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Genetic effects on first antler growth in relation to live-weight of red deer farmed in New Zealand

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ABSTRACT

Deer farmed in New Zealand for venison production are a composite of *Cervus elaphus* subspecies. Venison production systems target supply of yearling males for slaughter at live-weights of $\geq$95 kg between 8 and 12 months of age when first antler development is occurring. If the antlers exceed 110 mm they must be removed before the animal can be transported for slaughter which adds handling and costs which some producers consider unnecessary. We hypothesised that there are associations between live-weight and first antler development that are heritable and it would be possible to select sires on the basis of delayed antler development relative to live-weight of their progeny. Antler and live-weight measurements were recorded on 1033 male progeny from three elite recorded red deer breeding herds, DNA pedigree tested as sired by 106 different stags. Spline models were fitted to the antler length and live-weight data over time. Day-of-the-year was read off these splines to define traits of live-weight when antler length reached 50 mm (WA50) or 80 mm (WA80), and antler length when live-weight reached 95 kg (AW95). The predicted traits were analysed using a single-trait animal model incorporating the extended pedigree of the animals involved to calculate three estimated breeding values (EBVs) WA50, WA80 and AW95. The three antler traits had high heritability estimates of 0.67–0.81 with standard errors of 0.10, and were moderately-highly correlated with weaning and yearling live-weight traits. The phenotypic standard deviation of WA80 of 8.35 kg or 8.6% of the mean predicted live-weight and a genetic standard deviation or 6.86 kg indicated good variation within the population, providing scope for genetically improving the current New Zealand breeding herd for delayed antler growth relative to live-weight. Such selection could reduce the number of rising yearling males requiring velvet antler removal prior to slaughter.

1. Introduction

Venison production accounts for about 90% of revenue generated by the New Zealand deer farming industry, which is based on the pastoral farming of European red deer (*Cervus elaphus* spp. *scoticus hippelaphus, pannonensis*) and crossbreds with North American Wapiti (*C. elaphus* spp. *nelsoni, roosevelti, manitobensis*) Asher et al. (2011). The drive for improved productivity has seen farmed New Zealand deer become global composites due to frequent introductions of new genetic material which has produced a blurring of taxonomic boundaries (Nugent et al., 2001).

Over the last 30 years the production system has developed to focus on the supply of venison from rising-one-year-old (R1) males to traditional seasonal European game markets. Slaughter in the August–November (8–12 months of age)

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period enables chilled venison to be shipped to Europe to meet its seasonal demand. Premium prices are typically paid to producers over this period for 50–65 kg carcasses, with the average carcass weight being 54 kg (Pearse and Fung, 2007). At the 57% dressing-out percentage described by Asher et al. (2011), R1 red deer stags need to attain 95 kg live-weight to achieve this carcass weight.

During their first year of life, red deer stags develop their first antlers, which, in velvet phase must be removed prior to transport if they exceed 110 mm length, measured from the top of the skull between the pedicles under the Deer QA Transport Quality Assurance Programme, a New Zealand code of welfare. Most R1 stags therefore require velvet antler removal on-farm prior to transport for slaughter. In New Zealand it is legal for veterinarians and stag owners or their staff who are certified annually by the National Velvetting Standards Board (NVSB) programme to remove velvet antler in accordance with The Animal Welfare Act 1999 and drug administration regulations contained with the Agricultural Compounds and Veterinary Medicines Act 1997. However, some venison-producing farmers consider this removal of the R1 velvet antler problematic within their farming system, as it involves increased animal handling, and potential for stress and injury to stock immediately prior to slaughter. There are also certain markets for New Zealand venison that do not accept venison from animals which have undergone velvet antler removal. There is a desire by some venison producers to, as far as practicable, minimise velvet antler removal from their venison production systems.

Antlers are a secondary sexual characteristic that develop from structures on the frontal bone called pedicles. Pedicles develop in the first year of life, around 4–8 months of age, under the influence of testosterone and, once mature, support the subsequent growth of first antlers (Suttie and Kay, 1983). Pedicle initiation tends to occur at a “threshold body weight irrespective of age or season”, which Fennessy and Suttie (1985) considered as between 41 and 54 kg, dependent on plane of nutrition. Subsequent antler growth from the tip of the pedicles occurs quite rapidly between 6 and 12 months of age for red deer, depending on live-weight and genotype, with antler hardening occurring at puberty at 13–15 months of age (Suttie and Kay, 1983). Unlike horned ungulates there are no published accounts of genetically polled male deer.

In unpublished data from a previous study investigating growth and carcass yield in R1 stags, Asher et al. (2011) observed that some individual red deer and around half of the wapiti-crossbred stags attained target slaughter weights prior to development of any significant antler tissue, and that such individuals did not require antler removal before transport for slaughter. The current study investigated the possibility of selecting individuals within the genotypes of red deer farmed in New Zealand that exhibited delayed or restricted first antler growth relative to body mass.

It was hypothesised that:

1. There is an association between live-weight and first antler development in R1 red stags.
2. The variation which cannot be accounted for by the live-weight variable alone reflects heritable genetic (sire) effects on the timing of first antler development and growth.

If these hypotheses are valid it would be possible to genetically select red deer sires for venison production systems on the basis of delayed antler development relative to attainment of acceptable slaughter live-weights in their male progeny.

2. Methods and materials

The study was undertaken over three years (2008–2010) across three farms. The three farms were elite nucleus red deer breeding units for a large New Zealand farming enterprise. All manipulations were approved by the Invermay Animal Ethics Committee (application numbers: 11,430, 11,796 and 12,158).

2.1. Study design

Measurements were taken to detect pedicle emergence and measure antler growth through to full hardening and stripping, and live-weights were recorded at various intervals throughout this period. Animal numbers were chosen to minimise the standard error (se) of a designated heritability (h^2) estimate of 0.3 for pedicle or antler phenotypes recorded. This was based on the Kruuk et al. (2002) estimate of the heritability of antler mass $h^2=0.33 \pm 0.12$. This required 89 half sibling families, with 10 male offspring per sire.

2.2. Animals and management

The R1 male red deer in the study ($N=1033$) were of varying European subspecies composites, but generally with $>50\%$ Eastern European (*C. elaphus* spp. *hippelaphus, pannonensis*) parentage. They were born from 2007 to 2009 to elite recorded hinds on three different sire stag breeding farms in New Zealand: Farm 1 ($n=446$) in Southland, (45°28′36.43″S, 167°42′46.12″E), Farm 2 ($n=463$) in the central North Island, (38°50′39.82″S, 176°27′45.32″E), and Farm 3 ($n=124$) on the South Island's West Coast, (42°48′58.69″S, 171° 3′38.85″E). Data were collected from Farms 1 and 2 from 2008 to 2010 inclusive, and on Farm 3 in 2010 only. Individual animals were identified by visual ear tags (Year 1) and electronic (EID) ear tags (Years 2 and 3). The breeding programmes on each farm had a history of selection for growth and meat yield rather than velvet or trophy antler, and were supervised by a geneticist. The stags were not destined for slaughter and were retained in the herd through until two years of age for sale as breeding sires.

Recorded progeny were conceived from either natural mating (NM) or artificial insemination (AI). Common AI sires between farms and years provided links between data sets. DNA pedigree testing was used to determine correct parentage (Tate et al., 1998) and all herds recorded their animals' pedigrees, live-weights and reproductive measurements on DEERSelect, the New Zealand deer industry genetic recording database (Archer et al., 2005). Birth day (of the year) was assigned using a gestation length of 234 days (Kelly and Moore, 1977) for each individual, based on