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Genetic reduction of tail length in New Zealand sheep

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ABSTRACT

Literature evidence revealed several sources of genes that could be used to shorten the tails of sheep. Genes from the Northern short-tail group are preferable as there are no known detrimental effects on viability. Tail length from anus to tip, divided by the distance from anus to hock and calculated as a percentage was used to correct tail length for body size differences. Adjusted tail length of the progeny was best explained by additive effects for adjusted tail length of the sire ($P<0.001$) and dam breed ($P<0.001$). A small but significant interaction was also evident ($P<0.01$). Mean tail length was shortest for Finnish Landrace lambs (88mm) and longest for Wiltshire x Cheviot lambs (251mm). Cheviot lambs had long tails (226mm), while various crosses between Finnish Landrace and Cheviots suggest that mean tail length will be the average of the parents. The experiment suggests inheritance of a number of genes and that it will therefore be straightforward to produce genetically-docked tails using cross breeding followed by selection and interbreeding.

Keywords: coccygeal vertebrae; welfare; sheep; genetics.

INTRODUCTION

Tail docking has become a regular practice on sheep farms in New Zealand and many parts of the Western world. The purpose is to reduce the accumulation of faeces and urine stain with the goal of reducing flystrike.

Although widely used, tail-docking is not a standard practice throughout the world. Mason (1991a) described five major tail phenotypes in domesticated sheep throughout the world. **Fat-tailed** sheep are prized for their long pendulous fat tails, and are represented by the Awassi and Karakul in very small numbers in New Zealand. An interesting group are the **fat-rumped** breeds of Africa and Central Asia. Sadly, there are no purebred fat-rumped sheep in New Zealand: these have a very short tail or no tail at all. The Dorper, very recently introduced to New Zealand, was created in the 1930s by crossing the fat-rumped Black-headed Persian with the Dorset Horn. The few lambs that the authors have observed had tails, so it is quite possible that New Zealand does not have access to the fat-rumped genes.

Sheep with **short tails** occur throughout the world, but the representatives in New Zealand came from the Northern short-tailed group, namely the Gotland Pelt (small numbers) and the Finnish Landrace. The latter breed has been extensively used in cross breeding programs throughout New Zealand. Mason (1991a) also included the East Friesian and the Texel under the short-tailed group but classified them as Marsh type, distinct from the Northern short-tail. New Zealand readers will also be familiar with the widespread use of these two breeds.

Mason (1991a) also described **long-tailed** breeds from Sudan and Eritrea, with "a fleshy tail to the fetlocks or longer"! Finally the Romney, Merino and the Down breeds and their derivatives and crosses all come from the **thin-tailed** group.

At various stages in New Zealand (O'Hara, 1973; Carter, 1974) and Australia (James *et al*., 1991a, b) researchers have considered using tail length variants to produce genetically docked sheep. Both attempts seem to have been foiled by reduced viability of the homozygous embryos. This is perhaps analogous to the lethal effect of the Manx gene in cats (DeForest & Basrur, 1979).

Early last century American research was devoted to reducing tail length and a "No-tail" breed was developed in South Dakota following forty years of selection from an initial cross between fat-rumped and thin-tailed sheep (Jordan, 1952). Shelton (1977) reported tail length data from work carried out much earlier (Warwick *et al.,* 1946), from hybridising thin-tailed Rambouillet with the short-tailed Mouflon (*Ovis mouflon*). Wild sheep like the Mouflon or the North American bighorn (*Ovis canadensis*) have short tails.

Tail docking as a husbandry practice has been challenged by animal welfare and animal rights groups. This has led to a plethora of behavioural and endocrinological studies on the pain caused by docking. These references are too numerous to list here, but perhaps the most interesting of all these was by Graham *et al.* (1997) as it contains the following statement: "It is incumbent upon those responsible for sheep welfare to find the most humane practical method of docking, and to use it on lambs of an age when least pain or distress is caused." In the Materials and Methods section, Graham *et al.* (1997) noted that "Dorset-Finn cross ewes" were used and Branford Oltenacu & Boylan (1974) had shown that the Finnish Landrace could be used to genetically shorten the tails. Presumably when the sperm fertilizes the egg there is neither pain nor distress!

The following experiment was designed to expand upon the work of Branford Oltenacu & Boylan (1974) by testing the hypothesis that tail length of the progeny is determined by tail length of the parents.

MATERIALS AND METHODS.

Five ram lambs were chosen as sires on the basis of their own adjusted tail length (see below), from the progeny of various crosses of Finnish Landrace and Cheviot sheep. The sires had adjusted tail lengths of 37, 56, 79, 100 and 119% and were Finnish Landrace, 1/4 Cheviot 3/4 Finnish Landrace, 1/2 Cheviot 1/2 Finnish Landrace, 3/4 Cheviot 1/4 Finnish Landrace and Cheviot respectively. A Wiltshire ram lamb was chosen as the sixth sire as it had the largest adjusted tail length of any ram lamb measured during the 1999 lambing season (131%). Each sire was mated to six Finnish Landrace, seven Finnish Landrace x Cheviot ewes and eight Cheviot ewes. The purebred Finn and Cheviot ewes were obtained from outside suppliers and, unfortunately, all had been docked. The Finn x Cheviot ewes were bred on Winchmore research station but adjusted tail length was only available for a few of them.

