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Reproductive senescence in aged red deer hinds

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ABSTRACT

This study reports on the performance of some of the original animals used to establish the Invermay deer farm. These comprised a selection of some of the original 1973 animals, 21 hinds of unknown age and 19 of the first hind calves born at Invermay in that year.

Reproductive performance, expressed as the percentage of hinds weaning calves, decreased slowly from 90% at 6 and 7 years of age, to 50% at 17 years, then dropped markedly with only one calf being successfully reared in each season when the hinds were 19 and 20 years. Similarly, few (5/21) of the older unknown-age hinds raised calves when > 17 years old. When blood sampled twice-weekly during the breeding season (rising 21 years of age), only 6/12 of the known-age hinds had significant plasma progesterone concentrations, with only 3 animals displaying anything like normal cyclical patterns. In addition, most had elevated plasma LH concentrations. Post mortem examination revealed that all these hinds had small reproductive tracts and very few ovarian follicles at this age.

Despite an ability to live beyond 20 years, these results suggest that waning reproductive performance with age may be due to ovarian failure.

Keywords: red deer; hind; age; ovary; reproduction.

INTRODUCTION

The farming of deer in New Zealand has had a short but colourful history since approval was granted in 1971 (see Caughley, 1983; Drew, 1976, 1994). The Invermay deer research programme began in 1973 when 90 red hinds were "borrowed" from Herbie Taylor and Sons of West Dome Station near Mossburn. During the following decades, which have seen the development of a significant agricultural industry based on 1.4 million farmed animals (Fennessy *et al.*, 1993), some of these original animals and their calves were kept in order to assess longevity and lifetime reproductive performance. The present study describes the performance of these animals.

MATERIALS AND METHODS

Animals and management

The animals were comprised of (1) a group of 21 hinds of unknown age (at least 2 years of age in 1973), originally from West Dome Station; and (2) the first calves born on Invermay in the summer of 1973-74, some of which were progeny of the former group. Until 1984 the hinds were included regularly in experiments which may have affected reproductive performance. Experimental procedures included the induction of early seasonal breeding and the generation of wapiti x red hybrids, similar to those described by Moore and Cowie (1986) and Moore and Littlejohn (1989). From 1984, these hinds were farmed together under normal management except that they were generally kept separate from younger animals and were preferentially fed (ready availability of high quality pasture or supplementary feed). The unknown-age hinds were eventually culled in March 1991 (• rising 20 years old) and the known-age hinds in June 1994 (rising 21 years old).

Measurements

Data on live weight (autumn) and reproductive success (calves weaned) were collated annually, and any animals that died were subjected to post-mortem investigation. In addition, the surviving known-age hinds were blood-sampled twice-weekly (18 March to 22 April) by jugular venepuncture in their last breeding season (1994, rising 21 years of age) to monitor plasma progesterone (Jopson *et al.*, 1990) and LH (Meikle and Fisher, 1996) concentrations. For practical reasons, the hinds were run in isolation from stags during this period.

Following culling (slaughter in a commercial deer slaughter premise) the ovaries of both groups of hinds were recovered and either processed histologically (haematoxylin and eosin stain) for examination by light microscope (unknown-age hinds), or weighed and dissected in order to count the follicles > 2mm in diameter (known-age hinds).

All data are expressed as means \pm s.e.m. Preliminary reports of some of this data have been presented elsewhere (Fisher *et al.*, 1991, 1996; Walton, 1995).

RESULTS

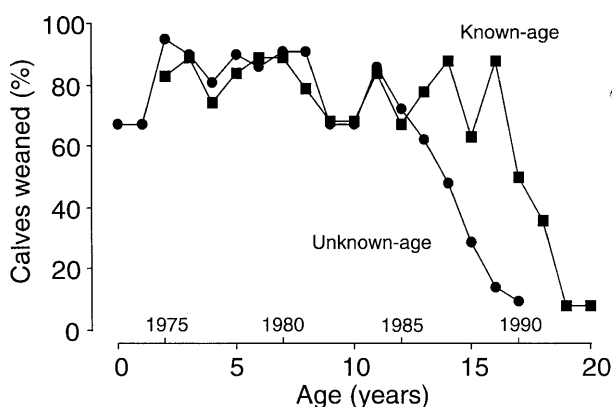
Initially (1973), the hinds were recalcitrant, frequently smashing into fences in panic when approached and were difficult to yard. However, within 6 months, both animals and staff had begun to adapt to deer farming. Eventually, compared with other Invermay-born hinds, they were noticeably very quiet to handle and they raised calves of similar temperament.

Most hinds generally maintained good live weights throughout most of their lifetime. The known-age hinds weighed 6.3 ± 0.3 kg at birth (compared with our current 8-9 kg average birth weight), reached mature live weights at about 3-4 years of age and were heaviest in later years

(mean 109 ± 3.4 kg at 20.3 years of age). The unknown-age hinds had an overall average liveweight of 102.8 (range 79 - 130) kg, varying little over the years except in most of the eleven individuals who lost condition prior to culling or death.

