DEER : POSSIBILITIES AND EXPERIENCE WITH EXPANDING THE GENE POOL

P.F. FENNESSY

Invermay Agricultural Centre
Private Bag 50034
Mosgiel, New Zealand

SUMMARY

The New Zealand deer farming industry is built mainly on the red deer (*Cervus elaphus*). There are considerable opportunities for hybridisation with other strains of red deer and with Canadian wapiti (CW). Although scientific comparisons are not readily available, the data suggest that hybridisation with CW and other red deer can increase yearling live weights by more than 40%.

INTRODUCTION

The New Zealand deer farming industry started in 1970 following legislation permitting the farming of an animal previously regarded as a pest. By 1982, there were an estimated 180,000 deer on farms and now 10 years later, the numbers have increased around 7-fold. The principal species are red deer and their close relations, the North American wapiti (*Cervus elaphus ssp*), and fallow deer (*Dama dama*) with the latter constituting less than 10%. Large numbers of deer were captured from the wild through the mid- to late-1970's so that by the start of the 1980's, the industry was well established. There was a ready market for live animals built on an increasing demand for velvet antler, an unsatisfied demand for venison, especially in Europe, and a NZ tax regime which encouraged investment in agriculture (Fennessy and Drew 1983).

GENETIC POSSIBILITIES

Although the NZ wild population is based largely on *C.e. scoticus* there is a variety of different groups of red deer, being the descendants of various importations and liberations (Yerex 1991a,b). In the 1970's the potential for genetic improvement within the NZ red (NZR) deer was being explored (eg, Fennessy 1982). There were proponents of the various red deer strains but in the early 1970's, hybridisation between the larger North American wapiti (*C.e. nelsoni*) and the smaller red deer in the Fiordland National Park (Smith 1974) alerted the industry to the possibility of such hybridisation to improve productivity. Hybridisation between different strains or subspecies of red deer has been practised widely in European deer parks. Similarly, hybrids between red deer and the smaller sika (*C. nippon*) have been produced (Harrington 1985) while hybridisation between the Chinese malu (*C.e. xanthopygus*) and meihualu (*C.n. hortulorum*) is practised in China. This capacity for hybridisation between closely related subspecies or even between species offers considerable possibilities for genetic manipulation of the red deer to suit market or production requirements.

In 1984, Moore reported that 166 CW and 37 red deer from English Parks had been imported over the previous 3 years. Since that time large numbers of red deer have been imported from Scandinavia, Europe and the UK along with a few Pere David's deer (*Elaphurus davidianus*; PD), European fallow (*Dama dama*) and Mesopotamian fallow (*D.d. mesopotamica*) deer.

EVALUATION

Wapiti x red hybrid stags captured from Fiordland were first used over red hinds at Invermay in 1977. The progeny of these stags were about 25% heavier than their red deer counterparts at 14 months of age (Moore 1984). While these data were impressive, the real interest lay in the parent species from North America. In 1981, a group of Manitoban wapiti (*C.e. manitobensis*) was imported from Canada's Elk Island National Park to Invermay (Moore and Littlejohn 1989). Private importations from Canada took place around the same time. The worldwide historical fascination with deer resulted in a wealth of literature (eg, Whitehead

1972) which provided the basic information on possible sources of genetic material. For example, Huxley (1931) analysed weight and antler size data from over 500 stags shot in various parts of Europe and showed that there was a strong relationship between these parameters such that antler weight increased at a rate about 1.6 times that of body weight. During the early 1980's numbers of NZ deer farmers visited parks and estates throughout Europe, North America, Scandinavia searching for the genes which would give their herd the commercial advantage. The intensive selection for antler size by selective culling in the European herds and the resultant large multi-pointed antlers attracted considerable attention among NZ farmers. In these European red deer, evaluation was based largely on antler size, usually the weight of cast hard antlers. Other species, such as the Pere David's deer were of interest due to their unusual breeding season (they are long-day breeders while red deer are short-day breeders, Wemmer 1983) coupled with the discovery of a natural Red x Pere David hybrid fertile hind at Woburn in England (H. Tavistock pers. comm.). The Mesopotamian fallow deer were known to be larger than the European fallow (Otway 1986) but as with the Pere Davids any scientific pre-evaluation was non-existent.

PERFORMANCE IN NEW ZEALAND

Some growth data for four imported strains or species and their hybrids with NZR deer are considered here.

