with secretory lobules



2 teat channels
2 glandular systems

24-26 milk ejections/ day
10-20 seconds of milk ejektion
< 10 minutes /day milk available

INTRODUCTION

⇨ **milk yield**

⇨ today: larger litter sizes

⇨ increase in milk yield per day

1970/1980ies ~ 5-7 kg (Elsley 1971, Noblet&Etienne 1986)

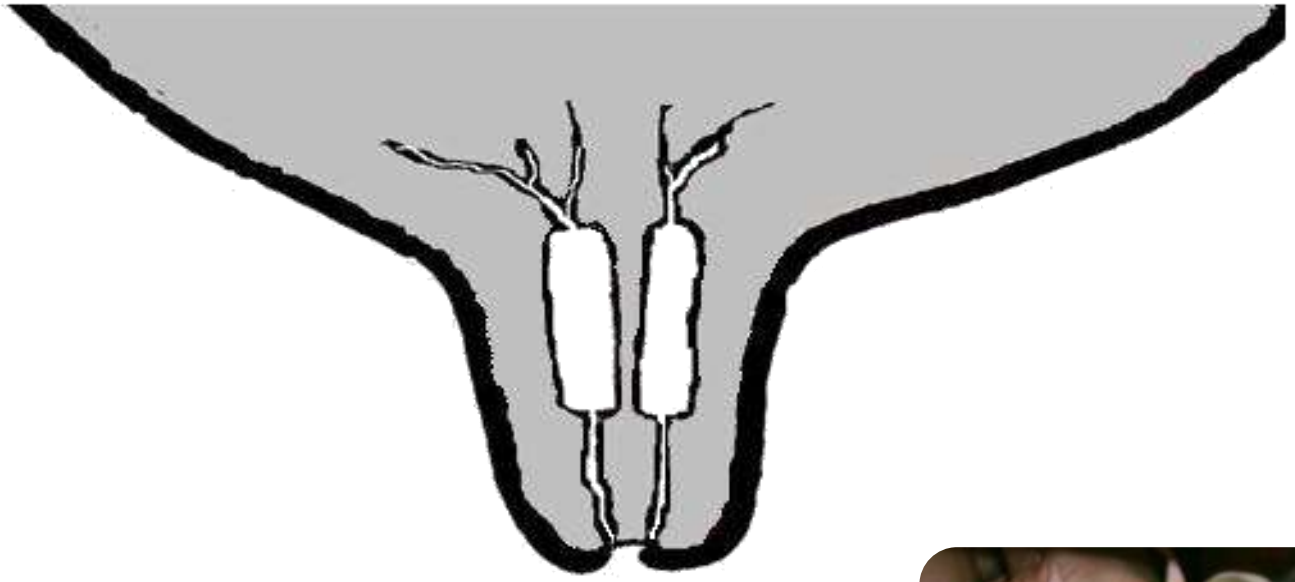
1990ies ~ 10 kg (Sauber *et al.* 1996, King&Eason 1998)

relatively higher increase in piglets ~9 ⇨ ~12-14

⇨ milk amount per piglet decreases

healthy sows with sufficient milk production

INTRODUCTION



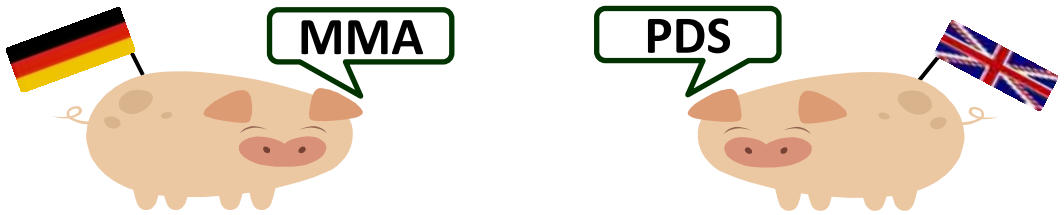
⇨ **mastitis in sows**

⇨ major problem in postparturient sows
⇨ 12-48 h post partum
⇨ since 1960 described worldwide

SYNONYMS

⇨ synonyms under discussion for mastitis in sows:

Agalactia toxemica, A. complex, A. post partum	(Ringarp 1960, Penny 1970, Hermansson *et al.* 1978)
Coliform Mastitis (CM)	(Bertschinger & Pohlenz 1980)
Farrowing Fever	(Halgaard *et al.* 1983)
Lactation Failure (LF)	(Elmore & Martin 1986)
Mastitis-Metritis-Agalactia (MMA)	(Tharp & Amstutz 1958, Smith 1965)
Periparturient Hypogalactia Syndrome (PHS)	(Smith 1992)
Postpartum Dysgalactia Syndrome (PDS)	(Klopfenstein 1999)
Puerperal Septicaemia and Toxaemia	(Bostedt *et al.* 1998, Heinritzi & Hagn 1999)



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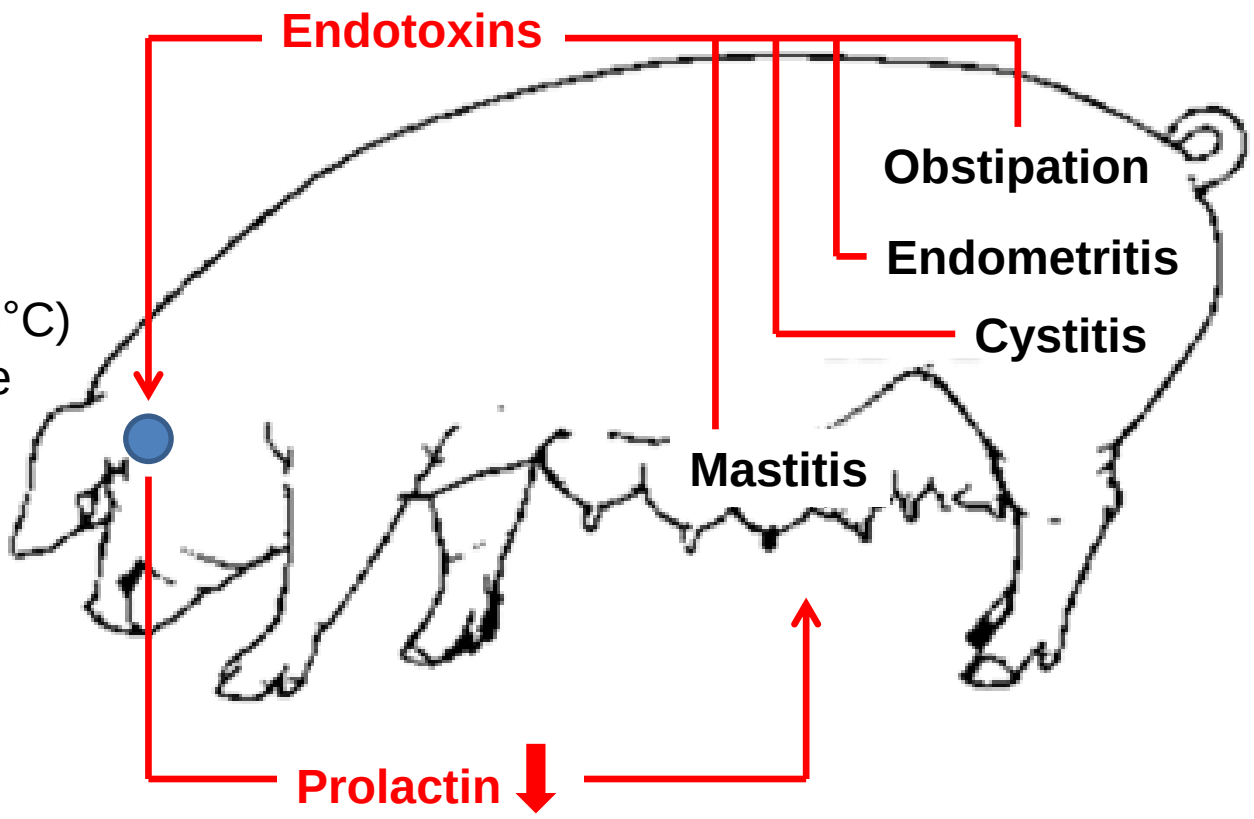
Lactation failure (Dysgalactia, Hypogalactia, Agalactia) >> Mastitis >> Metritis

