Genome wide association study for number of teats and inverted teats in Norsvin Landrace pigs

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Topigs Norsvin

PROGRESS IN PIGS

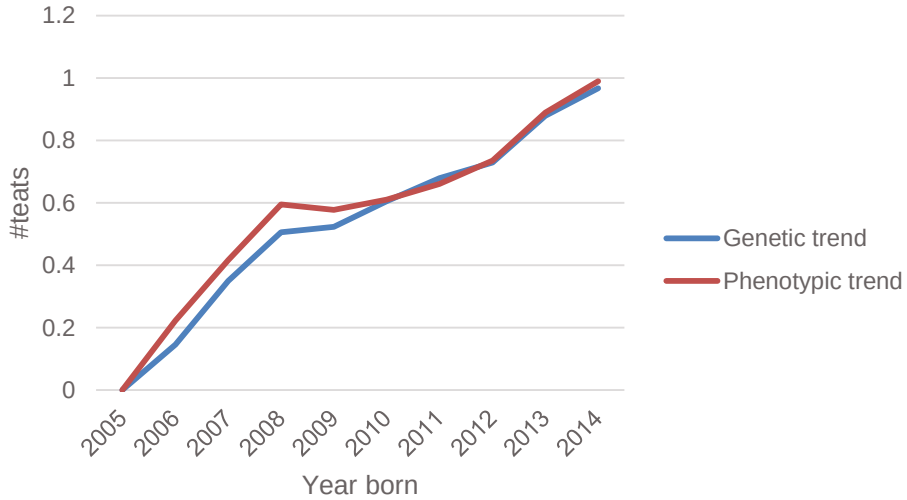
Background

- The number of functional teats in the sow is important in order to provide enough teats for larger litters.
- Every piglet born should be weaned by own mother
- Counted on all piglets at 3 weeks of age
- Included in the breeding goal from 2001

Photo: Kjersti Wold, Norsvin

Phenotype #teats

- Mean teat number in Norsvin Landrace is 15.4 (SD=1.04)
  - Minimum of 10, maximum of 25
  - Heritability is 0.42



Year	# obs.
2005	13226
2006	19283
2007	26442
2008	31268
2009	35171
2010	38104
2011	39696
2012	42227
2013	43702
2014	74322

Background

- Teat quality is also important and inverted teats are of less value for producers selling sows and some inverted teats can have reduced milk flow.
- Boars: registered at 120 kg, sows: registered at field test 5 months
- Included in the breeding goal from 2012

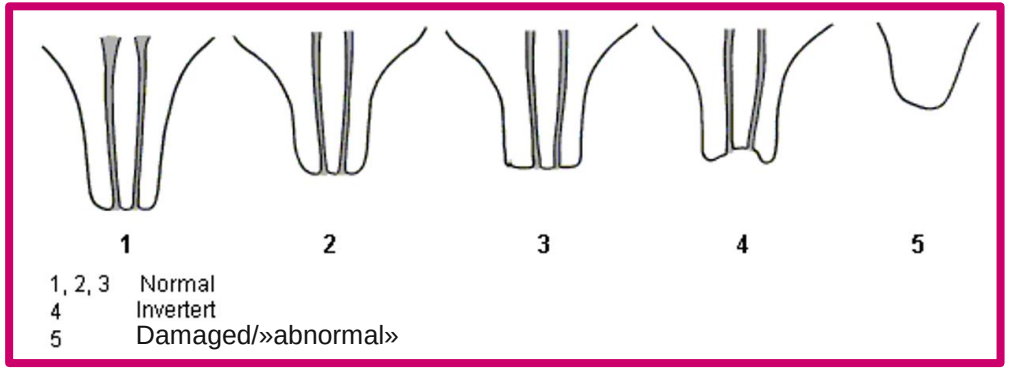
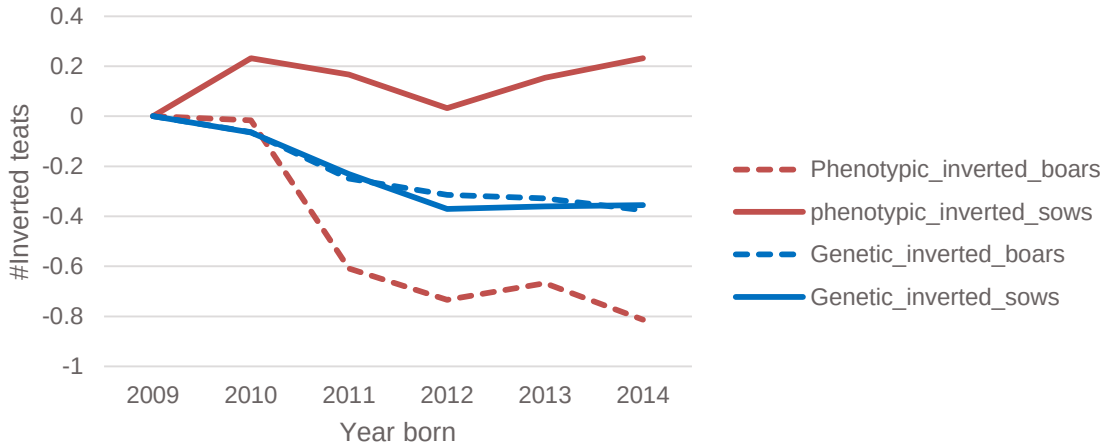