Canadian wapiti hybrids

Liveweight data by age for NZR, CW and their hybrids at Invermay are summarised in Table 1. The contrasting patterns of live weight change indicate the very rapid early live weight gain of the hybrids compared with the CW, such that large differences in birth weight had disappeared by weaning. Even at 1.3 years of age, there was little if any difference between the hybrids and the CW. Interestingly, the male hybrids were similar to the CW throughout while the CW females eventually attained a larger mature size. The data can be interpreted as indicating a very substantial hybrid vigour component for the males up to 3 years of age, but in the females, the substantial hybrid vigour apparent at the weaning and yearling stages had virtually disappeared by 3 years of age. In terms of velvet antler weight, the hybrid outperforms the CW purebred at both 2 and 3 years of age (Fennessy and Pearse 1990).

These data and the estimates of considerable apparent hybrid vigour raise interesting questions about the performance of the purebred CW in the NZ environment. Canadian data for the CW would suggest that the Invermay animals are performing poorly compared with the same subspecies in Canada. For example, the average weights of yearling *C. e. manitobensis* on a Canadian farm have been estimated (based on a small sample) at 218 kg for males and 185 kg for females, weights more than 40% higher than comparable values for CW in NZ at the same age (A.J. Pearse and R. Clark, unpubl. data). While direct comparisons with the NZ data are inappropriate, these data do question whether CW performance in NZ is suboptimal. In this respect, Fennessy and Pearse (1990) proposed that the poorer performance of the CW could be due, at least in part, to health problems including copper deficiency and internal parasitism. More recent evidence (Waldrup and Mackintosh, in press) provides strong support for this.

Table 1. Typical live weights (kg) by age for New Zealand red deer (NZR, *Cervus elaphus scoticus*), Canadian wapiti (CW, *C.e. manitobensis*) and the CWxNZR hybrid at Invermay (Fennessy and Pearse 1990)

	Males			Females		
Age	NZR	CWxNZR	CW	NZR	CWxNZR	CW
Birth	9.6	14.1	18.1	8.8	13.3	17.2
3 m	48	74	73	43	71	70
1.3 y	110	155	155	85	129	140
2.2 y	150	210	210	96	158	180
3.2 y	188	264	265	105	167	215

Further evidence of the poor performance of the CW in the NZ environment is provided by a comparison of the live weights by age for CW compared with NZR, ¼ and ½ CW (Table 2). The CW males were very similar to ½ CW males at the yearling stage although they were 10 kg heavier at weaning, perhaps an advantage due to the larger CW dam (in contrast the others were from NZR dams). However, the CW females retained their 10 kg weaning advantage, but if the CW influence was additive, both sexes should have been around 20 kg heavier than their ½ CW counterparts at the yearling stage. The ¼ CW were about mid- way between the parental strains (progeny of ½ CW males x NZR females) being about 20% heavier than the NZR at the yearling stage.

Table 2. Comparative weaning and yearling (1.2 y) live weights (± SD) for young NZR deer and their ¼ , ½ and CW hybrids (P.F. Fennessy and A.J. Whaanga, unpublished data)

	NZR	¼ CW	½ CW	¾ CW
Male				
Weaning	49.9 ± 6.1	56.7 ± 7.0	70.7 ± 5.4	81.9 ± 8.9
Yearling	106.3 ± 9.5	123.9 ± 14.7	149.9 ± 8.3	151.2 ± 12.6
n	15	19	14	12
Female				
Weaning	42.9 ± 3.0	51.2 ± 5.5	62.7 ± 7.7	73.3 ± 6.2
Yearling	87.9 ± 5.9	107.3 ± 12.2	128.8 ± 10.3	139.8 ± 9.7
n	15	20	19	10

European red deer hybrids

The Hungarian red deer, selections of which have been imported over the last few years, are of mixed background including a significant infusion of the large Carpathian strain of red deer (Harbord 1988). Although performance data are limited, Table 3 presents weaning and yearling weight data for groups of Hungarian (embryo transfer to NZR hinds), NZR and the F1 hybrid (ex NZR hinds) at Mt Hutt Station in the South Island of NZ. There is no evidence of hybrid vigour in the live weight data with the F1 being slightly below the mid-parent mean. Unfortunately comparable data for the males are not available. However the data support the contention that the Hungarian red deer are substantially larger than the NZR, the difference being nearly 40% at the yearling stage.