PATHOPHYSIOLOGY

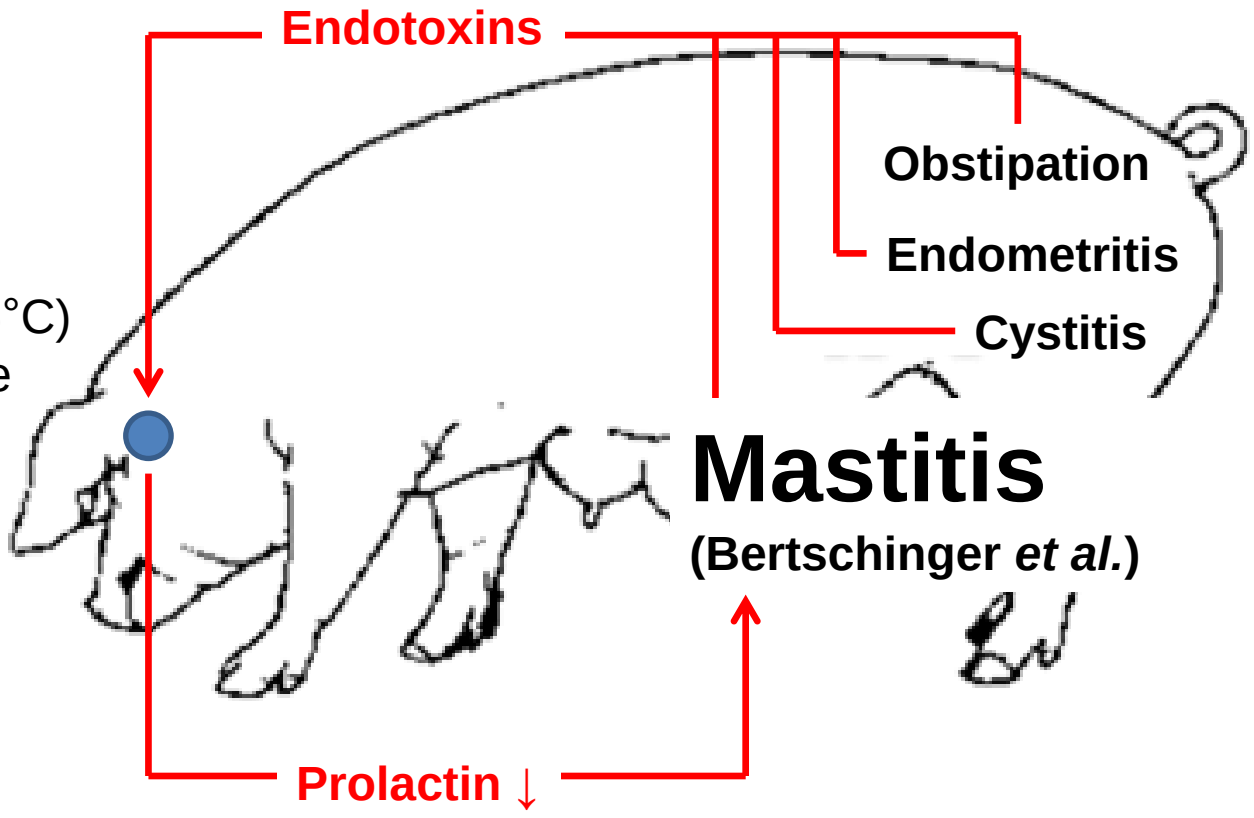
- ⇨ fever (T > 39.5°C)
- ⇨ loss of appetite



- ⇨ **milk yield⬇**
- ⇨ **dysgalactia**

PATHOPHYSIOLOGY

→ fever (T > 39.5°C)
→ loss of appetite



„coliform mastitis“

DIAGNOSIS

⇨ **clinical changes**

sow

- reduced milk production (dysgalactia, hypogalactia, agalactia)
- modified milk composition
- disturbed general condition
- fever
- ventral position

piglets

- intake of colostrum ⬇
- lower weight gain
- starving, restlessness, lethargy
- intake of other fluids
- secondary infections

DIAGNOSIS

⇨ **differences between clinical and subclinical mastitis**

simple classification concerning clinical signs and bacteriological results:

mastitis		**clinical signs**	
		yes	**no**
bacteriological results 	**+**	**clinical mastitis**	**subclinical mastitis or latent infection**
	-	**unspecific mastitis**	**healthy**

DIAGNOSIS

⇨ **When is a sow positive for mastitis?**

Diagnostic pattern for sows mammary glands (Wendt, Bostedt *et al.* 1994)

diagnosis	clinical signs	pH-value	cells (Mio/ml)	bacteriological analysis
healthy lactating	no	< 6,8	< 2,5	negative
healthy atrophic	no	> 7,0	> 6,5	negative
bacterial colonisation	no	< 6,8	< 2,5	positive
latent infection	no	> 7,0	> 6,5	positive
subclinical mastitis	no	> 7,0	> 10,0	neg/pos
clinical mastitis	**yes**	**> 7,0**	**> 10,0**	**pos/neg**

Wegmann, 1985: >5 Mio cells/ml and **>70% neutrophils**

DIAGNOSIS

⇨ **alternative subclinical changes**

somatic cell count	>5x10^6 cells/ml (Bertschinger& Bühlmann 1990)
	>10x10^6 cells/ml (Persson et al. 1996)
pH-value milk	>6,7 (Waldmann & Wendt 2001)
m[illegible]c	**in praxi difficult to establish!**
acute phase proteins	Haptoglobin, α1-acid-glycoprotein
cytokines	IL-1ß, IL-6, IL-8, TNFα

(Gooneratne *et al.* 1982; Zhu *et al*. 2007; Mirko & Bilkei 2004)

DIAGNOSIS

⇨ **milking a sow**

⇨ only directly post partum without Oxytocin injection

⇨ 2 - 3 days p.p. 20 I.U. i.m.

⇨ later on 40-60 I.U. i.m.

⇨ milk ejection 5 - 10 minutes after injection for 10 minutes

⇨ 3 - 4 ml

in praxi difficult to establish!

DIAGNOSIS

⇨ immediate diagnosis on herd level

⇨ daily temperature-control in the first three days postpartum

+ clinical alterations on teats and glands (reddening, swelling, hardening etc.)

+ noticeable behavioural changes in sows and/or piglets

DIAGNOSIS

⇨ **economical importance**

sow	**piglets**
decreased performance	increased death rate
conception failure	runt piglets
reduced litter size	crushed piglets
abortions	intake of colostrum ⇩
reduced milk yield and milk quality ⇩	lower weight gain

PREVALENCE

⇨ **prevalence in literature (1960-2010)**

3.7%	Sweden	(Ringarp 1960)
5.5-10.3%	Sweden	(Bäckström 1973)
13.1% (-19.8%)	Missouri, USA	(Threlfall & Martin 1973)
6.9% (1.1-37.2%)	Illinois, USA	(Bäckström *et al.* 1984)
16.5-18.5%	Norway	(Lingaas & Ronningen 1991)
25%	Denmark	(Berg *et al.* 2001)
38.4%	Germany	(Krieter & Presuhn 2009)
6.5% (1-15%)	Belgium	(Papadopoulos *et al.* 2010)

⇨ ‚problem herds' with prevalences up to 80-100%

(Glock 1983, Martin *et al.* 1974, Waldmann & Wendt 2004)