At docking the lambs were of variable ages and sizes. Previous research has adjusted tail length using birth weight (Branford Oltenacu & Boylan, 1974), total body length (Shelton, 1977), body weight (James *et al.* 1991b; Carter, 1974) or age (Carter, 1974) to correct for differences in skeletal size. In the current experiment, Cheviot and Finnish Landrace sheep were compared and it was determined that these methods would be inappropriate. Lambs of the two parent breeds could be about the same weight and body length, yet the New Zealand Cheviot is short-legged and wide, while the Finnish Landrace are comparatively tall and lean. The length from anus to the tip of the tail was measured to the nearest 10mm along the ventral surface of the tail. This was then divided by the length from the anus to the hock, on a leg straightened and held perpendicular to the spine, and calculated as a percentage. It was possible to make these measurements on lambs at docking and those that had died perinatally.

RESULTS

The mean adjusted tail lengths expressed as a percentage for the 18 combinations of progeny are shown in Figure 1. The progeny of Finnish Landrace ewes had smaller adjusted tail length than the progeny of Finnish Landrace x Cheviot ewes, and both had smaller adjusted tail length than the progeny of Cheviot ewes. There was an increase in the adjusted tail length of the progeny with increasing adjusted tail length of the sire. Indeed, adjusted tail length was best explained by additive effects for adjusted tail length of the sire ($P<0.001$) and dam breed ($P<0.001$). There was a small but significant interaction between the two main effects ($P<0.01$), the differences between mean adjusted tail length of the progeny becoming larger as adjusted tail length of the sire and dam increased.

Figure 2 shows the unadjusted tail length of the lambs in millimetres, excluding those sired by the Wiltshire and pooled on the basis of content of Finnish Landrace genes in the progeny. Although a quadratic model ($r^2 = 0.991$) ($P < 0.001$) described the relationship slightly better than a linear model ($r^2 = 0.988$) ($P < 0.001$), the increasing proportion of Finnish Landrace leads to increases in multiple births and consequent decrease in size of the lambs. Adjusted tail length is therefore a suitable transformation for analysis, unlike some percentages and ratios (Scobie & Saville, 2000). The unadjusted tail length of Wiltshire x Cheviot lambs was 251 mm, whereas that of the Wiltshire x Finnish Landrace was 152 mm and the Wiltshire x (Finnish Landrace x Cheviot) was an intermediate 214 mm.

DISCUSSION

Reducing tail length of New Zealand sheep should be a straightforward task. In contrast with other selection criteria, it can be measured at an early age and it is possible to use hogget lambing to improve the rate of progress. The genotypes examined by Carter (1974) and James (1991b), led to reductions in fecundity, whereas the Finnish Landrace has quite the opposite effect. The widespread use of Finnish Landrace for fertility has, by chance, put New Zealand in a good position to select for reduced tail length and thereby improve welfare. However, Scobie *et al.* (1999) showed that a short-tail may not be a complete solution, and it will also be desirable to

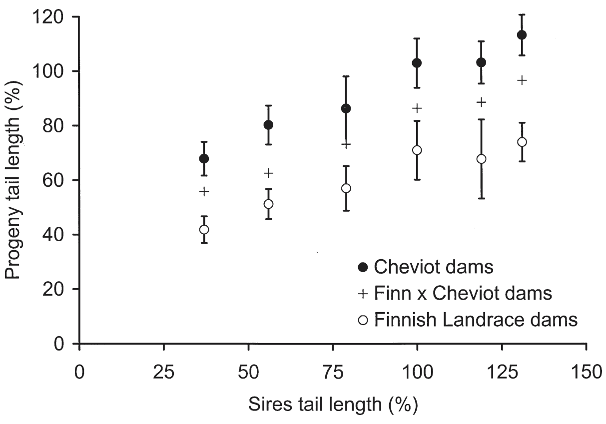

FIGURE 1: Adjusted tail length of the progeny of Cheviot, Finnish Landrace x Cheviot (Finn x Cheviot) and Finnish Landrace dams, plotted against adjusted tail length of the sire. (Error bars indicate standard deviation. Error bars of similar magnitude have been excluded for the Finn x Cheviot dams to improve clarity of the figure.)