Table 3. Comparative weaning and yearling (1.2 y ± SD) live weights for young female deer of NZR, Hungarian (Hng) and Hng x NZR strains (data from N.S. Beatson and K. Hood, pers comm)

	NZR	Hng x NZR	Hng x Hng
Weaning	48.7 ± 5.7	52.7 ± 7.2	59.0 ± 7.1
Yearling	71.7 ± 5.6	83.2 ± 5.8	99.5 ± 6.1
n	72	76	26

There have been a number of imports of German red deer, and a sample of ¼ German/ NZR are compared with NZR deer in Table 4. A feature of these data is the change in relative live weights of the hybrids and the NZR between weaning (25% heavier) and the yearling (10% heavier) stages. The yearling data would suggest that this strain of German red deer (Schulte Wrede) are about 40% larger than the NZR assuming no hybrid vigour, similar to the Hungarian strain in Table 3.

Table 4. Comparative weaning and yearling (1.1 y) live weights (± SD) for groups of young NZR and ¼ German/ NZR hybrids (the hybrids are progeny of only one sire; data from N.S. Beatson, pers comm)

	Males		Females	
	NZR	¼ German/¾ NZR	NZR	¼ German/¾ NZR
Weaning	46.0 ± 7.5	57.7 ± 9.4	39.3 ± 7.6	48.5 ± 9.9
Yearling	101.0 ± 10.9	109.6 ± 9.1	82.0 ± 8.56	92.2 ± 11.0
n	20	18	28	12

Pere David hybrids

The Pere David x red deer hybrid is a remarkable example of a very wide interspecies hybrid where both sexes are fertile. As an indication of the genetic distance between the two species, fixed differences were found for 19 of 45 blood proteins (ie, protein polymorphisms, Tate *et al.* 1992), a difference similar to that between the hybridising mouse species, *Mus spretus* and *Mus musculus* where only the female is fertile.

The use of a Pere David x NZR stag as a sire over NZR hinds has been investigated at Invermay (Fennessy *et al.* 1991). Comparative weights for NZR and ¼ PD hybrids are presented in Table 5. The hybrids were around 16% and 26% heavier than NZR at the weaning and yearling stages respectively. The hybrids grew at a rate 45% faster than the contemporary NZR over the spring-summer period. Unfortunately there are very few PDxNZR F1 hybrids or pure PD around. The live weight data available would suggest that both are only 5% to 10% heavier than the ¼ PD hybrids at the yearling stage.

Table 5. Comparative weaning and yearling (1.3 y) live weights (± SD) for groups of young NZR deer and (Pere David x NZR) x NZR hybrids (¼ PD) (P.F. Fennessy and A.J. Whaanga, unpublished data)

	Males		Females	
	NZR	¼ PD	NZR	¼ PD
Weaning	43.9 ± 3.0	50.4 ± 4.3	41.8 ± 1.5	49.5 ± 3.9
Yearling	107.6 ± 7.5	133.2 ± 7.7	86.8 ± 3.5	111.1 ± 5.7
n	10	5	6	10

Comparative live weights

A summary of the yearling live weights of the various strains discussed in this paper relative to the NZR deer is presented in Table 6. The data provide an indication of the relative sizes and the sexual dimorphism of the various strains available to the NZ deer farmer. However for valid comparisons, it is important that a number of sires and randomly selected NZR deer dams are used with the progeny given equal opportunity. This is the case for the Invermay studies (eg, Tables 2 and 5) but the commercial data must be treated with caution. The possibility of interactions between the various strains having an impact on the validity of the comparison is also important. For example the CW comparison (Table 2) had to be abandoned early in the rut (1.4 y), when the NZR red deer became very aggressive and dominant over the CW hybrids.

Table 6. Yearling live weights of the various strains compared with NZR (100) and the ratio of male to female yearling live weight within each strain (sexual dimorphism)

	Male	Female	Average	Sexual dimorphism
NZR	100	100	100	123
¼ German/¾ NZR	108	112	110	119
Hungarian x NZR	*	118	118	*
¼ CW/¾ NZR	117	122	120	115
¼ PD/¾ NZR	124	128	126	120
Hungarian x Hungarian	*	139	139	*
CW x NZR	141	147	144	121
¾ CW/¼ NZR	142	159	151	108

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