Photo: Kjersti Wold, Norsvin

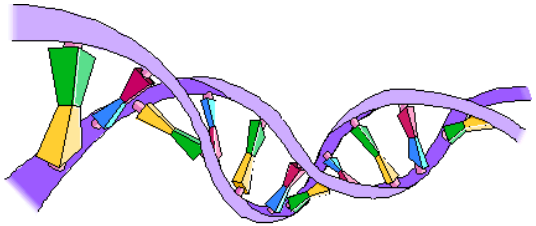
Phenotype #inverted teats

- Mean number of inverted teats is 0.67 (SD=1.76) and 0.82 (SD = 2.03) for boars (B) and sows (S)
  - Minimum is 0 for both, maximum is 16 (B) and 18 (S)
  - Heritability is 0.32 (B) and 0.3 (S)



Year	# obs.
2009	1340
2010	1214
2011	1794
2012	1641
2013	1191
2014	1592

- Aim: Detect QTL affecting number of teats and inverted teats in the Norsvin Landrace population.



Animals

- 5651 pigs included with breeding values estimated for
  - Total number of teats, corrected for fixed effects of heardyear and sex and random effects of litter and animal
  - Inverted teats for boars, corrected for fixed effects of heardmonth and random effect of animal
  - Inverted teats for sows, corrected for fixed effects of heardyear and sex, fixed regression of weight and random effects of litter and animal

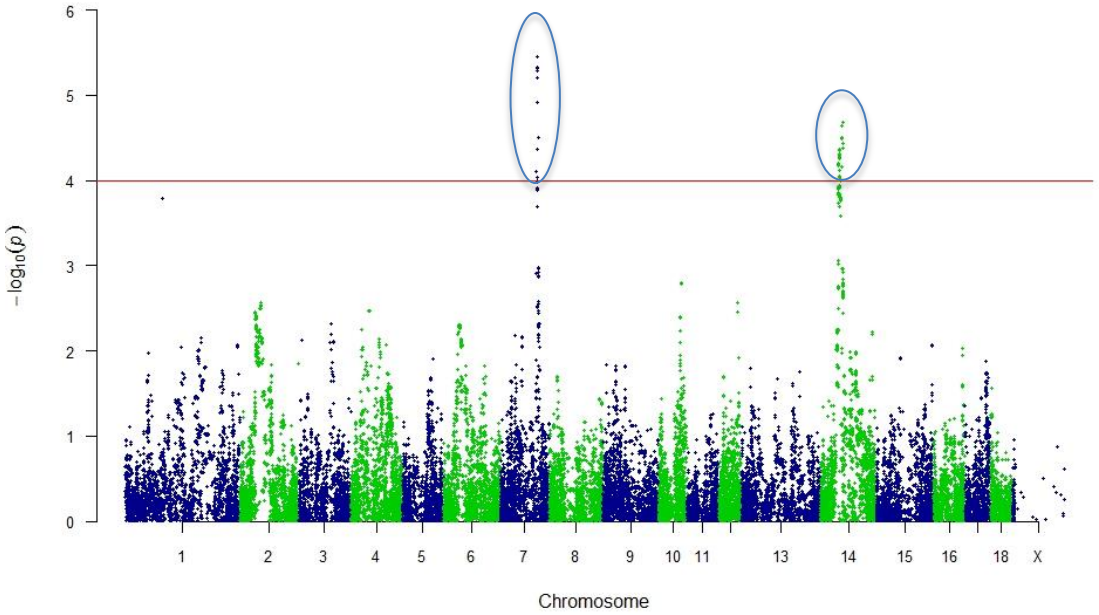
- Genotypes were included in a genomic relationship matrix (DMU, GMATRIX) together with phenotypes and pedigree using a single-step method (DMU, PGMIX)

Methods

- Illumina 60k chip
  - 37,244 mapped SNPs (Build10.2) passed quality control
  - MAF > 0.01, call rate > 0.95, error rate < 0.01
- Beagle used to impute sporadically missing genotypes
- GWAS was conducted using R package GenABEL (Aulchenko)
  - structured association approach (Cochran-Armitage test)
- The p-values were corrected for genomic control (GC) of a 1-df test
- GC-corrected p-value < 0.0001 considered significant