Mortality (died or euthanased) since 1984 amongst the unknown-age hinds was due to misadventure (2 hinds aged •13 and 16 years), a prolapsed uterus (1 hind aged •15 years) unknown causes (3 hinds aged •19 years), and poor condition (8 hinds aged •15, 16, 17 (2) and 19 (4) years) with 7/21 surviving to •20 years of age. Of the known-age hinds, mortality was due to misadventure (1 hind aged 12 years), malignant catarrhal fever (2 hinds aged 14 and 15 years), unknown causes (1 hind aged 19 years) and poor condition (2 hinds aged 18 years and 1 aged 21 years), with 12/19 surviving to 21 years of age.

FIGURE 1 Reproductive success of unknown- and known-age hinds expressed as the percentage of calves weaned as a proportion of those which went to the stag. N.B. Data for 1976 is an estimate since a number of calves were removed for hand-rearing as part of a separate experiment (Fennessy *et al.*, 1981).



Calving success, presented as the percentage of calves weaned, is summarised in Figure 1. In the known-age hinds it gradually decreased from 90% at 6-7 years of age through to 50% at 17 years and then dropped markedly, with only one calf being reared in each of the last 2 years. This pattern was similar, although occurred several years earlier in the unknown-age hinds. Analysis of the plasma progesterone profiles taken from the known-age hinds during the start of the 1994 breeding season indicated that only 6/12 hinds had any significant ovarian activity, with only 3 of these displaying what could be considered as a normal cyclic pattern. In addition, during this period most hinds had elevated (0.66 ± 0.09 ng/ml plasma) plasma LH concentrations (approximately twice the magnitude of those noted in younger animals). Examination of the ovaries of these hinds after slaughter (June 1994, rising 21 years of age) revealed them to be very small (0.89 ± 0.11g) and contain very few (0.89 ± 0.35) antral follicles >2 mm in diameter. Similarly, the ovaries of the unknown-age hinds examined by light microscopy after slaughter (March 1991) had very few primordial or antral follicles.

DISCUSSION

Red deer hinds in the wild, at least in Scotland, can live until about 18-20 years of age (Clutton-Brock *et al.*, 1982) although there are reports of older animals (see Blaxter, 1979; Baxter Brown, 1995). The present study suggests that similar, if not greater, life-spans can be expected of farmed deer. The unknown-age animals were at least 20 years of age when slaughtered, whilst the known-age hinds were rising 21-year old when slaughtered. The latter group in particular, were in good body condition at the time of slaughter, so a maximum lifespan in excess of 21 years could be expected. Although obviously conjectural in the absence of any definitive estimate regarding the unknown-age hinds, they could be considered to have been on average 5 years old in 1973. This is based on Caughley's (1971) data, indicating the average age of a hind in the wild in Fiordland. Thus the average year of birth of the unknown-age hinds would be 1968, and their average age in 1985 would have been 17 years. After this time their reproductive success declined as was also noted in the known-age hinds at about that age. Although these results are based on relatively few animals and represent a single cohort, they suggest red hinds can remain breeding productively until around 16 years of age. Furthermore, they are consistent with the extended lifespans of other farmed species (Table 1) with a suggested post-reproductive phase of greater than 25% of lifespan (vom Saal and Finch, 1988). During the latter years, a proportion of hinds in poor condition died or were culled, perhaps indicative of senility (post-mortem examination frequently revealed no obvious cause of their poor condition). Since most hinds had severely worn incisors for many years (for example, in 1987 15/16 of the unknown-age hinds and 12/18 of the known-age, 14 year old hinds had one or more incisors worn below the level of the lower dental pad), there would appear to be no clear association between toothwear and performance (Orr and Moore, 1989).

However, although able to survive beyond 20 years of age, like other farm animals (Table 1), fertility declined with age, dramatically so after 17 years. This observation concurs with data from Scotland (Wright, 1993) suggesting that red deer will perform efficiently for 15 or 16 years and thereafter should be culled. The scarcity of primordial and antral ovarian follicles in hinds in the present study

TABLE 1. Maximum recorded lifespan and the decline in fertility of some female animals (from vom Saal and Finch (1988) and the present study). N.B. The data have been collated from separate studies, thus the criteria for determining the age of decline in reproductive rate may differ between species.

Species	Maximum reported lifespan (years)	Onset of decline in reproductive rate (years)	Last offspring (years)
Rat & Mouse	>4	0.7	2
Horse	>45	20	42
Cattle	30	6	27
Sheep	>20	7	20
Red deer	>21	16	>20
Human	110	35	58

suggests the reason for waning reproductive performance may be due to ovarian failure. Around 20 - 30 such follicles are normally evident in the ovaries of adult hinds during both the breeding and non-breeding seasons (McLeod *et al.*, 1996). This would explain the lack of significant progesterone concentrations indicative of ovarian activity during the breeding season in the known-age hinds. Furthermore, the elevated plasma LH concentrations noted in these animals were of the same magnitude as that seen in ovariectomized hinds (Meikle and Fisher, 1996). Collectively, these results indicate that reproductive failure may have been due to exhaustion of ovarian oocytes and that the old hinds in the present study may have been postmenopausal-like in their later years.

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