SKEWING THE SEX RATIO

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FOR THE deer breeder, spring is a humbling season. The females, whether they be Fallow does, Red hinds or Wapiti cows, are usually best left undisturbed to bond with their newborns. The farmer watches from a distance and hopes his females have had daughters.

In an expanding livestock industry like the deer business, females are going to be more valuable than males, unless the farm is producing exceptional sires. Price at auction is just another example of sexual dimorphism – the scientific term for differences between the sexes within a species.

The farmer, hoping for more deer daughters than sons, won't be disappointed – about half the time. Averaging many farms over many years, the sex ratio remains remarkably constant, with a slight tilt toward males (51:49 per cent). With this sex ratio, there is still a 7 per cent chance that a hind will have four sons in four succeeding seasons.

If by bad luck, a farmer has mostly males, he may well ask why, with all the money spent worldwide on reproduction research, scientists haven't discovered a way to manipulate the sex ratio of domestic animals.

On paper, changing the sex of a mammal appears to be simply a matter of substituting X for Y. In practice, animal breeders may be fighting an evolutionary struggle, for as one sex predominated, natural selection would likely favour the other.

There is new hope, however, in recent more detailed studies of deer in the wild. The balanced sex ratio looks more and more like a scientific "fact" which is due for a fall. Some females, under particular conditions, may influence the sex of their offspring.

First, a bit of background is necessary on how the sex of a foetus is determined. All of the deer previously mentioned – Fallow, Red and Wapiti – have 68 chromosomes. Of these, 66 are similar to each other and transmit information on body structure and function. One pair, the sex chromosomes, is very different: XX in females and XY in males.

At cell division in the gametes, the number of chromosomes is halved so that half of the genetic information can come from each parent. Since all females are XX, they produce eggs with one X chromosome, whereas sperm can either have X or Y. If an X sperm does the fertilising, the foetus is female: If a Y sperm pierces the ovum, it is male. Thus, in mammals, the male determines the sex of the offspring.

But does he? A stag, after all, sends a great many sperm, X and Y, into the hind's reproductive tract. Could the hind, perhaps by her physiological state, play some role in which type of sperm does the fertilising? There is not a certain answer yet, but some clues are coming from studies of White-tailed deer in the United States and particularly the Red deer on Rhum in Scotland.

Much closer to the north pole than New Zealand is to the south pole, the Isle of Rhum provides a very harsh environment for deer. The treeless landscape makes it possible to study individual deer and calculate their lifetime reproductive success. (No shelter from the howling wind of the Hebrides tests not only the deer, but the stamina of the scientists). A Cambridge University team has followed the reproductive fate of almost a generation of hinds, and a pattern is emerging.

There is a definite hierarchy among hinds sharing the same home range on Rhum, and a hind's place in that hierarchy affects her reproductive performance. Dominance is determined by one female displacing another, usually by threat, sometimes by physical contact. On Rhum, dominant hinds have significantly more male calves, subordinate hinds more females. So while the sex ratio may tend to balance over the population, there are significant differences between individuals.

This finding, the result of more than a decade of research, makes evolutionary sense. In polygamous animals like deer, there will always be superfluous males. At the rut, a below average male has a much lower chance of breeding successfully than a below average female.

A subordinate hind, if she produces a stag calf, is unlikely to produce one that will be a top harem holder. Therefore, in genetic terms, she is better off having a daughter.

To digress for a moment, this reproductive strategy also helps explain some important differences in the growth of males and females. Males must grow fast if they are to build a frame substantial enough to eventually challenge other males at the rut. They are born larger than females, suck more frequently, but lay down less fat in their first year than females. They take a high risk road, and as a group, pay with a higher first year mortality. (These lessons are not reserved for deer. They explain why ram lambs, left entire, grow faster and are leaner.)