GWAS number of teats

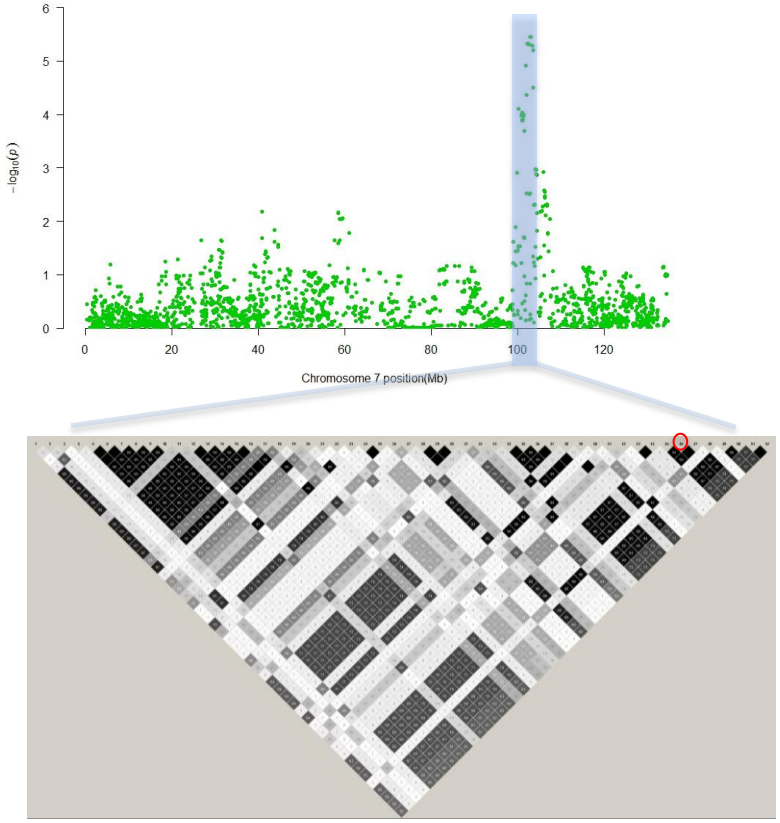
- 50 significant SNPs, two QTL regions

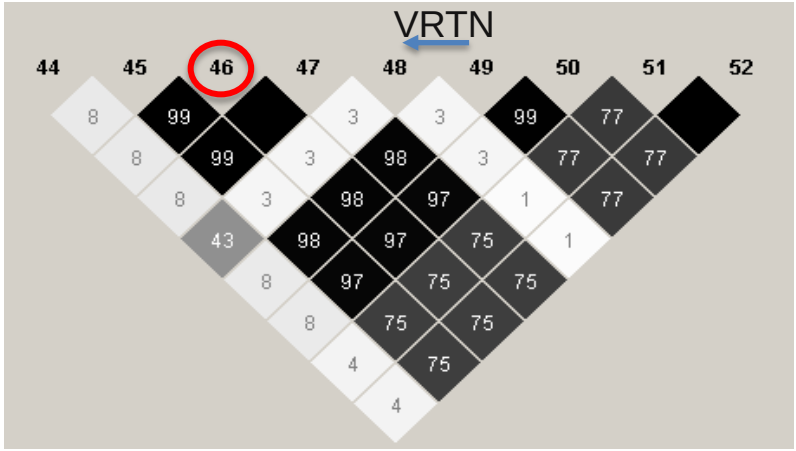


SSC7 = Duijvesteijn *et al.*, Ding *et al.*, Guo *et al.*, Sato *et al.*

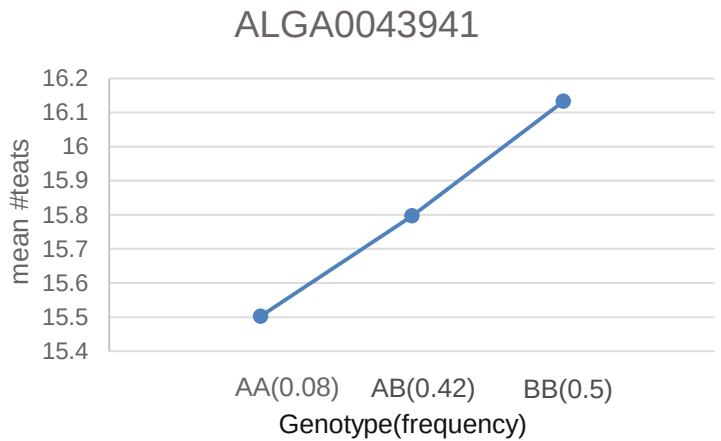
SSC14: EDAR-associated gene (EDARADD), required for normal development of mammary glands, Hair follicles, teeth, sweat glands