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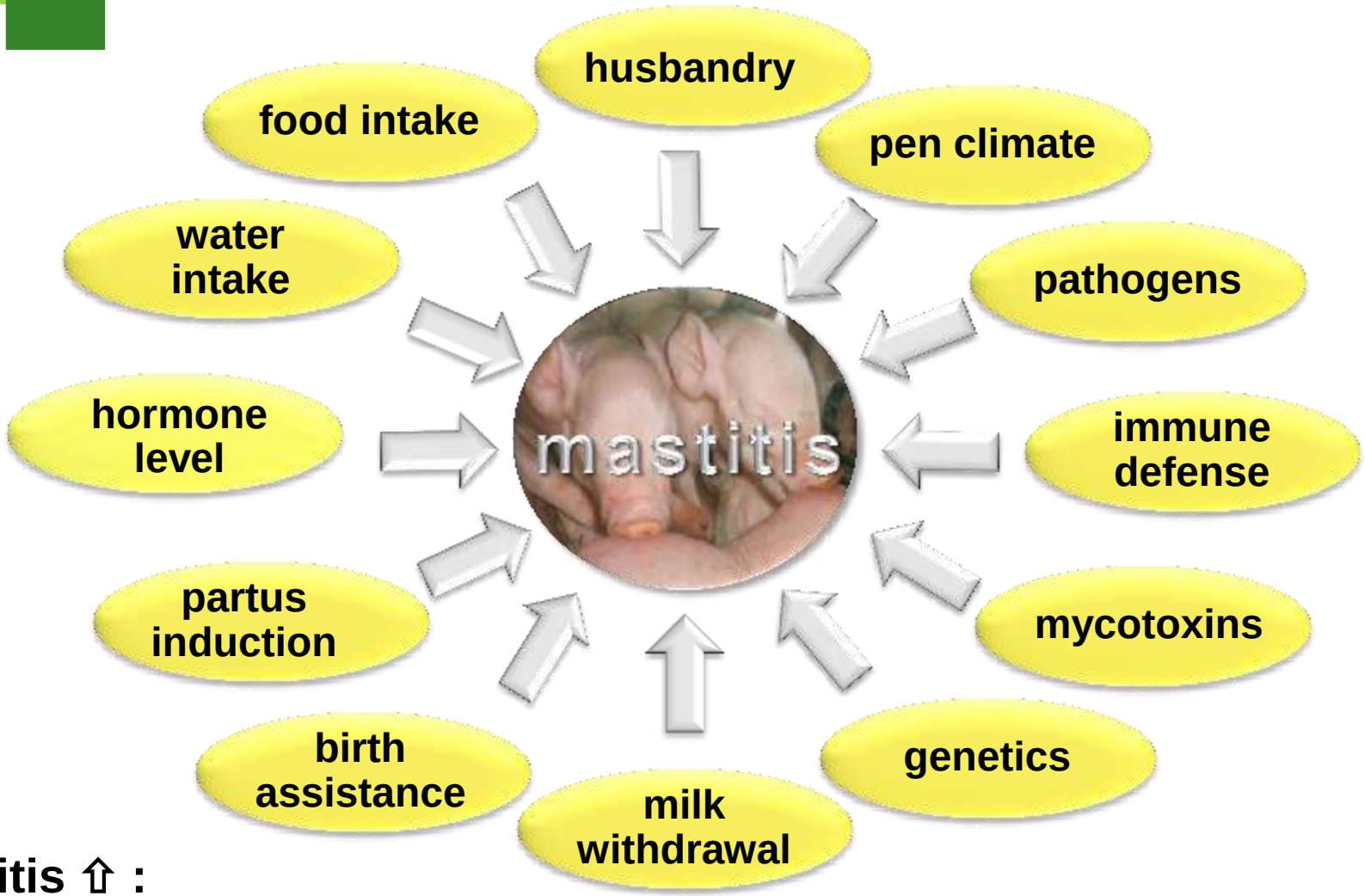
prevalence⬇ due to improvement of husbandry, feeding … and prophylactic treatment

INFLUENCING FACTORS



mastitis ⇧ :

immune defense ⇩	**infection pressure ⇧**	**birth duration ⇧**

INFLUENCING FACTORS

pathogens

⇨ *Escherichia coli*

⇨ *Strep. dysgalactiae*

⇨ *Staph. aureus*

environmental factors

⇨ husbandry

⇨ hygiene

⇨ feeding

sow factors

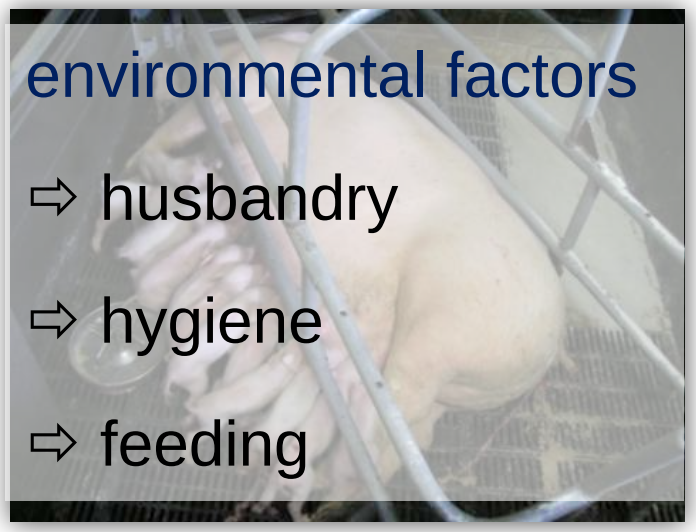
⇨ parity number

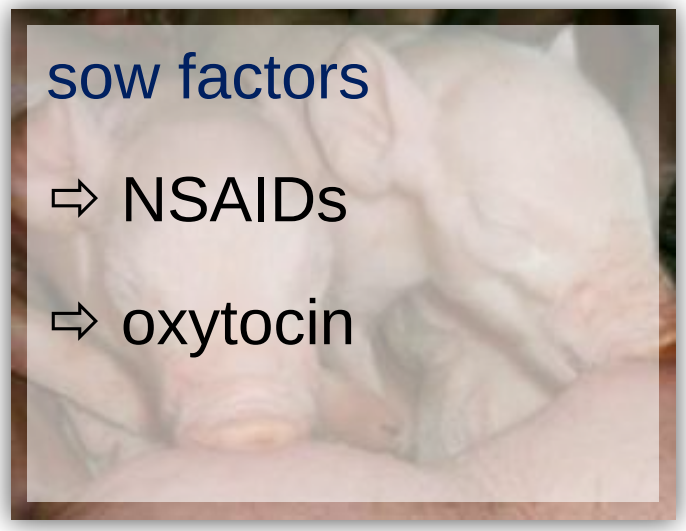
⇨ partus condition

⇨ genetic variation

TREATMENT


pathogens
⇨ prebiotics
⇨ antibiotics


environmental factors
⇨ husbandry
⇨ hygiene
⇨ feeding


sow factors
⇨ NSAIDs
⇨ oxytocin

TREATMENT

Future aspects

⇨ medicamental treatment is not a long-term solution

Methods of choice

⇨ 1st approach: improve farm management (hygiene, feeding, husbandry)

⇨ 2nd approach: breeding and genetic improvement

⇨ 3rd approach: medicamental treatment

geMMA

FUGATO

⇨ FUGATOplus: „geMMA – structural and functional analysis of the genetic variation of the MMA-syndrome“

Nicole Kemper, Jens Wolfmüller
Imke Gerjets, Regine Preißler

CAU Kiel

Danilo Bardehle, Regine Preißler,
Nicole Kemper, Jörg Lehmann

MLU Halle-Wittenberg

geMMA

- structural and functional analysis of the genetic variation of the MMA-syndrome geMMA

phenotype
- bacteriological analysis
- *Escherichia coli*

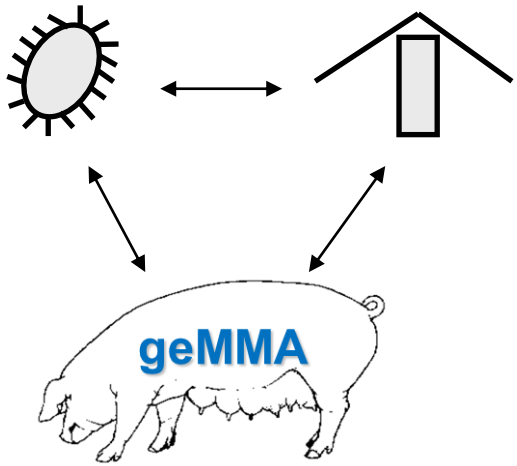
genotype
- genome-wide association
- candidate genes

⇩ **phenotypic variation**

⇩ **genetic variation**

geMMA

pathogens



environment

PIC

host

- parity number
- partus induction (y/n)
- birth assistance (y/n)
- genetic variation

Material and Methods

⇨ familybased Case-Control-Design

PIC

12-48 h post partum

fever: Temp > 39.5°C

+ clinical investigation
mammary glands
piglets

affected sow

unaffected half- or fullsibs

n = 1.028

n = 973

MATERIAL AND METHODS

- ✓ bacteriological analysis of milk samples (Gerjets *et al.*, 2011)