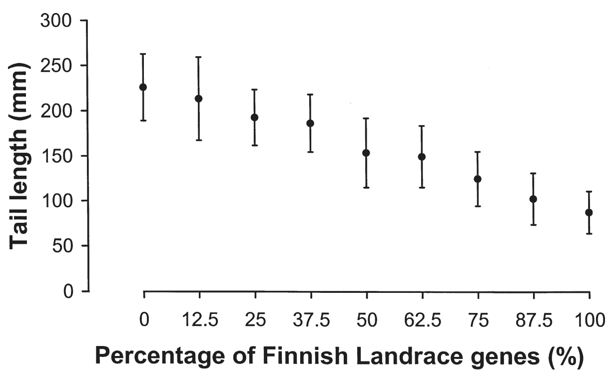

FIGURE 2: Mean tail length of groups of lambs pooled on the basis of their content of Finnish Landrace genes (Error bars indicate standard deviation).

have the tail bare of wool.

Branford Oltenacu & Boylan (1974) estimated the heritability of tail length at 0.77 for Finnish Landrace sheep and 0.50 for more common breeds, while Shelton (1977) gave estimates of 0.387 for Rambouillet and 0.706 for crosses containing some Mouflon. Using the regression (b) of offspring on sire (Falconer, 1967), excluding the progeny of the Wiltshire sire, the estimated heritability of tail length (2xb) was 0.822 (standard error = 0.096) for the various crosses of Finnish Landrace and Cheviot presented here. Although this is greater than the earlier estimates it is based on small numbers of animals.

Four lambs that died at birth, and had similar hock and leg length measurements, were dissected to recover the vertebrae. The vertebrae were not fused into the sacrum, so they were dissected from the last lumbar. There was only one Finnish Landrace, one Cheviot and two first cross lambs. There was, therefore, no indication of the variation possible, but the data suggest fewer vertebrae in Finnish Landrace (16) than the first cross (18, 18), both of which had fewer than the Cheviot (24). This concurs with the report of Shelton (1977) in which there were 14 or 15 vertebrae in the hybrid between the Mouflon (11) and the Rambouillet (19 to 24). Texts show enormous variation between a minimum of 3, up to 24 or more coccygeal vertebrae (Getty, 1975), and the few lambs we dissected seem to fall well within these bounds.

Although the number of coccygeal vertebrae was an academically interesting avenue of investigation, it was abandoned. The number of vertebrae in the neonate will not change with maturity in an un-docked lamb, but it may not reflect the ultimate length of the tail. The length of the skeletal remains that constitute the tail was only about 50mm in the Finnish Landrace, when the total tail was 100mm, while 80mm of bones from the Cheviot came from 140mm of total tail. We are seeking a shorter tail: whether it is a consequence of fewer vertebrae, less cartilage or smaller vertebrae is less important.

One point of concern is that when Finnish Landrace or their crosses are docked at the recommended length (AWAC, 1996), the final length of the tail stump seems to be much shorter than intended. This short stump may contribute to problems with rectal or vaginal prolapse as the animal matures, it can also contribute to more difficult and less effective crutching. There may be differences in the rate of development of different parts of the skeleton, particularly the sacrum in Finnish Landrace sheep compared with thin-tailed breeds New Zealand farmers are familiar with. This may justify further inquiry into skeletal development using x-ray.

Shelton (1977) harks back to the evolution of domesticated sheep with long tails from their presumed ancestors, the Mouflon or similar short-tailed wild sheep. This un-testable hypothesis is also interesting but not constructive. An alternative explanation could be that North America, Australia and New Zealand were colonized by the British and therefore established thin-tailed sheep populations. The subsequent importance of sheep to the economies of these countries has possibly led to an arrogant opinion that the thin-tailed breeds are the pinnacle of selective breeding rather than a product of convergent evolution with other tail types. South Africa, for example, was also colonized and to a certain extent reliant on sheep, but had access to fat-rumped, fat-tailed, thin-tailed and short-tailed breeds for many years and have continued to use them to this day.

Perhaps one of the most astounding claims is that the presence of a long tail will interfere with mating (Shelton, 1977). The tail certainly does not prevent the mating of wild, feral or domesticated sheep, or other species for that matter. The Finnish Landrace and Romanov are aomongst the most fertile breeds in the world (Mason, 1991b) without being docked. The Finnish Landrace was introduced to New Zealand to improve fertility, but New Zealand shepherds are committed to docking them. The authors believe there could be a greater chance of reproductive failure due to vaginal prolapse as a consequence of poor docking techniques (AWAC, 1996).

It is clear that tail length is a strongly inherited trait which is likely to be controlled by several loci that have an additive effect. Given the widespread use of Finnish Landrace in crossbreeding throughout New Zealand it should be relatively simple to implement selection to reduce tail length.

The practice may not be adopted without consumer pressure and price signals within niche markets, since the longer tails of the inter-crosses will require docking in the short term. Also, the short tail may be more hindrance than help if it is not bare of wool, since woolly tails readily accumulate dags and make crutching more difficult (Scobie *et al*., 1999).

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