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Within-litter variation of birth weight in hyperprolific Czech Large White sows and its relation to litter size traits, stillborn piglets and losses until weaning

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Abstract

Data from about 2900 litters (approximately 40,000 piglets) originating from 1063 Czech Large White hyperprolific sows were analyzed. The phenotypic and genetic relations between litter size traits, piglet mortality during farrowing and from birth to weaning and several statistics referring to the distribution of the birth weight within litter were analyzed. All genetic parameters were estimated from multi-trait animal models including the following factors: mating type (natural service or insemination), parity, linear and quadratic regression on age at first farrowing (1st litter) or farrowing interval (2nd and subsequent litters), herd-year-season effect and additive-genetic effect of the sow. The phenotypic correlations of the mean birth weight with the total number of piglets born and piglets born alive were −0.30. Traits describing the variability of the birth weight within litter (range, variance, standard deviation, coefficient of variation) were mostly positively correlated with litter size. A statistically significant phenotypic correlation (−0.09 to −0.15) between mean birth weight and losses at birth and from birth to weaning was found. The heritability for the number of piglets born, piglets born alive and piglets weaned was around 0.15. The number of stillborn piglets had only a very low heritability less than 0.05, whereas the heritability for losses from birth to weaning was 0.13. The heritabilities of the mean, minimal and maximal birth weight were 0.16, 0.10 and 0.10, respectively. The heritability for all statistics and measures referring to the variability of the birth weight within litter was very low and did never exceed the value of 0.05. An increase in litter size was shown to be genetically connected with a decrease in the mean piglet birth weight and an increase in the within-litter variability of birth weight. Selection on litter size should be accompanied by selection on mortality traits and/or birth-weight traits. Losses from birth to weaning and the minimal birth weight in the litter were proposed as potential traits for a selection against piglet mortality.

Keywords: Pig; Large White; Hyperprolific line; Birth weight; Litter traits; Piglet mortality

1. Introduction

Birth weight is considered to be one of the most important factors influencing pig survival (Leenhouwers et al., 2001). The low-birth-weight piglet is particularly at risk for preweaning morbidity and mortality. It is physiologically compromised in terms of energy stores

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and susceptibility to cold and is at a disadvantage in competing with larger littermates at the udder (Lay et al., 2002). Having in mind the whole litter of the sow, the distribution of the birth weight within the litter (mean birth weight and variability within the litter) is of importance for the overall productivity of the sow.

Selection for the sow's ability to give birth to a higher number of piglets has led to an increased within-litter variation in piglet birth weight (Tribout et al., 2003). Large litters result in a longer farrowing duration and thus may be critical to survival for piglets born toward the end of farrowing. Litter size can also influence piglet survival after birth as piglet losses tend to be greater in larger litters which may be attributed to the within-litter variation in piglet body weight (Marchant et al., 2000; Lay et al., 2002).

Genetic analyses of the birth weight and its variation within litter have been presented in several papers (Högberg and Rydhmer, 2000; Hermesch et al., 2001; Damgaard et al., 2003; Huby et al., 2003; Tribout et al., 2003; Täubert and Henne, 2003). In these studies, the standard deviation and/or the coefficient of variation of the birth weight were investigated in data sets from 15,000 to 30,000 piglets.

Using a large data set with nearly 40,000 weighed piglets, the aim of the present study is to investigate the question to what extend measures of the distribution of the birth weight within litter are heritable. Besides the standard deviation and coefficient of variation which have been currently used in the literature, a number of further statistics will be considered. Next, the phenotypic and genetic relations between the statistics for birth weight and litter size traits including farrowing losses and losses from birth to weaning will be analyzed. Finally, the possible use of the statistics for birth weight in selection programmes will be discussed.

2. Materials and methods

2.1. Animals and structure of data

A hyperprolific line has been formed as a subpopulation within the Czech Large White breed starting approximately in the year 2000. To be included into a hyperprolific line, a sow must have a breeding value for litter size (number of piglets born alive in the second and subsequent litters) among the top 15%. The top 15% is calculated from the breeding values of all sows with a minimal age of two years. The candidate sow may be on her first to third litter and must have an average of 12 or more live-born piglets per litter. The number of functional nipples must be at least 7 on both sides and the sow must be MHS negative. For testing the MHS status, the ryanodine receptor gene (RYR1) was used and the test was carried out according to Brenig and Brem (1992).

Table 1
Numbers of piglets, litters, sows and boars

Characteristics	Number or value
Total number of piglets born alive	40,102
Number of litters	2933
Number of sows	1063
Number of boars	393
Mean number of litters/sow	2.76
Mean number of litters/boar	7.46

Table 2
Relative frequencies (%) of individual parities

Parity	Relative frequency
1	22.3
2	21.2
3	18.6
4	14.9
5 or 6	15.7
≥7	7.3

Data of about 2900 litters originating from 1063 Czech Large White sows from the hyperprolific line were analyzed. The farrowing years were in the range from 2000 to 2005. The sows were distributed over 24 farms. Table 1 gives a survey on the number of litters, number of sows, number of boars and the mean number of litters per sow and boar. The relative frequencies of individual parities are listed in Table 2.

Data were available on age at first farrowing, the farrowing interval, total number of piglets born, number of piglets born alive and number of piglets weaned. The number of piglets born and born alive were recorded immediately after birth (not later than 24 h after birth). The number of piglets born included piglets born alive and stillborn piglets, but no mummified piglets. The number of weaned piglets was stated between 18 and 24 days after birth. Crossfostering was not used.

From these data the number of stillborn piglets and the losses from birth to weaning, both as absolute (number of piglets) and relative (per cent of the total number of piglets born or per cent of the number of piglets born alive, respectively) numbers were calculated. Furthermore, the individual birth weight for each live-born piglet was given.

2.2. Parameters describing the distribution of individual birth weight within litter

The distribution of the birth weight within the litter was described by several quantities. The arithmetic and