SSC7 number of teats



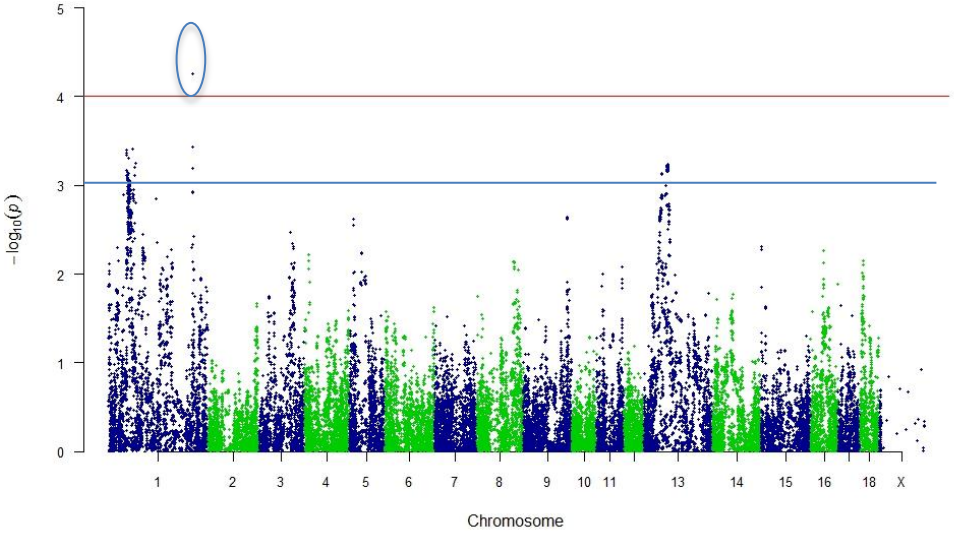


SSC7 number of teats



Year	Freq.(B)
2011	0.695
2012	0.710
2013	0.721
2014	0.777

GWAS number of inverted teats, boars



1 significant SNP on SSC1:
Intergenic region between genes LOC102162094 – ANKS6

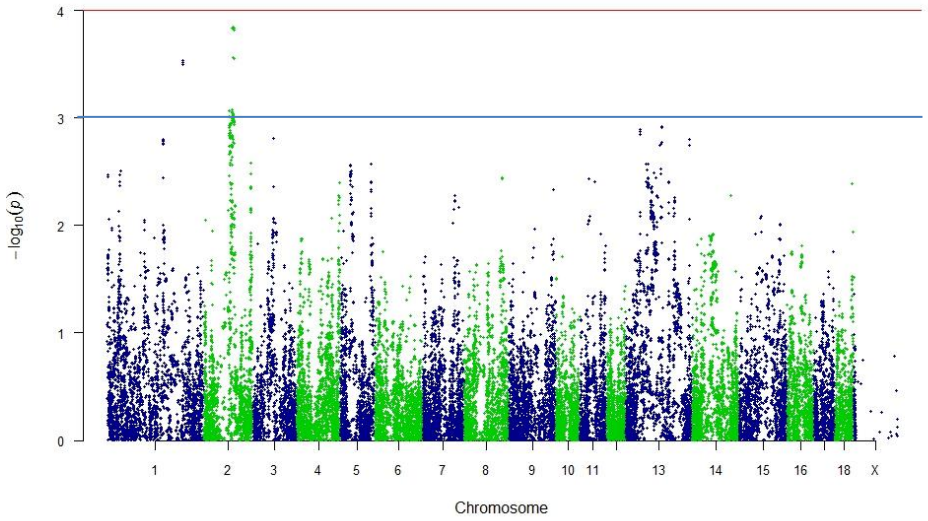
ANKS6

- Associated with dental anomalies in human

GWAS number of inverted teats, sows

SSC1: close to KANK1, gene involved in regulation of wnt signaling

- important for teat development in mice



Conclusions number of teats

- Significant QTL for number of teats found on SSCs 7 and 14
- SSC7 QTL previously characterized in other breeds and is now confirmed in Norsvin Landrace
  - Overlap with QTL and gene for number of vertebrae
  - Sequencing needed to identify causal variant
- SSC14 QTL
  - Not previously identified
  - Role of candidate gene should be investigated

Photo: Kjersti Wold, Norsvin

Conclusions number of inverted teats

- One significant SNP for number of inverted teats registered on boars
  - Role of candidate gene should be investigated

- No significant SNPs for number of inverted teats registered on sows

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