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AGE AT PUBERTY, DAYS TO CALVING AND FIRST PARITY RETURN TO OESTRUS IN AUSTRALIAN TEMPERATE BEEF BREEDS

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SUMMARY

571 females from six beef breeds (Angus, Brahman, Charolais, Hereford, Shorthorn and Wagyu) from the first cohort of the Southern MultiBreed project were recorded for fertility traits at different physiological stages up until their second mating. Traits included age at puberty, days to calving and days to return to oestrus following first calving. Sire least-square means for these traits were used to examine relationships between traits. There was a strong positive relationship between age at puberty and days to calving, indicating that sires whose progeny reached puberty at a later age also conceived and calved later. There was a weaker positive relationship between age at puberty and return to oestrus indicating that sires whose progeny reached puberty at a later age also took longer to return to oestrus after the birth of their first calf. A weak negative relationship between days to calving and return to oestrus indicates that sires whose progeny calved later in the calving season exhibited a quicker return to oestrus. The nature of the relationship between these two traits was unexpected given previous studies, and further analyses once data from other years/cohorts is available will be required to gain confidence in the nature of the relationships between these three traits.

INTRODUCTION

Research in Australian northern beef cattle breeds has shown that fertility traits measured with a high degree of precision (such as serial ovarian scanning to detect age at puberty) are heritable, favourably genetically correlated with lifetime reproductive outcomes, and may be suitable to achieve genetic improvement in fertility (Johnston *et al.* 2009). Studies in temperate beef breeds have found moderate heritabilities (0.38-0.42) for age at puberty (Wolcott *et al.* 2019; 2021), highlighting the potential of these traits for improved fertility outcomes in the southern beef industry. While studies in tropically-adapted breeds have indicated that early-life fertility traits have a strong genetic relationship with later fertility traits (Johnston *et al.* 2014), these relationships have not yet been quantified in temperate breeds. This current study aimed to characterise fertility traits at various physiological stages in young beef females from several temperate beef breeds and gain an understanding of the relationships between these different fertility traits.

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MATERIALS AND METHODS

The Southern MultiBreed (SMB) project is being conducted across New South Wales Department of Primary Industries research facilities; Trangie Agricultural Research Centre, Trangie; Grafton Primary Industries Institute, Grafton; Tocal Agricultural Centre, Tocal; Glen Innes Agricultural Research and Advisory Station, Glen Innes; and Elizabeth MacArthur Agricultural Institute (EMAI). Animals from the six different breeds (Angus, Brahman, Charolais, Hereford, Shorthorn and Wagyu) are managed in mixed breed groups at all stages of the production cycle except for joining, which is undertaken in breed groups. See Walmsley *et al.* (2021; 2023) for further details on the SMB project.

Female progeny born in 2020 at the research sites were recorded for fertility traits from weaning through to post-calving in the first parity. Age at puberty (AP) was detected by serial ultrasound ovarian scanning to identify the animal's first *corpus luteum* (CL) (Johnston *et al.* 2009). Scanning commenced within the first month after weaning (approximately nine months of age) and was conducted at 4-5 week intervals. The decision to cease pubertal ovarian scanning was made on a within-breed basis at each site, and occurred once 100% (or extremely close to 100%) of heifers had reached puberty, such that there was little value in collecting additional records. Animals not observed as having reached puberty by the end of ovarian scanning that were pregnant were given an age of puberty value equal to their date of conception, calculated using foetal age at pregnancy test. Animals not observed as having reached puberty by the end of ovarian scanning that failed to fall pregnant were given a penalty value equal to the largest AP trait value within their site breed group + 21 days. Females were joined by natural mating at approximately 15 months of age for 60 days and commenced calving at approximately two years of age. Days to calving (DC) was calculated as the number of days from the start of the joining period until the date of calving. Animals that failed to calve were given a penalty value equal to the largest DC record within their contemporary group + 21 days. Return to oestrus interval (RO) was detected by serial ultrasound ovarian scanning to identify the animal's first *corpus luteum* post-calving. Only females that calved and were lactating were scanned to identify the first return to oestrus. Scanning commenced approximately 45 days after the first calf was born, and ceased once the percentage of females that had cycled post-calving within a breed was at 100% or extremely close to 100%, such that there was little value in collecting additional records. Animals not observed as having cycled post-calving by the end of ovarian scanning were given a penalty value equal to the largest RO trait value within their site breed group + 21 days (if not pregnant) or a trait value equal to their date of conception, calculated using foetal age at pregnancy test .

Statistical analyses. PROC MIXED in SAS (SAS Institute, Cary, NC, USA) was used to obtain least-square mean estimates for the effect of sire. The model fitted for AP included site, contemporary group and sire; for DC the model included site, joining group and sire; and the model for RO included site, joining group, sex of calf and sire.

RESULTS

Table 1 contains a statistical summary of the raw fertility phenotypes pooled across sites and breeds. There were 571 age at puberty (AP) records including 20 females whose first CL was not observed prior to the cessation of ovarian scanning, and received a penalty AP value. There was significant variation for age at puberty, with the first detected CL ranging from approximately 7 months to approximately 27 months with an average of 12 months of age. Results from the pubertal ovarian scanning showed that 72% of heifers were pubertal at joining, though this varied between sites and breeds. There were 542 days to calving records including 105 females that failed to calve and received a penalty DC value. DC ranged from 273 to 386 days, with an average of 316 days. There were 416 return to oestrus records, including 30 females whose first CL post-calving was not observed prior to the cessation of ovarian scanning, and received a penalty RO

value. RO was only recorded on lactating females and ranged from approximately 1 month to 6 months with an average of approximately 3 months post-calving.