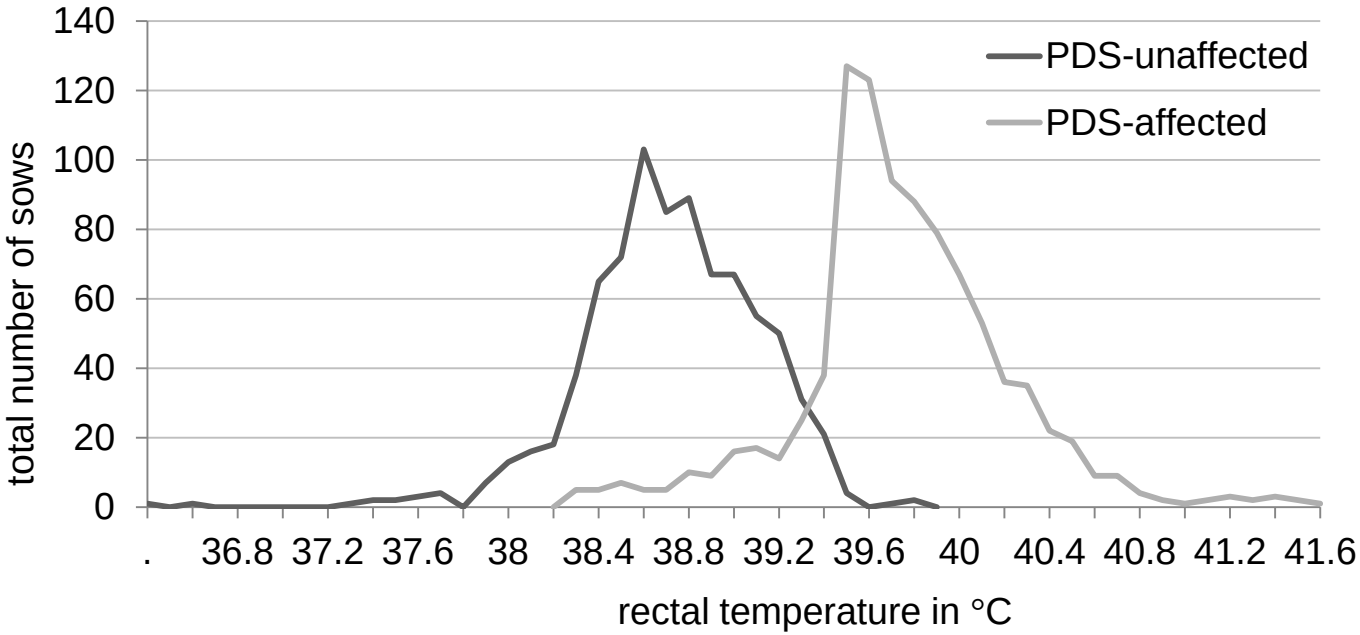


- ✓ genotyping using the PorcineSNP60 BeadChip from Illumina



- ✓ statistical analysis (R, GenABEL, Plink, Haploview, …)

RESULTS



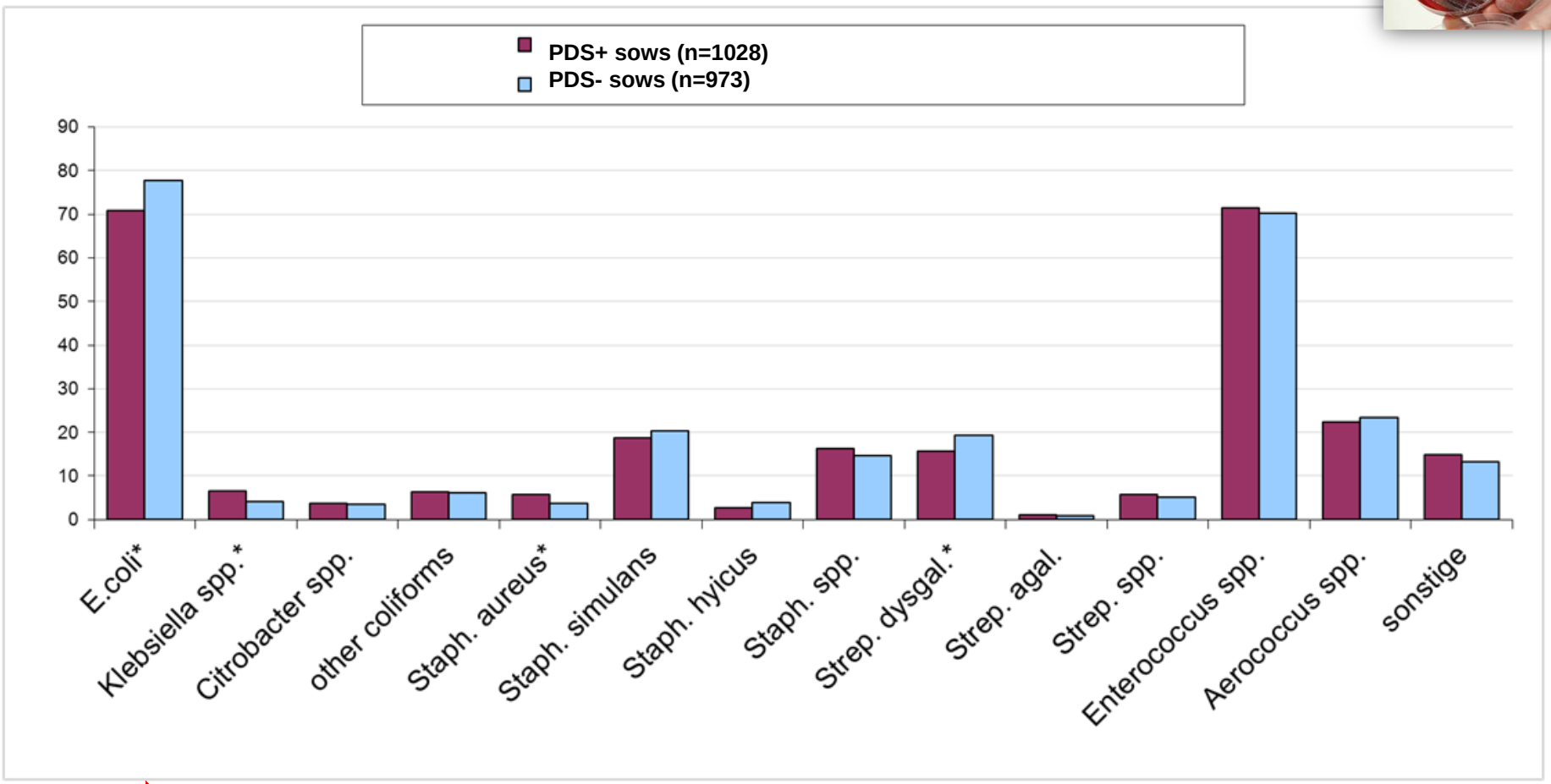
Absolute frequency of PDS-affected and PDS-unaffected sows in relation to rectal temperature

16.6% of affected sows had rectal temperatures (T) < 39.5°C

28.8% of affected sows had T > 40.0°C

RESULTS

Gerjets *et al*., 2011



no significant differences in bacteria spectrum

RESULTS

Gerjets *et al.*, 2011

	PDS=1 (n=1024)	PDS=0 (n=970)	
no „pathogen“*	188	147	**335 (16.8%)**
all „pathogenes“*	6	5	**11 (0.5%)**
only STREP[1]	25	16	**41 (2.1%)**
STREP + SA[2]	6	1	**7 (0.3%)**
only COLIFORM[3]	619	597	**1.216 (61.0%)**
only SA	25	16	**41 (2.1%)**
STREP + COLIFORM	134	174	**308 (15.4%)**
COLIFORM + SA	21	14	**35 (1.8%)**
	1024	**970**	**1994 (100%)**

