RELATIONSHIPS OF REPRODUCTIVE TRAITS AMONG LITTERMATE SWINE

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Story in Brief

Testicular traits, plasma hormone profiles and breeding performance of littermate boars and age and weight at puberty of littermate gilts were collected from litters born for five consecutive seasons starting in the fall of 1976. Correlation coefficients were calculated between male and female reproductive traits. In general these correlations were small and nonsignificant. However, weight at puberty is favorably correlated with total testicular sperm (-.205) and sperm per gram of testis (-.207), but unfavorably correlated with plasma hormone levels of testosterone in littermate boars. Average conception rate of herd sires for the breeding season was favorably correlated with their brother's testicular weight (.384) and cauda epididymidal sperm number (.453). If phenotypic correlations are indicative of genetic relationships, then selection for decreased weight at puberty in gilts or increased testes size in boars may result in favorable changes in the reproductive performance of male relatives. However, antagonistic relationships are also present, and better understanding is needed before appropriate selection programs can be devised for sex-limited reproductive traits.

Introduction

Several of the economically important traits in swine are expressed in only one sex (e.g. litter size and libido). Selection for these traits is more difficult as selection can only be applied in the sex expressing the trait. The dairy industry has circumvented this problem, for milk production, by extensive progeny testing of sires. This is an expensive venture that can be feasible only through extensive marketing of semen from superior sires and is not a viable option for a large portion of the livestock industry. Another approach is to identify a trait(s) in one sex that is controlled by similar genes as those controlling the trait(s) in the sex of interest. There is some information on these relationships in mice, sheep and cattle, but limited information is available for swine. This study was conducted to: (1) evaluate the relationship of a boar's testicular traits, hormone profile and breeding performance with his littermate sister's age and weight at puberty; (2) estimate the relationship of a boar's testicular traits and hormone profile with his full-sib brother's breeding performance.

Materials and Methods

Purebred and two-breed cross litters of Duroc, Landrace, Spotted and Yorkshire breeding were produced for five consecutive seasons

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beginning in the fall of 1976 at the Stillwater Swine Research Farm. Two boars from each litter were left intact at 42 days of age. One was randomly assigned to become a herd sire while the other was castrated at seven months of age when testes and hormone traits were measured.

For boars used for breeding, the number of services a sire needed to settle a female was recorded and an average number of services per conception for the eight week breeding season was calculated. Testicular and epididymidal weights and sperm counts were evaluated on those boars castrated at seven months. Before castration luteinizing hormone (LH) and testosterone (TE) were evaluated prior to and at four hourly intervals following gonadotropin releasing hormone (GnRH) injection. Age and weight at puberty of littermate gilts were recorded. Puberty was defined as the first detected estrus (standing response to a teaser boar).

Phenotypic correlations among traits of differing sexes were calculated adjusting for year and season of birth, breed of sire, breed of dam and the rearing status of the gilt (pasture lots or confinement pens). Phenotypic correlations have values between -1.0 to 1.0. An absolute value of 1.0 suggests a perfect relationship between two traits while a value of zero implies no relationship. A positive correlation indicates that larger values for one trait are associated with larger values for the second trait, while negative correlations indicate the reverse.

Results and Discussion

Phenotypic correlations of male reproductive traits and plasma hormone profiles with age and weight at puberty of littermate gilts are presented in Tables 1 and 2. Many of the correlations are small and non-

Table 1. Phenotypic correlations between male reproductive traits and age and weight at puberty in littermate gilts.

Male reproductive traits[a]	Age at puberty	Weight at puberty
TWT	-.028	.001
CCW	-.029	.138
CW	.065	.210*
TTS	-.276	-.205*
CCS	-.014	-.136
CS	-.068	-.111
TEPW	.017	.194*
TEPS	.054	-.136
SGT	-.019	-.207*
ANSC	-.124	-.084
ACR	-.101	.098

*P<.05.

