ONSET OF PUBERTY IN ANGUS, FRIESIAN, FRIESIAN × ANGUS, AND FRIESIAN × JERSEY HEIFERS

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SUMMARY

In an investigation of some factors which may have affected the attainment of puberty in 61 Friesian (F × F), 40 Angus (A × A), 60 Friesian × Angus (F × A), and 56 Friesian × (Friesian × Jersey) (F × (F × J)) heifers in three seasons, it was found that breed of sire and year affected both weight and age at puberty. Age and weight at puberty were strongly related. Breed of dam influenced weight at puberty, but just failed to reach significance for age at puberty. Age of dam and sire within year within breed did not influence either weight or age at puberty.

Heifers of Friesian breeding were younger and heavier at puberty than those of Angus breeding, while those from Friesian × Jersey dams were lighter, but not older at puberty than those from Angus dams.

Regression equations were fitted for age and weight at puberty on a number of independent variables which measured development from birth to puberty. Although it was concluded that the attainment of puberty was not consistently influenced by any of the variables studied, pre-weaning traits appeared to have more influence than post-weaning variables.

INTRODUCTION

The mating of beef heifers to calve at two years of age has been shown to be feasible under New Zealand pastoral conditions (Carter and Cox, 1973; Pleasants, 1974), provided management is adequate. The early attainment of puberty is correlated ($r = -0.33$) with breeding efficiency (Hawk *et al.*, 1954; Dickerson, 1970), and early calving can result in higher lifetime production (Lesmeister *et al.*, 1973).

Nevertheless, little work has been done to define those critical points during early development which influence the fertility of replacement beef heifers (see review of Pleasants and Barton, 1975). The need to allocate resources within an integrated farming unit demands that information on the effect of the environment on the attainment of puberty should be available to the farmer. The identification and influence of critical factors during early growth and the degree of management flexibility possible

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are obviously essential pieces of information for efficient herd management.

This paper explores some of the factors affecting puberty in heifers of two breeds and two crosses.

MATERIALS AND METHODS

Data from 61 Friesian (F × F), 40 Angus (A × A), 60 Friesian × Angus (F × A), and 56 Friesian × (Friesian × Jersey) (F × (F × J)) heifers that had been reared together at the Whatawhata Hill Country Research Station over the three seasons 1969-70, 1970-71, and 1971-72 were available for this study. The same Friesian bulls were used as sires to produce F × F, F × A, and F × (F × J) heifers, except in 1969 and 1970 when first-cross Friesian × Jersey cows in-calf to straightbred Friesians were purchased. Dams varied in age from 2 to 10 years, except the Friesian × Jerseys which were 2 to 4 years old when purchased. All calves were identified and weighed within 48 h of birth, and single-suckled to weaning in February when they were about 4½ months old.

The heifers were grazed together from weaning until the commencement of mating to entire bulls at about 15 months of age. Two vasectomized bulls fitted with chin-ball mating harnesses (Lang *et al.*, 1968) were grazed with the heifers from weaning, and matings recorded every 7 days, but classified into time periods of 14-day intervals when the colour of the marker ink was changed. Fresh marker bulls were introduced at intervals. Monthly liveweights were recorded, and feeding and management followed normal hill country practice.

The measurements of age and weight at puberty for the 160 heifers by known sires were fitted to the model:

$$Y_{ijklmn} = \mu + a_i + b_j + c_k + d_l + S_{mkj} + b(x_{ijklm} - \bar{x}) + e_{ijklmn}$$

where:

μ is a general mean
a_i is the effect of the ith breed of dam
b_j is the effect of the jth breed of sire
c_k is the effect of the kth year
d_l is the effect of the lth age of dam
S_{mkj} is the effect of the mth sire within the kth year within the jth breed of sire
b is the regression of age on weight or weight on age according to the dependent variable being analysed.
e_{ijklmn} is the error term.

Regression equations were fitted within each herd and year using the model:

$$\text{Puberty age/weight} = a + b_1 \text{ (birth wt)} + b_2 \text{ (weaning wt)} + b_3 \text{ (pre-weaning growth)} + b_4 \text{ (Period 1)} + b_5 \text{ (Period 2)} + b_6 \text{ (Period 3)} + b_7 \text{ (Period 4)} + b_8 \text{ (Period 5)} + b_9 \text{ (Period 6)} + b_{10} \text{ (birth date)} + \text{error},$$

where Periods 1 to 6 refer to the monthly post-weaning weight gains.

Because of insufficient numbers of observations in some herd-years, not all data could be analysed.

RESULTS AND DISCUSSION

Actual mean ages and weights at puberty within breeds and years are given in Table 1.

TABLE 1: MEANS AND STANDARD DEVIATIONS (S.D.)