* „pathogen“ .. STREP+COLIFORM+SA

[1] STREP: *Streptococcus dysgalactiae* and/or *Streptococcus agalactiae*,

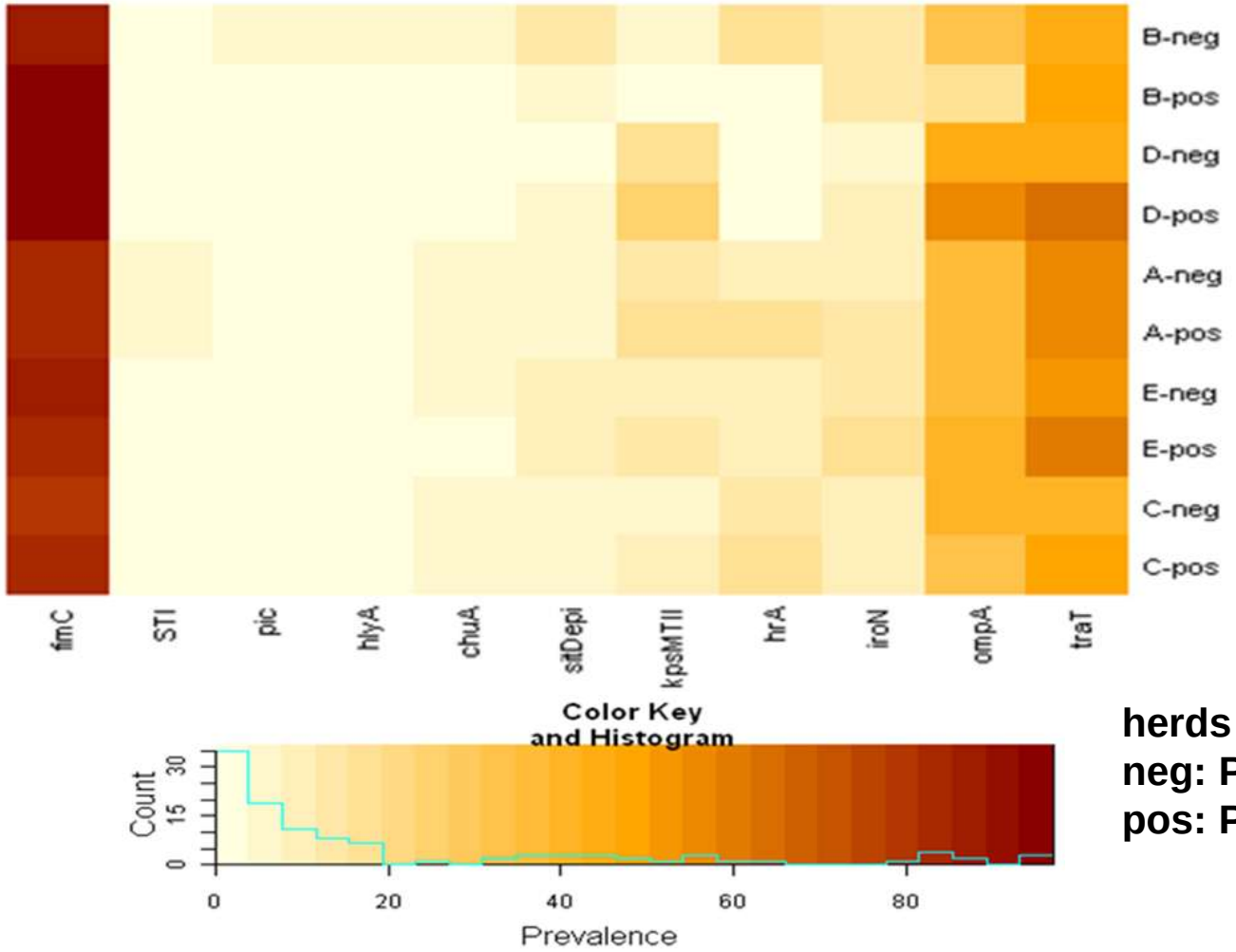
[2] SA: *Staphylococcus aureus*,

[3] COLIFORM: all Coliforms (especially *Escherichia coli)*

RESULTS

Gerjets *et al.*, 2011

prevalence of *Escherichia coli* virulence factors



herds A, B, C, D, E
neg: PDS- sows
pos: PDS+ sows

RESULTS

Gene(s)/categories		prevalence of virulence-associated genes (%)				*P*-value
		E. coli isolates (n = 1,271) of CM-negative sows	no. of farms with isolates with the respective gene	E. coli isolates (n = 1,132) of CM-positive sows	no. of farms with isolates with the respective gene	
Adhesins						
afa / dra	ExPEC	-	-	-	-	-
fimC	ExPEC	82.30	4	84.72	4	0.1112
*hra**	ExPEC	11.33	4	14.84	4	0.0106
iha	ExPEC	0.16	2	0.18	2	0.9077
sfa / foc	ExPEC	0.08	1	0.18	2	0.4971
K99 (fanA)	ETEC	-	-	-	-	-
K88 (faeG)	ETEC	0.08	1	0.09	1	0.9367
987P (fasA)	ETEC	0.08	1	-	-	0.3443
F18 (fedA)	ETEC	-	-	0.09	1	0.2892
F41 (fedA subunit)	ETEC	-	-	-	-	-
Iron acquisition						
*chuA**	ExPEC	4.80	4	6.71	4	0.0434
*iroN**	ExPEC	9.28	5	12.37	5	0.0148
sitD chr.	ExPEC	0.24	3	0.62	3	0.1461
sitD epi.	ExPEC	5.74	5	6.27	5	0.5858
Protectins						
neuC	ExPEC	0.39	2	0.18	2	0.3251
*kpsMT II**	ExPEC	9.99	4	13.07	4	0.0178
ompA	ExPEC	37.61	5	35.34	5	0.2480
traT						
Toxins						
E						
STII						
STI						
LT						
Shiga Toxins						
Stx2e	STEC	-	-	-	-	-
Invasins						
gimB	ExPEC	0.08	1	0.00	-	0.3452
ibeA	ExPEC	0.63	3	0.97	2	0.3443
Miscellaneous						
pic	ExPEC	0.63	4	1.33	3	0.0804
malX (RPai)	ExPEC	-	-	0.18	1	0.1338

Gerjets *et al.*, 2011

Prevalence of virulence-associated genes in *E. coli*-isolates of healthy and diseased sows

no specific ‚CM-strain', if conditions are unfavorable, any strain could cause CM

(Gerjets, Traulsen, Reiners & Kemper 2011, Veterinary Microbiology)

