3.11 Breeds with Newly Discovered Genes for Prolificacy

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Introduction

The information emerging from research conducted in various countries seems to show that the *FecB* gene of the Booroola is not unique, and that other sheep have either the same gene or other genes with similar effects. It is now well established that prolificacy in the Cambridge and Javanese breeds is caused by major genes. These breeds are presented in detail in earlier parts of Chapter 3. Other breeds with newly identified major genes are presented in the following section.

The Inverdale Gene of Romney Sheep

The Inverdale gene ($FecX^I$) on the X chromosome of Romney sheep was discovered in 1990 in a research flock of screened prolific sheep (Kelly *et al.*, 1983). A Romney ewe that had produced 33 lambs in 11 parturitions in a commercial flock in Canterbury in the South Island of New Zealand had been screened into the flock in 1979. By 1984 the progeny of this ewe in the screened flock included seven ewes with high ovulation rates. This result prompted a series of progeny tests of male descendants, which suggested the existence of a major gene for prolificacy that had a smaller effect than and a different inheritance from the Booroola gene (*FecB*) (Davis *et al.*, 1988). The progeny tests showed that rams whose pedigree indicated that they could have only one copy of a major gene were apparently passing on the high prolificacy trait to all daughters. A large progeny test of sons and maternal grandsons of a carrier ram subsequently showed an inheritance pattern indicating that the gene was located on the X chromosome (Davis *et al.*, 1991). Thus, a ram carrying the Inverdale gene passes a copy to all daughters but not to his sons, whereas ewes with one copy of the Inverdale gene pass a copy to half their offspring of each sex. A single copy of the Inverdale gene increases the ovulation rate by about 1.0 and the litter size by about 0.6. Production data from a flock carrying the Inverdale gene showed no significant pleiotropic effects on barrenness, embryonic mortality or lamb mortality, although the latter two traits were both affected as a consequence of the effect of the Inverdale gene on ovulation rate (Davis *et al.*, 1993). However, ewes that are homozygous carriers ($FecX^I/FecX^I$) of the Inverdale gene have since been shown to have small, non-functional streak ovaries and consequently are sterile (Davis *et al.*, 1992).

In 1993 the Inverdale gene was apparently found in another two

commercial flocks with no known relationship to the original flock. One of these flocks is in the North Island of New Zealand and records of the last 29 years showed no transfer of stock between the flocks. A few prolific ewes from both flocks were mated with progeny-tested rams known to carry the Inverdale gene. Streak ovaries were observed among some of the female offspring, which strongly suggests that the Inverdale gene is present in these flocks.

The streak ovary condition cannot be identified by visual examination of the ovaries in newborn lambs, but it has been observed by laparoscopy as early as 2 months of age. Ram lambs can be progeny-tested by mating them to a small number of heterozygous ($FecX^I/FecX^+$) ewes and checking the female progeny for the presence of streak ovaries. Because, on average, half the daughters of carrier rams mated to carrier ewes will have streak ovaries, only five daughters per ram are needed to identify 97% of carrier rams, i.e., 0.5^5. Also, because the daughters with streak ovaries are identified as lambs before puberty, the carrier rams can be identified prior to mating at 1.5 years of age. In the future a genetic marker should obviate the need to progeny-test rams.

Although the Inverdale gene has not been released to industry from the research flock, pending the identification of an accurate genetic marker, recent evidence from two flocks suggests that the gene is already in the marketplace. In commercial flocks matings between carrier rams ($FecX^{I}/Y$) and $FecX^I/FecX^+$ ewes should be avoided because only 50% of the female progeny are fertile. The Inverdale gene allows genetic improvement in other traits in ram-breeding flocks to be channelled through a non-Inverdale ram when there is a suitable genetic marker available for selection of carriers of the Inverdale gene. Ram breeders could have a flock of $FecX^I/FecX^+$ ewes mated to non-carrier (or non-Inverdale) rams selected for other traits. A genetic marker would enable $FecX^I/FecX^+$ female offspring to be identified for flock replacements and $FecX^{I}/Y$ rams to be identified for sale.

The Inverdale gene is well suited to sheep industries with a tiered structure. For example, in Australia a proportion of the Merino flock is mated to Border Leicester rams and the F_1 ewes are sold to lamb-meat producers who mate them to meat-breed sires, with all progeny sold for slaughter. The Inverdale gene could be introgressed into the Border Leicester breed, and carrier rams could be used to generate prolific F_1 ewes, all carrying one copy of the Inverdale gene. In this situation, only the Border Leicester ram breeder would need to identify carrier sheep because no progeny of F_1 ewes would be retained for breeding.

The Thoka Gene of Icelandic Sheep

Icelandic sheep are a breed in which a major gene for prolificacy has been recently identified. The gene is given the name 'Thoka' after the ewe originally possessing the gene. The discovery of the Thoka gene is similar

to that of the Booroola. Two flocks in southeastern Iceland contained sheep that produced an unusually high percentage of triplets. The pedigree of almost all ewes with multiple births could be traced to the ewe Thoka, born in 1950 at the Smyrlabjoerg farm. The gene might have existed even before Thoka, since it is claimed that Thoka's grandmother gave birth to triplets around 1940 (Jonmundsson and Adalsteinsson, 1985). Producing triplets in an area where twins were a rarity was indeed an astonishing event. One son of Thoka was used in a neighbouring farm (Borgarhoefn) and resulted in a marked increase in the number of triplets (8.7 vs. 1.4%) and quadruplets (0.7 vs. 0%) as compared with averages for sheep-breeding associations (Jonmundsson and Adalsteinsson, 1985).

Twelve ewe lambs and three ram lambs were purchased by the Skriduklaustur Experimental Station in 1976 for research. The first report published in 1985 by Jonmundsson and Adalsteinsson confirmed the presence of a single major gene responsible for the increased prolificacy. The researchers presented various results to justify their conclusions. They noted that in 'normal' Icelandic sheep non-carriers of the gene ovulated, on average, 1.39 ova, whereas the carriers ovulated 2.14, the difference being statistically highly significant. In another group of ewes born in 1984 and examined for ovulation rate between 1985 and 1989, gene-carrier ewes ovulated, on average, 3.4 ova compared with 2.2 for non-carrier ewes. The repeatability of ovulation rate for carriers averaged 0.69, whereas that of non-carriers averaged 0.24. As in the case of prolific breeds resulting from a single gene, identifying the carrier sires with one or two copies of the gene is the greatest challenge. So far, most of the results on Icelandic sheep with the Thoka gene assume the existence of heterozygous animals. Researchers calculated that a copy of the gene may be responsible for an increase of 0.64 lambs per ewe lambing; the effect on ovulation rate is even greater (1.21 ova).

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