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Factors affecting the sex ratio in dairy cattle in New Zealand

Z. Z. XU, D. L. JOHNSON AND L. J. BURTON

Livestock Improvement Corporation, Private Bag 3016, Hamilton, New Zealand

ABSTRACT

The sexes of calves born in 1996 ($n = 319,539$) and 1997 ($n = 408,381$) to artificial insemination in selected herds were analysed to study the effects of region, dam breed, dam age, semen type, semen breed, semen age, and sires on the sex ratio of calves. There was a significant ($P < 0.001$) effect of semen type on sex ratio; frozen semen resulted in 1.66% and 1.24% more male calves than fresh semen, respectively, in the 1996 and 1997 seasons. There was also significant ($P < 0.01$) variation among sires in sex ratio, but the heritability estimate for sex ratio was low ($h^2 = 0.02$). No other effects were significant. Industry-wide use of fresh semen will result in more heifer calves from which future replacements can be selected.

Keywords: sex ratio; dairy cattle; semen type.

INTRODUCTION

Sex ratio is an important economic trait for commercial dairy cattle production where a high proportion of heifer calves is desirable. Tremendous effort has been devoted to develop means to manipulate sex ratio in cattle and other species (Clutton-Brock and Iason, 1986, McEvoy, 1992). In addition, many biological and environmental factors have been shown to affect sex ratio of calves under certain conditions (Astolfi and Tentoni, 1995, Skjervold and James, 1979; Rorie, 1999). In a survey of calves born in 1960 in New Zealand, it was found that the sex ratio was 51.4% male (New Zealand Dairy Board, 1961). In addition, semen age, sire fertility, and sires were found to affect sex ratio (New Zealand Dairy Board, 1961). Since then, there has been no systematic study of sex ratio in dairy cattle in New Zealand. The objective of the present study was to investigate the effects of some biological and environmental factors on sex ratio in dairy cattle in New Zealand.

MATERIALS AND METHODS

The data sets

Data used in the present study was extracted from the National Dairy Animal Database. Two data sets were created, one for the 1996 calving season and one for the 1997 calving season. Only spring-calving herds that used herd testing and that used semen mainly from Livestock Improvement Corporation (LIC) were included in the study. The initial data sets were edited to remove records for cows that conceived to natural service or to AI with non-LIC semen, records for cows that gave multiple births, and records for cows in herds that did not record the sex information of more than 5% of the calves born to artificial insemination (AI). The reason for removing herds with a significant amount of missing data is to remove potential bias due to selective recording of information on the database. In New Zealand, since most male AI calves are not reared, some herd owners are less likely to supply the sex information for male calves. A small percentage (5%) of missing data for calf sex is allowed in this study to account for cases (such as premature births, mummified foetuses and dead calves) in which calf sex might not be recorded. As a result, 946 and 1108 herds were removed

from the 1996 and 1997 data sets, respectively.

Determination of the successful mating

No pregnancy diagnosis information was recorded on the database. Depending on herds, dates of natural mating were recorded with varying degrees of accuracy. Therefore the mating to which each calf conceived had to be determined retrospectively from calving information. A previous study found that gestation length (GL) was 281 days with a standard deviation of 5.7 days (Grosshans *et al.*, 1997). In this study, the normal range of gestation length is considered to be within 2 standard deviations of the mean, i.e., between 269 and 293 days. From the information associated with each successful mating, the types of semen (fresh or frozen), breed and sire of semen, and semen age (for fresh semen only) were determined.

Statistical analysis

A linear model was fitted to the individual cow data. The model included the fixed effects of region (six LIC regions), age of cow (2, 3, ... ≥ 9 years), breed of cow, breed of semen, semen type (fresh or frozen), and semen age (fresh semen only). Herd and sire were fitted in the model as random effects. The analyses were performed separately for the two seasons using SAS (SAS Institute Inc, 1989) and ASREML (Gilmour *et al.*, 1999).