RESULTS

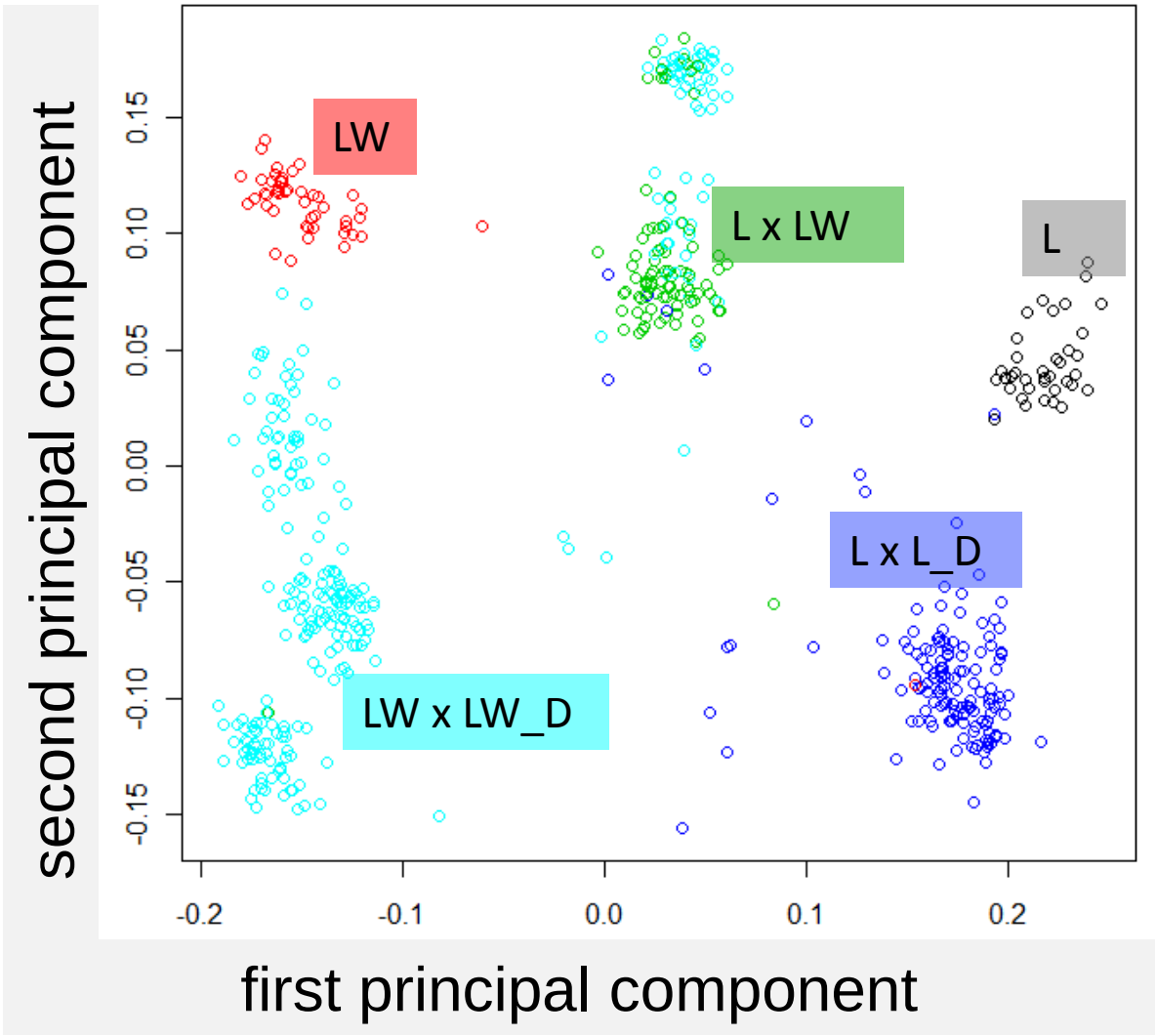
„The characteristic microbe of a disease might be a symptom instead of a cause.“ (G.B. Shaw in „The Doctor‘s Dilemma“, cited by Ringarp 1960)

⇨ genetic predisposition (Ringarp 1960, Hildenbrand 1983, Awad-Masalmeh *et al.* 1990)

⇨ heritability estimates:

- $h^2 = 0.1\text{-}0.2$ (Lingaas *et al.* 1991)
- $h^2 = 0.02\text{-}0.06$ (Berg *et al.* 2001)
- $h^2 = 0.13$ (Krieter & Presuhn 2009)
- $h^2 = 0.09$ (geMMA)

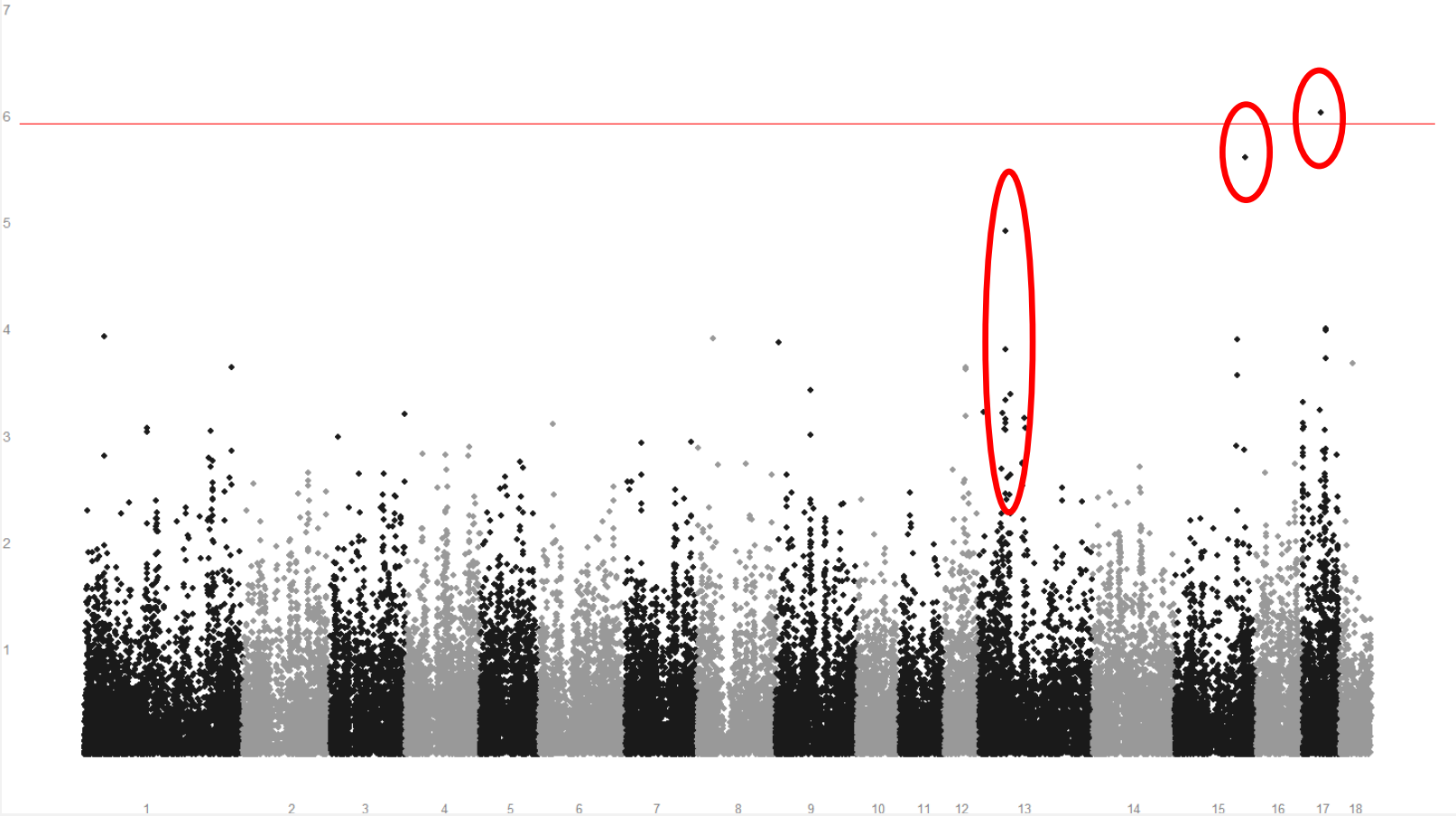
RESULTS



Landrace (L)
Large White (LW)
L_Duroc (L_D)
LW_Duroc (LW_D)

