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The influence of red deer genotype on conception pattern: Eastern vs Western subspecies.

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ABSTRACT

Advancing the calving pattern of red deer from November/December to October/November would better align the nutritional demands of lactation to pasture quality and availability. This study investigated the hypothesis that red deer of 'Eastern' (E) genotype (*Cervus elaphus hippelaphus*) have advanced reproductive seasonality traits compared to those of 'Western' (W) genotype (*C. e. scoticus*). Hinds of E (135) or F1 (E x W; 165) genotype were single sire mated to one of 6 E stags, while W (506) hinds were single sire mated to one of 11 W stags. Reproductive seasonality traits measured were stag roaring and body condition score (BCS), and conception date as estimated by fetal aging. Peak roaring frequency occurred earlier in E than W stags (mean March total roars observed 144 vs. 68 for E and W stags respectively; SED 33.4; P<0.05), and they also had a slightly lower BCS throughout the observation period. Mean conception date of the E hinds (16 March) was 13 days earlier than that of both the F1 and W hinds (29 March; SED E vs. F1 3.0 days; P<0.001). We conclude that red deer of E genotype have advanced reproductive seasonality traits compared to those of W genotype.

Keywords: red deer; subspecies; genotype; reproductive seasonality; conception

INTRODUCTION

There has been much discussion within the NZ deer industry over several years about the desirability of advancing mean calving date as a tool to increase production by better aligning peak lactation with improved pasture quality and availability. To this end, some farmers have managed to shift from a November/December to an October/November calving pattern. There are probably a number of ways in which this has been achieved, including better feeding of hinds (Beatson *et al.*, 2000), earlier weaning (Pollard *et al.*, 2000) and earlier stag joining (Moore and Cowie, 1986). However, we also need to consider a potential role for genetics, particularly the option of introducing new genotypes into the national herd.

Red deer are the mainstay of the NZ deer farming industry, which was largely built up from wild captured stock and imports from British herds, with the predominant subspecies being *Cervus elaphus scoticus*. By contrast, many recent importations have been from Eastern Europe (e.g. Hungary and Romania) and are likely to be almost wholly of the *C. e. hippelaphus* subspecies. Essentially, these genotypes represent different subspecies of red deer that are part of the West-East 'cline' (gradual genetic change) from the smaller bodied Scottish red deer (*C. e. scoticus*), through to the larger Eastern European red deer (*C. e. hippelaphus)* (Whitehead, 1993). Irrespective of the finer detail of subspecies make-up, 'Western' and 'Eastern' red deer genotypes (for want of a better name) do demonstrate significant physical and behavioural differences.

The objectives of this study were: to compare the roaring pattern and body condition score (BCS) during the rut of 'Eastern' (*C. e. hippelaphus*) stags with those of 'Western' stags of English descent (predominantly *C. e. scoticus*); and to compare conception dates of 'Eastern' and F1 ('Eastern' x 'Western') hinds joined with 'Eastern' stags with those of 'Western' hinds joined with 'Western' stags. We tested the hypotheses that pure 'Eastern' stags commence the rut earlier, and hence lose body condition earlier, than 'Western' stags; and 'Eastern' hinds conceive earlier than 'Western' hinds, with F1 hinds being intermediate between the two parental genotypes.

MATERIALS AND METHODS

Animals and treatments

This study was conducted on a commercial deer farm at Palmerston, Otago and approved by the AgResearch Invermay Animal Ethics Committee (Project 10487).

The hinds were weaned in the first week of March before joining with stags. Single sire mating groups were established as follows: 7 March - three purebred 'Eastern' (E) stags joined with 135 purebred 'Eastern' (E) hinds and eleven purebred 'Western' (W) stags joined with 506 purebred

'Western' (W) hinds; 14 March - three E stags joined with 165 F1 'Eastern' x 'Western' (F1) hinds. Because this study was carried out on a commercial farm we were unable to balance stag:hind ratios between individual stags, with the ratio varying between 1:12 and 1:69.

Roaring counts (the number of times a stag vocalised) were conducted for each stag for a period of five minutes in the morning and afternoon every Monday, Wednesday and Friday from 14 March until 27 April. Observations began within half an hour of sunrise and ended within half an hour before sunset and the same route was followed for each observation period so that animals would become used to a set routine. Body condition score (BCS: 1 - 5) of stags was also assessed in the field each day by a single observer (J.E.L.) with the aid of binoculars.

Hinds were scanned ultrasonically in mid-May, two-three weeks after stag removal, to establish pregnancy status and estimate conception date from fetal age. Hinds in which pregnancy could not be confirmed were scanned ultrasonically again mid-June.