Season	*Breed or Cross*	*No. of Animals*	*Age at Puberty Mean (days)*	*S.D.*	*Weight at Puberty Mean (kg)*	*S.D.*
1969-70	F × F	15	331	77.2	213	50.0
	F × (F × J)	16	313	84.7	206	34.4
	F × A	12	416	84.9	222	40.6
	A × A	14	404	77.3	216	28.3
1970-71	F × F	26	374	87.6	224	33.0
	F × (F × J)	23	347	91.4	220	32.4
	F × A	23	386	63.9	219	28.8
	A × A	5	414	92.3	196	42.4
1971-72	F × F	20	258	58.8	228	31.8
	F × (F × J)	17	267	52.6	213	28.6
	F × A	25	316	64.9	223	40.2
	A × A	21	304	80.4	192	45.4

Note: F × F = Friesian; F × (F × J) = Friesian × (Friesian × Jersey); F × A = Friesian × Angus; A × A = Angus.

There were highly significant ($P < 0.001$) effects on age at puberty owing to breed of sire, year of birth, and the regression on liveweight. Breed of dam failed to reach significance ($0.10 > P > 0.05$), but there was no effect due to dam age or sire within year within breed.

Similarly, weight at puberty was affected ($P < 0.001$) by breed of sire, year of birth, and the regression on age. Breed of dam also

affected weight at puberty ($P < 0.10$), but no effects were found for either dam age or sires within year and breed.

The least squares means for age and weight at puberty are shown in Table 2. Heifers born to Friesian dams were, on the average, 348 days old at puberty and 20 days younger than those born to Angus or Friesian × Jersey dams. Heifers born to Friesian dams weighed 218 kg at puberty and were 13 and 25 kg heavier than those born to Angus and Friesian × Jersey dams, respectively.

TABLE 2: LEAST SQUARE MEANS FOR AGE AND WEIGHT AT PUBERTY

Effect	*Age*		*Weight*	
	Mean (days)	*S.E. (days)*	*Mean (kg)*	*S.E. (kg)*
Breed of dam:				
Friesian	348.2[a]	± 6.2	217.7[a]	± 3.1
Angus	367.8[b]	± 9.7	205.5[ab]	± 4.8
Friesian × Jersey	368.0[b]	±11.7	193.1[b]	±13.0
Breed of sire:				
Friesian	328.3[a]	± 5.5	223.3[a]	± 2.8
Angus	394.4[b]	± 5.9	194.1[b]	± 6.6
Year of birth:				
1969	376.9[a]	± 7.6	203.6[a]	± 3.7
1970	411.0[b]	± 8.7	189.1[ab]	± 4.5
1971	296.2[c]	± 6.8	231.9[b]	± 7.6
Regression of age on weight	0.285	±0.05		
Regression of weight on age			0.350	± 0.07

Note: Differently superscripted values are different from each other at the 1% level of significance.

Daughters of Friesian sires also reached sexual maturity 66 days earlier and weighed 28 kg more than those of Angus sires. This effect could result from the higher growth rate of Friesian offspring.

There were clear differences ($P < 0.001$) in weight at puberty between years, and particularly for age at puberty. For example, heifers born in 1971 reached puberty 115 days earlier than those born in 1970, and also weighed 43 kg more. This indicates the presence of marked environmental effects.

An attempt was made to identify how these environment effects could act on the onset of puberty by calculating the regression equations for age and weight at puberty on a number of variables

measured during growth. The independent variables—namely, birth weight, weaning weight, weight gain from birth to weaning, and monthly post-weaning gains—were used as well as birth date. Equations were fitted within each herd-year. Only one equation, that for age at puberty for the F × F herd in 1971-72, reached significance ($P < 0.05$). The remaining equations accounted for approximately 30 to 60% of the variance in age at puberty and between 40 and 80% of the variance in weight at puberty measured by the coefficient of determination. It was therefore concluded that the regression coefficients did not satisfactorily predict either the weight or age at puberty.

A similar technique was used by Arije and Wiltbank (1974) when they regressed age and weight at puberty on birth weight, weaning weight, post-weaning gain, and the square of post-weaning gain. In that study they accounted for 35 to 67% of the variation in age at puberty, and for 23 to 55% of the variation for weight at puberty in various breeds and crosses.

Although there was a general lack of significance for the regression equations, significant partial regression coefficients for birth and weaning weight, pre-weaning growth and birth date were found in the present study. The standard partial regression coefficients are commonly used to indicate the relative importance of each independent variable in controlling variation in the trait being analysed, although the presence of correlations between the independent variates implies that they are not entirely satisfactory for this purpose (Snedecor and Cochran, 1969). Nevertheless, the inconsistency of the effects of these variables on the age and weight at puberty could indicate the presence of additional factors to age and weight on the attainment of puberty as noted by Wiltbank *et al.* (1966) and Wiltbank *et al.* (1969), Short and Bellows (1971) and Ellis (1974). The measurement of physiological age appears of importance to the definition of these other underlying factors affecting puberty.

Significant pre-weaning growth effects on puberty were found even though age of dam effects were absent. It is possible that acute checks to growth, particularly before weaning, may be more important to the attainment of puberty than the absolute level of feed intake as measured by growth or weight. Hawk *et al.* (1954) have demonstrated, for example, that calfhood scours can delay puberty by 40 days in Friesian heifers. The present data therefore, indicate the presence of a pre-weaning environmental effect, but it has not been possible to identify the specific pathway involved in a manner useful to the cattleman.

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