[a]TWT=testicular weight; CCW=caput-corpus epididymidal weight; TTS=total testicular sperm; CCS=caput-corpus epididymidal sperm number; CS=cauda epididymidal sperm number; TEPW=total epididymidal weight; TEPS=total epididymidal sperm number; SGT=sperm number per gram of testis; ANSC=average number of services/conception; ACR=average conception rate.

Table 2. Phenotypic correlations between boar hormone concentrations and age and weight at puberty in littermate gilts.

Hormone levels[a]	Age at puberty	Weight at puberty
TE	.160	.259*
TE1	.197*	.217*
TE2	.208*	.206*
TE3	.232*	.371**
TE4	-.029	.190+
LH	.014	.198+
LH1	.179+	-.005
LH2	.044	.155
LH3	.072	.126
LH4	.070	.117

**P<.01.
*P<.05.
+P<.10.
[a]TE=basal plasma testosterone level; TE1-TE4=plasma testosterone level at hourly intervals after GnRH injection; LH=basal plasma LH level; LH1-LH4=plasma LH level at hourly intervals after GnRH injection.

significant. Weight at puberty had a positive relationship with cauda epididymidal weight (.194) and had a negative relationship with total testicular sperm number (-.205) and sperm number per gram of testis (-.207). This suggests that gilts with heavier weights at puberty had brothers with greater epididymidal weights but less testicular sperm. Age and weight at puberty had a positive relationship with TE at 0, 1, 2 and 3 hours after GnRH injection, while LH levels of boars had little relationship with the age and weight at puberty of littermate sisters. Phenotypic correlations between a boar's testicular traits and plasma hormone levels and his littermate brother's breeding performance are presented in Tables 3 and 4. Average number of services per conception was found to have little relationship with any of the testicular traits or plasma hormone levels investigated. Average conception rate was found to have a moderate positive relationship with testicular weight (.384), cauda epididymidal sperm number (.453) and LH levels 3 (.341) and 4 (.354) hours after GnRH injection. This indicates that boars who settled a greater percentage of the females they were exposed to, had brothers with heavier testes, more cauda epididymidal sperm number and higher amounts of TE at 3 and 4 hours after GnRH injection.

If we assume these correlations are partially genetic in origin these results have impact on selection programs for reproductive traits. Age and weight at puberty in gilts and testes size in boars are easily measurable. Selection involving these traits may aid in improving sperm numbers and conception rate. Many of the relationships shown here are favorable; however, they are generally low so expected improvement may be small. There are also some unfavorable relationships that need further investigation. Until a clearer understanding exists, selection programs using measures of sperm numbers or hormone levels are not recommended.

Table 3. Phenotypic correlations between testicular traits and littermate's breeding performance.

Testicular traits[a]	Average number services/conception	Average conception rate
TWT	-.164	.384*
CCW	.038	.013
CW	-.041	.138
TTS	.007	.258
CCS	-.163	.291
CS	-.265	.453*
TEPW	.002	.084
TEPS	-.256	.443
SGT	.004	.268

*P<.05.
[a]TWT=testicular weight; CCW=caput-corpus epididymidal weight; CW=cauda epididymidal weight; TTS=total testicular sperm; CCS=caput-corpus epididymidal sperm number; CS=cauda epididymidal sperm number; TEPW=total epididymidal weight; TEPS=total epididymidal sperm number; SGT=sperm number per gram of testis.

Table 4. Phenotypic correlations among boar hormone concentrations and littermates's breeding performance.

Hormone levels[a]	Average number services/conception	Average conception rate
TE	.082	-.018
TE1	-.110	.115
TE2	-.135	.131
TE3	-.147	.062
TE4	-.194	.177
LH	.209	-.044
LH1	-.350	.173
LH2	-.158	.240
LH3	-.288	.341+
LH4	-.265	.354+

+P<.10.
[a]TE=basal plasma testosterone level; TE1-TE4=plasma testosterone level at hourly intervals after GnRH injection; LH=basal plasma LH level; LH1-LH4=plasma LH level at hourly intervals after GnRH injection.