Table 1: Summary statistics of the raw unadjusted age at puberty (AP), days to calving (DC) and return to oestrus interval (RO) phenotypes across sites and breeds

Trait	Number	Mean	SD	Minimum	Maximum
AP (days)	571	355.4	81.2	207	816
DC (days)	542	316.1	34.3	273	386
RO (days)	416	98.3	25.3	23	180

Table 2 contains summary statistics by breed for the number of trait records, the number of sires represented in the data set, and the average number of progeny for these sires. There were 158 sires with progeny recorded for AP, with the average number of recorded progeny per sire ranging from 2.6 to 4.0. The number of sires with progeny recorded for DC was 151. The number of sires with progeny recorded for RO was 140 (average number of progeny ranged from 2.6-3.4), which was lower than AP and DC as only progeny that were lactating (i.e. successfully raised a calf) were recorded for this trait.

Table 2: Number of records, number of sires, average number of progeny (standard error) per sire by breed for age at puberty, days to calving and return to oestrus interval

	Age at puberty			Days to calving			Return to oestrus Interval		
Breed	No. records	No. sires	Av No. progeny	No. records	No. sires	Av No. progeny	No. records	No. sires	Av No. progeny
Angus	205	51	4.0 (3.5)	203	50	4.0 (3.5)	157	46	3.4 (2.8)
Brahman	13	5	2.6 (2.1)	13	5	2.6 (2.1)	1	1	-
Charolais	56	16	3.5 (1.8)	55	16	3.4 (1.7)	43	16	2.7 (1.5)
Hereford	133	38	3.5 (2.2)	111	34	3.3 (1.8)	82	31	2.6 (1.6)
Shorthorn	79	20	4.0 (1.9)	77	19	4.1 (1.8)	56	19	2.9 (1.4)
Wagyu	85	28	3.0 (2.0)	83	27	3.1 (2.1)	77	27	2.8 (1.7)

The relationships between the three fertility traits were examined by plotting the sire least-square means. There was a strong positive relationship between AP and DC (Figure 1a), indicating that, in general, sires whose progeny reached puberty at a later age also conceived later and hence calved later in the calving season. This result concords with previous studies which have reported strong genetic correlations (~0.80) between these traits (Johnston *et al.* 2014). However, there was variation observed, with some sires having progeny that reached puberty earlier than average but calved later (and hence conceived later) than average. There was a weaker positive relationship between AP and RO (Figure 1b), indicating that, in general, sires whose progeny reached puberty at a later age also took longer to return to oestrus after the birth of their first calf. Johnston *et al.* (2014) reported moderate to strong genetic correlations (0.31 to 0.72) between these traits. There was a weak negative relationship between DC and RO (Figure 1c), indicating that, in general, sires whose progeny calved later in the calving season exhibited a quicker return to oestrus. The nature of the relationship between these two traits is different to previous studies (Johnston *et al.* 2014) in tropically-adapted cattle, which reported a strong positive genetic correlation (0.75) between DC and lactation anoestrus interval. In this study, sires had relatively low numbers of progeny as only the first year/cohort of females born within the project were included. It is anticipated that future analyses including data from other years/cohorts will allow for greater confidence in the nature of the relationships between these three traits.

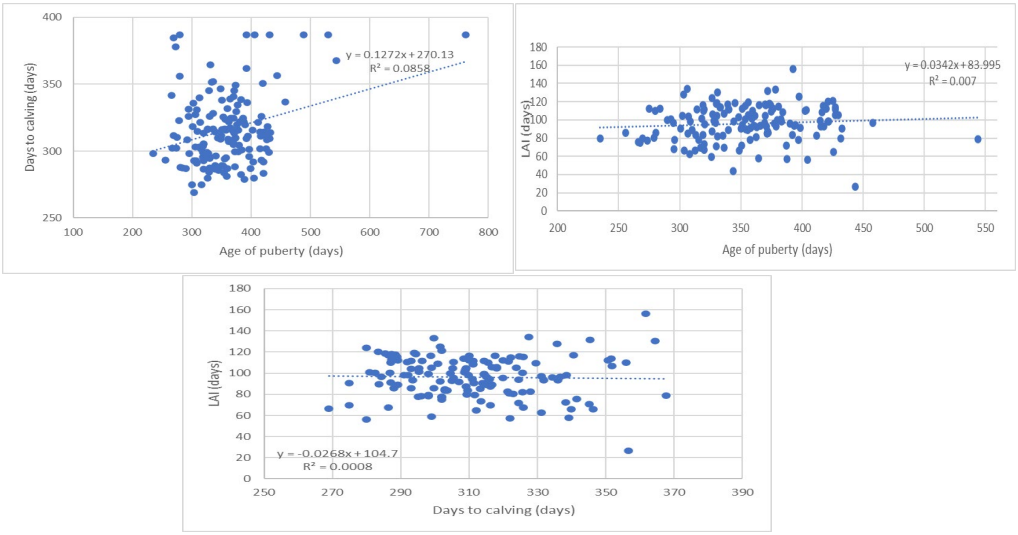

Figure 1: Plot of (1a) age at puberty and days to calving least-square sire means; (1b) age at puberty and return to oestrus interval least-square sire means; (1c) days to calving and return to oestrus interval least-square sire means

CONCLUSIONS

This study reports an initial investigation of female fertility traits in several temperate beef breeds that have been managed in mixed-breed groups. Results showed that phenotypic variation exists in age at puberty, days to calving and return to oestrus interval for these breeds. The next steps will investigate whether genetic variation is also present for these traits once sufficient records are available. Plots of least-square sire means indicated a positive relationship between age at puberty and days to calving and a weaker positive relationship between age at puberty and return to oestrus. A weak negative relationship was found between days to calving and return to oestrus interval, which was contrary to previous studies. Further analyses will be undertaken once more data is available to quantify these relationships with greater confidence.

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