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Genetic analysis of reproductive disorders and their relationship to fertility and milk yield in Austrian Fleckvieh dual-purpose cows

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ABSTRACT

The objective of this study was to estimate genetic parameters for various reproductive disorders based on veterinary diagnoses for Austrian Fleckvieh (Simmental) dual-purpose cattle. The health traits analyzed included retained placenta, puerperal diseases, metritis, silent heat and anestrus, and cystic ovaries. Three composite traits were also evaluated: early reproductive disorders, late reproductive disorders, and all reproductive disorders. Heritabilities were estimated with logit threshold sire, linear sire, and linear animal models. The threshold model estimates for heritability ranged from 0.01 to 0.14, whereas the linear model estimates were lower, ranging from 0.005 to 0.04. Rank correlations among random effects of sires from linear and threshold sire models were high (>0.99), whereas correlations between any sire model (linear, threshold) and the linear animal model were lower (0.88–0.92). Genetic correlations among reproductive disorders, fertility traits, and milk yield were estimated with bivariate linear animal models. Fertility traits included interval from calving to first insemination, nonreturn rate at 56 d, and interval between first and last insemination. Milk yield was calculated as the mean from test-day 1 and test-day 2 after calving. Estimated genetic correlations were 1 among metritis, retained placenta, and puerperal diseases and 0.85 between silent heat–anestrus and cystic ovaries. Low to moderate correlations (−0.01 to 0.68) were obtained among the other disorders. Genetic correlations between reproductive disorders and fertility traits were favorable, whereas antagonistic relationships were observed between milk yield in early lactation and reproductive disorders. Pearson correlations between estimated breeding values for reproductive disorders and other routinely evaluated traits were computed, which revealed noticeable favorable relationships to longevity, calving ease maternal, and stillbirth maternal. The results showed that data from the Austrian health monitoring project can be used for genetic selection against reproductive disorders in Fleckvieh cattle.
Key words: reproductive disorder, fertility, linear model, threshold model

INTRODUCTION

Functional traits such as fertility and health traits are becoming increasingly important in selection decisions worldwide because of economic reasons as well as animal welfare concerns and consumer demands for healthy and naturally produced products.

In most dairy cattle populations, the primary selection objective during the past several decades was milk production, whereas fertility and health traits received less attention (Miglior et al., 2005). As a consequence, genetic trends in fertility are negative because of an unfavorable correlated selection response (VanRaden et al., 2004; Liu et al., 2008). A slight decrease in fertility was also observed in Austrian dual-purpose breeds such as Fleckvieh (dual-purpose Simmental; Fuerst and Gredler, 2009). In contrast, genetic fertility trends are constant or even positive for the different Nordic Red breeds, arising from a simultaneous and consequent selection of bulls for production and fertility for more than 30 yr (Fogh et al., 2003; Philipsson and Lindhé, 2003; Andersen-Ranberg et al., 2005).

In Austria, genetic evaluations for fertility based on nonreturn rate at 90 d were carried out from 1995 to 2008; since 2002, genetic evaluations for all traits have been performed jointly with Germany for Fleckvieh cattle (Fuerst and Egger-Danner, 2002). However, female fertility has many components and cannot simply be explained by 1 trait only. Female fertility is represented by different abilities: the ability to show heat or maturity, the ability to conceive and to carry on to term, the ability to resist disorders, and the ability to recycle. Hence, in 2008 a new fertility index was introduced (Fuerst and Gredler, 2009) based on the results of Gredler (2008). Several traits are combined in this index: interval from calving to first insemination

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(**CFI**), nonreturn rate at 56 d (**NR56**), and interval from first to last insemination (**FLI**). The trait CFI describes mainly the ability of a cow to come into estrus and show heat, and NR56 and FLI are measures of the ability of a heifer or cow to conceive after insemination. The latter traits also include losses because of embryonic death. Because the physiological status of heifers is quite different from that of cows, the traits NR56 and FLI are analyzed separately for heifers and cows. The fertility index is included in the total merit index with a relative weight of 6.8% for Fleckvieh cattle (Fuerst and Gredler, 2009).