Ultrasonography

A single operator (I.C.S.) using a 5 MHz linear array transducer (Aloka SSD 500; Aloka Co. Ltd., Japan) performed all the rectal ultrasonographic diagnoses for pregnancy assessment and fetal aging. During ultrasonography, hinds were restrained individually in an upright position in a pneumatic crush. A liberal coating of carboxymethylcellulose lubricant was applied to the transducer, which was then inserted carefully into the rectum until an echo-image of the bladder was observed. The transducer was gently rotated 90^{o} clockwise and 180^{o} counter-clockwise while being moved forward until the uterus was located. Pregnancy was confirmed by identification of the chorionic vesicle, fetus or placentomes, and fetal age was estimated by the size of one or all of these identifying structures according to the method of Revol & Wilson, (1991).

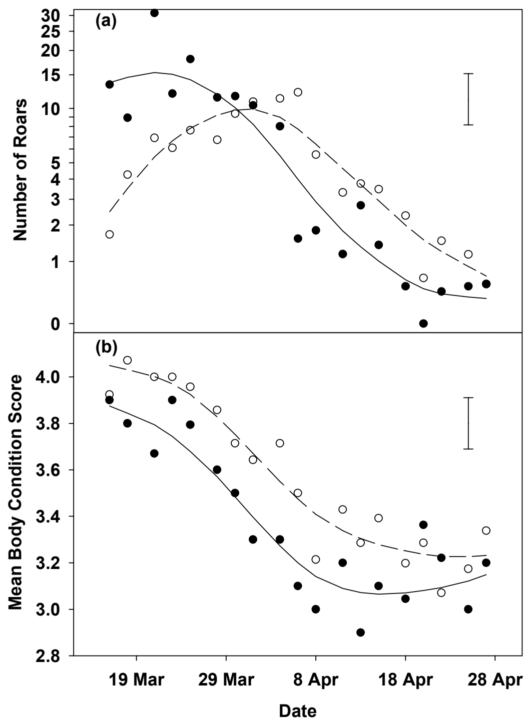
Statistical analyses

The number of roars observed per day was log(1+x)-transformed to stabilise the variance. Along with body condition score (BCS), it was then analysed using residual maximum likelihood (REML), with stag as the random effect, genotype splines (smoothed curves) over day (Verbyla *et al.*, 1999), and genotype, day and their interactions as the fixed effects. Conception date data were analysed using REML, with stag as the random effect and hind genotype as the fixed effect. A further analysis included the number of hinds in each mating group as a fixed effect.

RESULTS

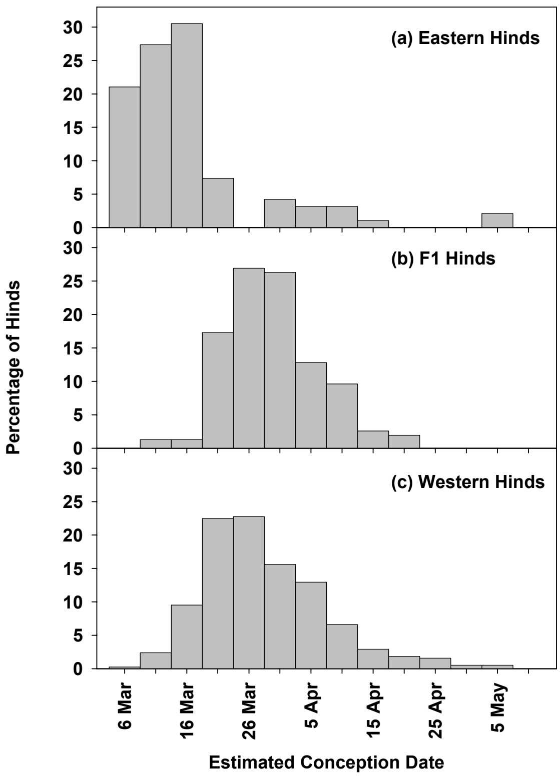
At the start of observations on 14 March the E stags were in full rutting voice, with the mean number of roars per observation day peaking around 19 March; thereafter roaring frequency declined rapidly such that they were virtually silent by mid-April (Figure 1a). By contrast, the W stags were relatively quiet at the start of observations and did not reach their peak roaring frequency until the beginning of April when, as with E stags, roaring activity declined rapidly (Figure 1a). The mean number of observed roars per stag totalled for the period 14 - 31 March was 144 for E stags and 68 for W stags (SED 33.4; P<0.05), while in April the respective means were 49 and 93 (SED 28.2; n.s.) observed roars. BCS for stags of both genotypes decreased over the observation period. Although BCS was lower for E than for W stags throughout the observation period and increased over the last two weeks of April (Figure 1b), there was no significant evidence that BCS or its slope or spline over time differed with genotype.

FIGURE 1: Scatter plots of mean and fitted smoothing spline of (a) number of roars per observation day and (b) body condition score of E (filled circles; solid line) and W (open circles; dashed line) stags during the observation period (March-April). The data has been log(1+x)-transformed to stabilise the variance.