Why then haven't we been able to select for a particular sex in domestic animals? Tim Clutton-Brock, who leads ▷

the Rhum research team, suggests a couple of reasons. Perhaps behind fences, deer and other domesticated animals are too well fed for the dominant and subordinate strategies to emerge. Another possibility is that domestic animals have just lost the knack, though this seems less likely in deer just a few years from the wild.

Across the Atlantic, there is also evidence that new world deer improve the odds for the conception of a particular sex in response to environmental conditions. In this case, deteriorating habitat seems to select for males. Verme and Ozoga, working on White-tailed deer, even suggest how sex determination may occur. Females bred near the end of their oestrus cycle more frequently conceived males, whereas those inseminated early in the cycle produced mainly females.

Louis Verme puts it this way: A doe hardly "decides" what sex to conceive in an anthropomorphic sense. Rather, the sum physiological and optical stimuli are funnelled to responsive endocrine glands whose hormones act on target organs to change the odds that an X or Y sperm will fertilise the shed ovum.

If sex determination is not random, and if it is done primarily at conception rather than by differences in foetal survival, will we ever be able to alter the sex ratio on deer farms? On the experimental farm at Glensaugh in Scotland, they may already have selected for each sex artificially, without knowing how.

In the first seven years of operation, there was a preponderance of males in even numbered years, and females in odd numbered years. There was no obvious reason for this significant trend, but foetal mortality alone could not explain it.

How will we select for daughters? It may be a matter of endocrinology – pinpointing the biological feedback mechanism and convincing a well fed hind that she is a subordinate in poor condition. Recall that we can already convince the hind that the breeding season has arrived when it is still six weeks away for her untreated relatives. Alternatively, we may eventually be able to sort sperm as X or Y and by insemination with one type, give the hind no choice in the sex of her offspring.

The technical difficulties remaining before we can skew the sex ratio are substantial. But one barrier has been overcome, manipulating the sex of offspring no longer seems impossible; instead it now seems within a hind's potential. For animal breeders, seeing that potential tailored to particular deer farms will give new meaning to the rites of spring.

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TURNING ON IMPORTED STAGS

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OVER THE recent past we have had several requests for information regarding the possibility of getting stags imported from the northern hemisphere in November to breed next rut i.e. April in New Zealand. Assuming the stags are over 12 months old it should be possible to stimulate activity by manipulating the light/dark ratios that they are exposed to.

Red deer are short day breeders – they require short day stimulation following a period of long days in order to turn on their reproductive system (see Fennessy and Dratch 'TDF' 24, p.20). Therefore, with a bit of playing with lights, we should be able to convince the stags it is time to go to work.

At the time they are sent to New Zealand, the stags will have had about 20 weeks of short days in the UK (from late June to mid-November) and will be right at the end of the rut.

In New Zealand they will experience a rapid switch to long days as they spend till mid-December in quarantine.

However, day-length starts to decline from the summer solstice (December 21) and this means that there are insufficient long days to reset the stags day-length detecting mechanism. The stag must be exposed to supplementary light until his antlers are cast.

The next step is to switch the stag back to short days to stimulate reproductive development. In order to do this quickly, it is better not to just rely on the natural decrease in day-length at this time. After the start of this short day stimulation it can be expected to take at least two months for the stag to produce good semen.

Probably the simplest way to manipulate day-length is to run stags every night into yards where the lighting can be controlled. The yards will need to be naturally dark, have fairly powerful electric lighting such as strip lights and be well ventilated, especially if a small pen in the yards is to be used.

During late December and January, the stags should be run in every evening and the lights kept on to provide a total of about 16 hours light and 8 hours dark per day (e.g. lights off at 10 p.m. and on at 6 a.m.) until all imported stags have cast their buttons.

After casting, the lighting should be switched to go to about 8 hours light and 16 hours dark (e.g. into the darkened yards at 5 p.m. with lights turned on the next morning at 9 a.m.).

Based on this schedule the stags would be expected to cast their antlers in late December–early January and clean them in early March. They should be ready and willing by early April to mate with your hinds.