RESULTS

⇨ 17 principal components + birth assistance



RESULTS

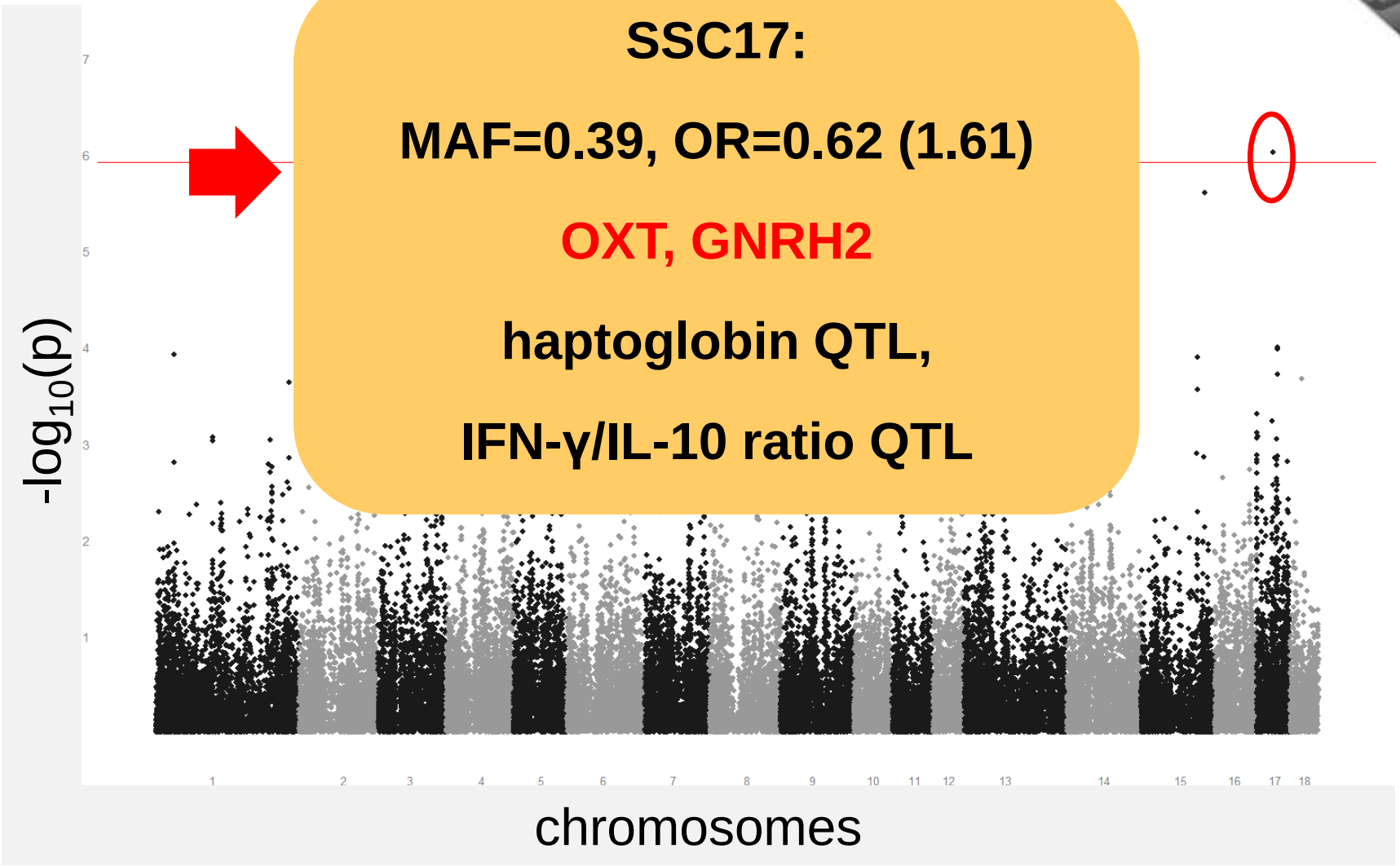
SSC17:

MAF=0.39, OR=0.62 (1.61)

OXT, GNRH2

haptoglobin QTL,

IFN-γ/IL-10 ratio QTL



RESULTS

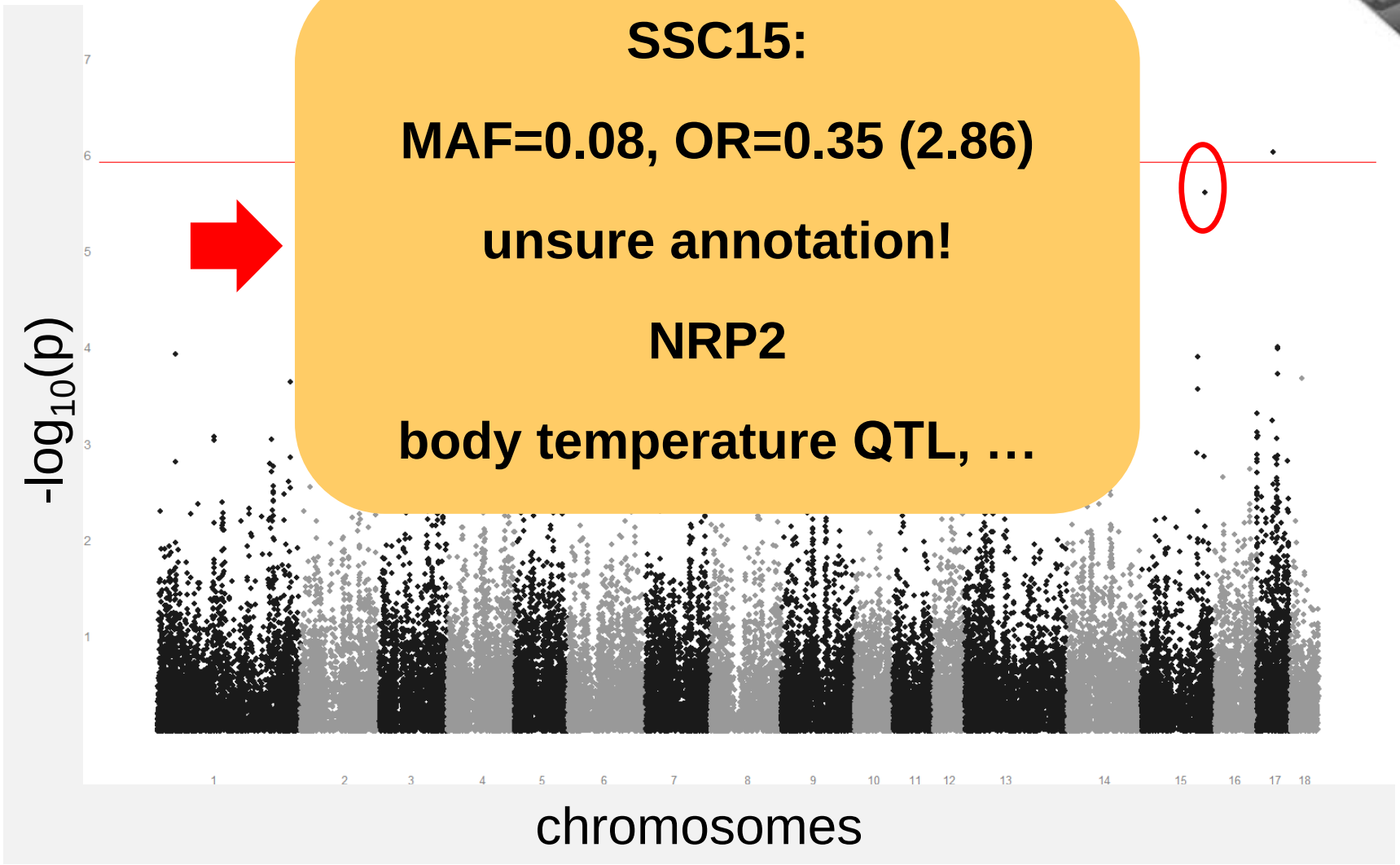
SSC15:

MAF=0.08, OR=0.35 (2.86)

unsure annotation!