At present, no direct health traits are included in the total merit index of Austrian Fleckvieh cattle because no recording system of diseases existed until recently. A project to establish a nationwide health monitoring system for cattle was started in Austria in 2006 in which diagnoses from veterinarians are recorded (Egger-Danner et al., 2007). The main project aims are to provide support for herd management and to obtain breeding values for health traits. Health traits are, so far, routinely evaluated only in the Scandinavian countries (Interbull, 2009), where disease recording programs have been carried out on a large scale for more than 30 yr. The routine Scandinavian genetic evaluation of disease traits is based on linear models, which assume normal distribution of the data. Because diseases are treated as binary traits in genetic evaluation, nonlinear threshold models would be, at least theoretically, more appropriate for variance component and breeding value estimation (Gianola and Foulley, 1983).

Based on data from the Austrian health monitoring project, besides mastitis, reproductive disorders are the most frequent disease category in Fleckvieh cattle. Therefore, the objectives of this study were 1) to estimate heritabilities with threshold and linear models for various reproductive disorders; 2) to compare sire rankings for reproductive disorders from genetic evaluations with threshold and linear models; 3) to investigate relationships between reproductive disorders, fertility traits, and milk yield in early lactation (**MY**); and 4) to assess correlations between reproductive disorders and other traits that are routinely evaluated.

MATERIALS AND METHODS

Data

Health Monitoring. In Austria, under legal obligation, veterinary diagnoses and treatments have to be documented. These documents must be kept for 5 yr by the veterinarians as well as the farmers. However, up until now these data have been neither collected nor stored in a database. Since July 2006, diagnosis data from veterinarians have been recorded in Austria within the framework of the project called "Health monitoring in cattle" (Egger-Danner et al., 2007). For this purpose, a standardized diagnosis key is used that consists of 10 disease groups (diseases of calves; diseases of the digestive tract; metabolic diseases; infertility and disorders associated with parturition; udder diseases; diseases of the claw and other diseases of the legs; diseases of the respiratory tract; cardiovascular diseases, diseases of the blood and urinary tract; diseases of the central nervous system, skin and infectious diseases; and other diseases) covering 65 different disease codes. The diagnosis data from veterinarians are collected monthly by the milk recording technicians or are sent electronically to the database by the veterinarians. The data are stored within the Austrian central cattle database (Rinderdatenverbund). Recording of health data on farms is currently voluntary.

Data Validation and Editing. A basic prerequisite for an efficient use of health data is a correct data validation. Several measures were applied to ensure adequate reporting within individual herds. Before recording the data in the database, routine plausibility checks were carried out. To distinguish farms with low frequencies of diseases from those with incomplete documentation and recording, at least 1 diagnosis per 10 cows, year, and farm must have been reported. Additionally, continuous recording and reporting by the veterinarians and farmers was a precondition. Furthermore, only data from veterinarians who recorded at least 500 diagnoses during the whole period were considered in this analysis to rule out inconsistent data collection. About 25% of the farms had to be excluded by data editing, assuming unreliable documentation and recording.

At present, about 70% of all cows participating in the Austrian milk recording scheme belong to the Fleckvieh breed (ZAR, 2009), so the analyses were carried out for this breed only. Records of 33,362 Fleckvieh cows with a maximum non-Fleckvieh gene proportion of 25%, calving between January 1, 2007 and November 30, 2008, were used in this study. Only cows from first to fifth lactation with an age at first calving between 19 and 43 mo were included. Records of animals with a calving interval <300 d or >800 d were excluded.

Traits. Reproductive disorders with an incidence far below 1% were not considered in the analyses; these were uterine prolapse (0.10%), abortion (0.19%), injuries incidental to parturition (0.21%), and difficult calving (0.34%). The latter proportion is low because only veterinary-assisted calvings are included, whereas calving ease scores are reported by farmers (Fürst and Fürst-Waltl, 2006). Thus, the following disease traits were analyzed: retained placenta (**RP**), puerperal diseases (**PUERP**), metritis (**MET**), silent heat and anestrus (**ESTRUS**), and cystic ovaries (**CYST**).