The mean conception date for E hinds (16 March) was 13 days earlier than for the F1 hinds and W hinds (both 29 March; SED E vs F1 3.0 days; P<0.001) (Figure 2). There was no evidence (P>0.05) that conception date changed as the stag:hind ratio increased. Also, 80% of E hinds had conceived by 15 March, compared with 3% of F1 hinds and 12% of W hinds.

FIGURE 2: Density histograms of the estimated conception date to the percentage of (a) E (b) F1 and (c) W hinds conceiving in five-day periods.



DISCUSSION

These data clearly show marked reproductive seasonality differences in both the hind and stag between 'Eastern' and 'Western' genotypes under the same environmental conditions. This is evident from the significantly higher roaring frequency of E stags in March, and the two-week difference between E and W hinds in mean conception date. Indeed, the early breeding characteristics of the E genotype may have been under-expressed due to being constrained to a 7 March joining date. We make this supposition because of two observations: firstly, the E stags were already close to their peak roaring frequency by the time observations began; and secondly, the conception profile of the E hinds indicates that nearly a quarter of the hinds were mated immediately the stags were introduced. This strongly suggests that some hinds may have initiated oestrus/ovulation before joining, and therefore would not be mated until a return to oestrus 18-19 days later. The F1 and W hinds had typical conception date profiles expected for hinds that had not initiated ovulatory activity before stag introduction (Scott *et al.,* 2005).

Body condition score of both the E and W stags decreased as the roar progressed, indicative of the increased physical activity and decreased appetite of a rutting stag (Lincoln, 1971). Although not significantly different, the BCS pattern of E stags is further evidence that E stags began and ended the rut earlier than W stags; their BCS was lower throughout the observation period, but began to increase from the second week of April, which coincides with the time that they virtually stopped roaring. However, assessing BCS from a distance is a limiting factor in the accuracy of our BCS data.

Previous studies (e.g. Fisher and Fennessey, 1990) have shown that seasonally advanced stags will induce hinds to cycle earlier than control stags. It is unlikely that the more intense roaring of E stags at the start of the present study induced an earlier mean conception date of pure E hinds; the F1 hinds were also joined with E stags, and their mean conception date was the same as W hinds (about two weeks later than E hinds). Also, the W hinds would have been able to hear the earlier roaring of the E stags and McComb (1987) has shown that auditory processes alone are sufficient to advance conception date in red deer hinds. Although the F1 hinds were joined with stags a week later than E hinds, their pattern of conception dates does not indicate that hinds were already cycling before the stag was introduced. Also, although the stag: hind ratio varied between mating groups, there was no evidence of stag:hind ratio having an effect on conception date. Therefore, we conclude that the limiting factor to early mating/conception was differential seasonality traits of the hinds and that expression of oestrous initiation was not altered by the early roaring of stags.

Interestingly, the F1 hinds had the same mean conception date as the W hinds, despite being 50% 'Eastern' genotype and run with E stags. This suggests that maybe only one or few genes control the seasonality traits studied and that these may be recessive for the 'Eastern' phenotype. If this is the case, then we would expect that the next generational cross (F2) obtained by mating F1 X F1 would produce individual hinds that expressed either early or late seasonal oestrus phenotypes. While this remains speculative, it opens up a huge array of opportunities to identify genes that may be responsible for early calving and to fix them into populations of red deer by selective breeding.

This study was carried out on a commercial farm and it was not practical to ultrasonically scan all of the hinds on two occasions to get a better estimate of fetal age, which is most accurate when the pregnancy is between 40 - 50 days. A single scanning date was set to coincide with the expected time that most hinds would be at that stage of pregnancy, as was indeed the case with W hinds. However, many of the E hinds in particular had a pregnancy of 70 days or more, sometimes making it difficult to visualise the fetus. In such instances, the less accurate method of estimating fetal age from placentome size was used. The conception profiles suggested that some of the hinds conceived in the five-day period before stags were joined with the hinds. This is clearly not the case and may reflect the inaccuracy of using placentome size to estimate fetal age. Alternatively, although we have no supportive data, it is possible that E fetuses grow more quickly, in which case fetal age would be overestimated.

Our data clearly demonstrate that *C. e. hippelaphus* hinds joined with *C. e. hippelaphus* stags conceive earlier than *C. e. scoticus* hinds joined with *C. e. scoticus* stags, but have yet to demonstrate that this leads to an earlier calving date. It is known that the larger wapiti subspecies (e.g. *C. e nelsoni*) has a longer gestation period than *C. e. scoticus* (Haigh, 2001) and this may also be the case for *C. e. hippelaphus*, thus cancelling out some of the benefit of an early conception date. However, anecdotal evidence from farmers using artificial insemination in their breeding programme suggests that there is no difference in gestation length between the two genotypes used in this study.

CONCLUSION

Our data support the anecdotal evidence that introduction of pure 'Eastern' genetics into the deer herd will promote advancement of the mean calving date. However, it appears that this will not be expressed in F1 hinds, and further research is required to elucidate if reproductive seasonality is controlled by a single gene system.

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