RESULTS AND DISCUSSION

After the editing steps, the final data set for the 1996 season contained 319,539 records for 3,049 herds and that for the 1997 season contained 408,381 records in 3,828 herds. The overall sex ratio (defined as the percentage of males) was 51.4% for the 1996 season and 51.5% for the 1997 season. These figures are similar to the 51.4% reported for calves born in 1960 from inseminations with fresh semen (New Zealand Dairy Board, 1961).

There were no significant effects of region, age of cow, breed of cow, breed of semen, and semen age on sex ratio. Semen type significantly ($P < 0.001$) affected sex ratio; frozen semen (1996, $n = 27,849$; 1997, $n = 30,605$) resulted in more male calves than fresh semen (1996, $n = 291,690$; 1997, $n = 377,776$) in both the 1996 ($1.66\% \pm 0.35$, least square difference \pm standard error of difference) and the

1997 ($1.24\% \pm 0.30$) seasons. There was also significant ($P < 0.01$) variation among sires in sex ratio, but the heritability estimate for sex ratio was low ($h^2 = 0.02$).

The reasons for the difference in sex ratio between fresh and frozen semen are not known. Alteration in sex ratio can only be achieved by changes in the proportion or function of live X- or Y-bearing sperm in the semen, differences between X- and Y-bearing sperm in the speed of transport through the reproductive tract, preferential selection of sperm at fertilisation, or selective elimination of embryos and foetuses of a particular sex. In the current context, it is possible that the two semen-processing procedures might have slightly different effects on the survival or the function of X- or Y-bearing sperm. Freezing causes membrane changes in sperm equivalent to capacitation (Gillan *et al.*, 1997). If X- and Y-bearing sperm have different sensitivity to freezing, this could explain the observed difference in sex ratio. Because the age of fresh semen (1 to 3 days post collection) had no effect on sex ratio, it was unlikely that the storage condition for fresh semen differentially affected the survival or function of the two types of sperm. It is improbable, although not entirely impossible, that use of frozen and fresh semen would have a differential effect on the survival of embryos after fertilisation. Further studies would be needed to establish the reasons for the observed difference in sex ratio between fresh and frozen semen.

Although the observed difference in sex ratio between fresh and frozen semen is small in magnitude, the use of fresh semen will still have a significant economic benefit from a New Zealand dairy industry perspective. Currently about 2 million cows conceive to AI each year. Use of fresh instead of frozen semen will result in an extra 1.2 to 1.7% (or 24,000 to 34,000) female calves from which replacement animals can be selected to improve the rate of genetic gain.

REFERENCES

- Astolfi, P.; Tentoni, S. 1995. Sources of variation of the cattle secondary sex ratio. *Genetics, Selection, Evolution* **27**: 3-14.
- Clutton-Brock, T.H.; Iason, G.R. 1986. Sex ratio variation in mammals. *Quarterly Review of Biology* **61**: 339-374.
- Gillan, L.; Evans, G.; Maxwell, W.M.C. 1997. Capacitation status and fertility of fresh and frozen-thawed ram spermatozoa. *Reproduction, Fertility and Development* **9**: 481-487.
- Gilmour, A.R.; Cullis, B.R.; Welham, S.J.; Thompson, R. 1999. ASREML Reference Manual. New South Wales Department of Agriculture, Orange, Australia.
- Grosshans, T.; Xu, Z.Z.; Burton, L.J.; Johnson, D.L.; Macmillan, K.L. 1997. Performance and genetic parameters for fertility of seasonal dairy cows in New Zealand. *Livestock Production Science* **51**: 41-51.
- McEvoy, J.D. 1992. Alteration of the sex ratio. *Animal Breeding Abstracts* **60**: 97-111.
- New Zealand Dairy Board 1961. Sex ratio of calves born. *New Zealand Dairy Board Annual Report* **37**: 79-80.
- Rorie, R.W. 1999. Effect of timing of insemination on sex ratio. *Theriogenology* **52**: 1273-1280.
- SAS Institute Inc, 1989. SAS/STAT User's Guide, Version 6. Cary, NC: SAS Institute Inc.
- Skjervold, H.; James, J.W. 1979. Causes of variation in the sex ratio in dairy cattle. *Journal of Animal Breeding and Genetics* **95**: 293-305.