NRP2

body temperature QTL, …



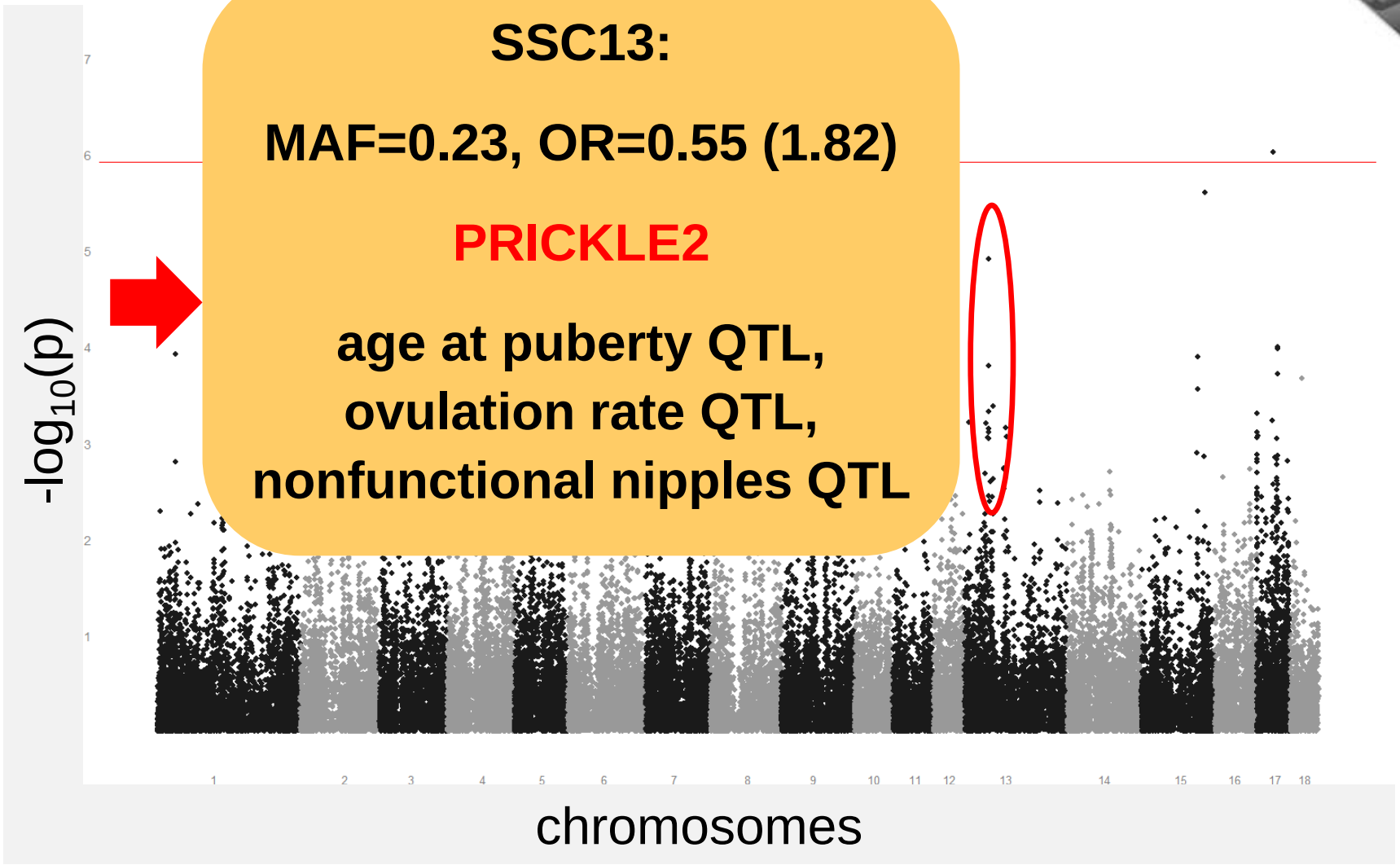
RESULTS

SSC13:

MAF=0.23, OR=0.55 (1.82)

PRICKLE2

age at puberty QTL,
ovulation rate QTL,
nonfunctional nipples QTL



DISCUSSION

- ⇨ association with several QTLs (body temperature QTL, age at puberty QTL, ovulation rate QTL, nonfunctional nipples QTL, haptoglobin QTL, IFN-γ/IL-10 ratio QTL)
- ⇨ multiple genes involved (e.g. SSC13, SSC15, SSC17)
- ⇨ different pathomechanisms:
  - ⇨ neurohormonal processes and networks
  - ⇨ immune system interactions (Haptoglobin, IFN-γ/IL-10 ratio)

replication and confirmation study in process

DISCUSSION

possible reasons for positive bacteriological results in clinical unaffected sows

- ⇨ only bacterial colonisation
- ⇨ emerging subclinical mastitis in sows
- ⇨ contamination via teat canal (two to three milk cisterns)
- ⇨ resistance due to genetic variation
- ⇨ resistance due to unknown factors

requires further clinical and experimental studies...

SUMMARY

sow

- dysgalactia
- mastitis
- fever (>39.5°C)

antibiotics and antiphlogistics

piglets

- intake colostrum ⇩

↓

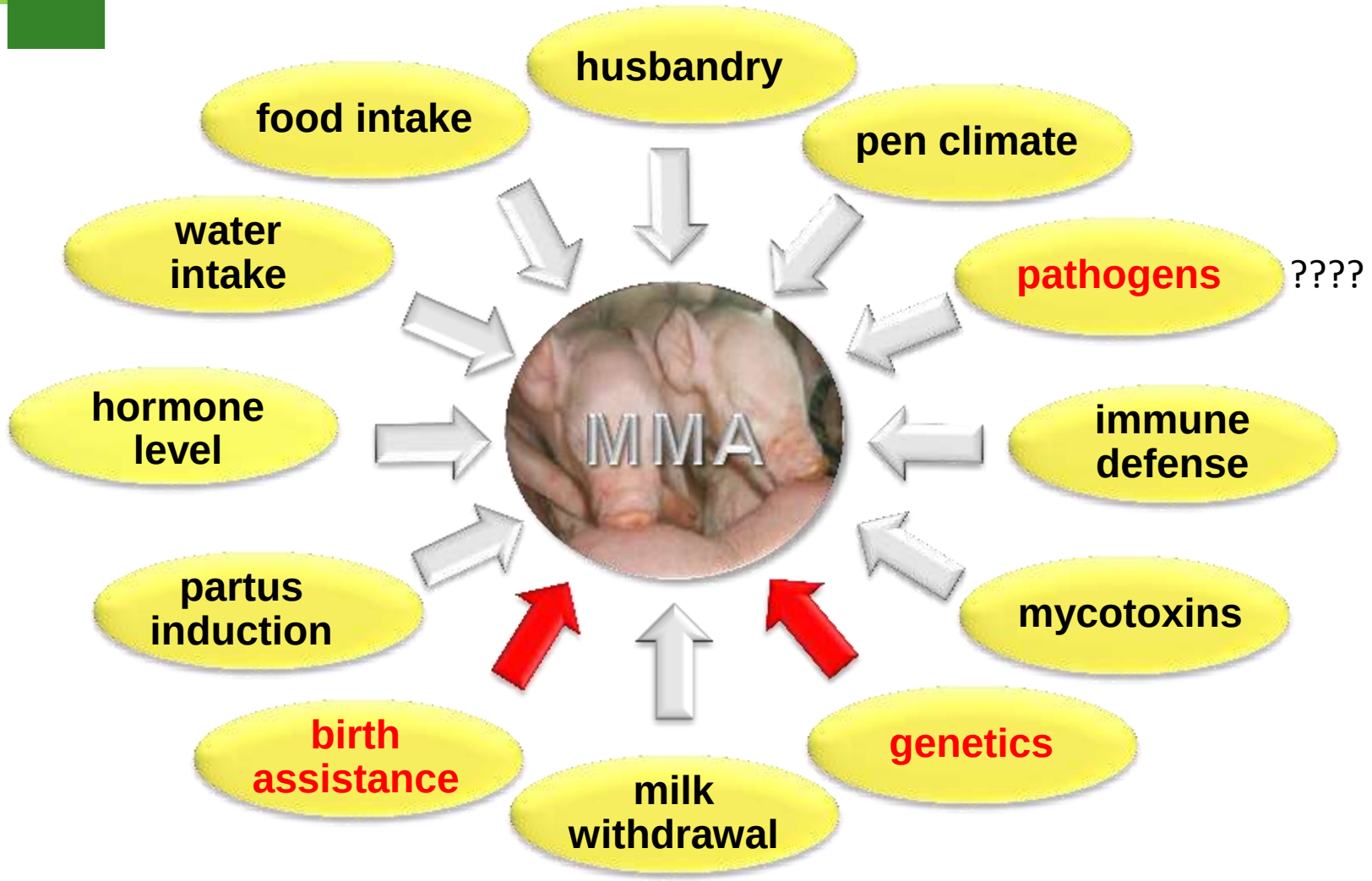
apathia, diarrhea, death

milk substitute

prevalence ⇩

subclinical cases ⇧

SUMMARY



multifactorial disease

SUMMARY

⇨ main results from geMMA up to now

- ⇨ no significant differences in pathogen spectrum
- ⇨ >60% only coliform mastitis, >18% mastitis without pathogen described in literature, >13% Strep-coliform mastitis, 2,5% *Staph. aureus* mastitis, 2,1% *Staph. aureus*- coliform
- ⇨ significant correlation between birth assistance and CM
- ⇨ genomewide moderate significant genetic variations
- ⇨ moderate genetic risks (OR) ranging from 0,3 to 2,2
- ⇨ heritability 9%

replication and confirmation study is under planning

SUMMARY

⇨ New insights - special recommendations

⇨ diagnosis: 12-48 h p.p. >39.5°C + clinical examination

⇨ careful recording and documentation on herd level

⇨ immediate, adequate and specific treatment

⇨ hygiene - hygiene - hygiene

⇨ special emphasis on healthy piglets (‚restaurant-hypothesis‘)

holistic approach with long-term measures → plan ahead (feeding, housing, breeding…)

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Thanks for your attention!

Special thanks to all colleagues and collaborating affiliations.

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