*Proc. Assoc. Advmt. Anim. Breed. Genet. 22:457-460*

# PREPUTIAL EVERSION IN YOUNG, TROPICALLY ADAPTED BULLS IS A USEFUL GENETIC INDICATOR TRAIT FOR IMPROVING FEMALE REPRODUCTION

**M.L. Wolcott and D.J. Johnston**

Animal Genetics and Breeding Unit*, University of New England, Armidale, NSW 2351, Australia

## SUMMARY

Beef CRC research showed that a measure of preputial eversion (PEV: an estimate of the length of preputial mucosa (mm) exposed while a bull stands freely) in tropically adapted bulls at 18 months of age was heritable, and had significant genetic associations with female reproduction performance. The current study examined the sensitivity of genetic parameters for PEV to age by expanding the analysis to include measures at 12 and 24 months. For Brahman bulls, the incidence of non-zero PEV increased with age, from 45 to 59 to 71% at 12, 18 and 24 months respectively. For Tropical Composite bulls, the incidence of PEV was lower and less influenced by age (27 – 31%). Heritabilities for PEV at 12 and 24 months were comparable to those previously reported at 18 months ($h^2$ = 0.23 to 0.34). These results confirm that if breeders of tropically adapted beef cattle wished to apply selection to improve PEV, this could be undertaken successfully. Genetic correlations of PEV with female age at puberty, lactation anoestrous and lifetime annual weaning rate showed that if PEV were to be exploited as a genetic indicator for female reproductive performance, measures at 18 and 24 months would be more useful than those collected at 12 months of age. Compared to female reproduction traits, preputial eversion is easy to measure and this study suggests it would be a useful trait to add to the genetic evaluation for tropical breeds.

## INTRODUCTION

Research reported by Corbet *et al.* (2013) showed that a trait scoring the 'length (in mm) of exposed preputial mucosa' in 18 month old bulls (PEV18) was heritable in both Brahman (BRAH) and Tropical Composite (TCOMP) ($h^2$ = 0.30 and 0.23 respectively). Johnston *et al*. (2014*b*) showed that lower PEV18 displayed significant genetic relationships with lower age at puberty, and higher lifetime annual weaning rates in BRAH ($r_g$ = 0.33 and -0.71 respectively). In TCOMP, lower PEV18 was genetically associated with lower lactation anoestrus interval, and higher lifetime annual weaning rates ($r_g$ = 0.52 and -0.88). As part of that research preputial eversion at 12 (PEV12) and 24 (PEV24) months of age were also measured. Given the clear potential of PEV18 as an indirect genetic indicator of female reproductive performance, this study aimed to examine the genetics of preputial eversion at 12 and 24 months in BRAH and TCOMP bulls, to estimate the genetic relationships between repeated measures of the trait, and to determine their genetic relationships with key female reproduction traits.

## MATERIALS AND METHODS

**Bull management and trait definition.** The bulls evaluated for this study were from the Beef CRC Northern Breeding Project, and comprised the Brahmans (BRAH) and Tropical Composites (TCOMP) described by Burns *et al*. (2013). That publication also provided a thorough description of the experimental design and animal management. Briefly, bulls bred on 5 co-operating properties in northern Australia from 2004 - 2010 (n = 2742) were transported to Brigalow Research Station (170km southwest of Rockhampton) at weaning for evaluation of male reproductive traits. A smaller cohort were born and raised at the Belmont Research station (n = 1321) and remained there for the duration of the evaluation period (to 24 months of age).

* AGBU is a joint venture of NSW Department of Primary Industries and the University of New England

Burns *et al*. (2013), defined preputial eversion as 'an estimate of the length (mm) of preputial mucosa everted while the bull stands freely', and the trait was scored at 12, 18 and 24 months of age (PEV12, PEV18 and PEV24). For each genotype and age, the proportion of bulls with a non-zero PEV result was calculated to describe the change in the expression of the trait with age.

**Female management and reproduction traits.** Breeding and management of heifers up to their first annual mating was described by Barwick *et al*. (2009), and Johnston *et al*. (2009) described ultrasound scanning of females to identify age at first corpus luteum (CL), which defined age at puberty (AP). Females were first mated at an average age of 25 months, to calve as 3 year olds. At the start of the second annual mating period, ultrasound scanning to identify the presence of a CL commenced for lactating cows to detect the onset of cycling and allow the calculation of lactation anoestrous interval (LAI: the days from the start of the second annual mating period to the identification of a CL by ultrasound scanning) (Johnston *et al*. 2014*a*). Cows remained in the project until the weaning of calves from their sixth annual mating unless they failed to successfully wean a calf in consecutive years. For all females, lifetime annual weaning rate (LAWR) was calculated as the total number of calves weaned from the first, and up to the sixth mating, divided by the number of annual matings to which the animals were exposed (Johnston *et al*. 2014*a*).

**Fixed effect modelling and genetic parameter estimation.** Fixed effect models for PEV12 and PEV24 were built as described by Corbet *et al*. (2013) for PEV18. Initial modelling for preputial eversion traits tested the fixed effects of year (2004–10), birth location (six herds), birth month (Sept. to Jan.), post-weaning location (Brigalow or Belmont), dam age (3–9 years), dam previous lactation status (wet or dry), dam management group and all first order interactions. In TCOMP, sire and dam group were fitted to account for the average additive differences between the composite groups and any heterotic effects among combinations of sire and dam groups. Modelling was carried out using the PROC MIXED in SAS (SAS Institute Inc., Cary, NC, USA), with sire fitted as random. Final models were determined by sequentially dropping non-significant terms ($P > 0.05$). Following the methods described by Corbet *et al*. (2013), variance components for PEV12 and PEV24 were estimated in ASReml (Gilmour *et al*. 2009), with animal fitted as random and relationships between animals described using a three generation pedigree. Genetic correlations between preputial eversion traits at different ages, and with female reproduction traits were estimated in bivariate analyses using ASReml. When estimating genetic correlations between male and female traits, the data was edited to remove bull records of dam-offspring pairs where the bull was the resultant progeny of the female trait analysed (Johnston *et al*. 2014*b*).

## RESULTS AND DISCUSSION

**Preputial eversion data and variance components.** Table 1 presents summary statistics, variance components and heritabilities for PEV12 and PEV24 in BRAH and TCOMP bulls, with the already published results for PEV18 (Corbet *et al*. 2013). Results showed that preputial eversion in BRAH tended to increase with measurement age, while the trait was relatively constant from 12 to 24 months in TCOMP. Despite this, in both genotypes, additive genetic variance represented a reasonably constant proportion of the phenotypic, with heritabilities ranging from 0.23 to 0.34. These results support the conclusion of Corbet *et al*. (2013) that preputial eversion could be improved by selection, and suggest that measurements collected in bulls at 24 months of age would be as effective a basis for selection as those collected earlier in life. Evaluating the trait at 24 months would be useful in BRAH, as the incidence of non-zero results increased from 45 to 59 to 71 percent at 12, 18 and 24 months. For TCOMP, the proportion of non-zero preputial eversion scores showed less variation with age (30, 27 and 31% at 12, 18 or 24 months), suggesting that age at measurement would be less important for bulls of this genotype.

**Table 1. Number of observations (N), mean, and standard deviation (s.d.), additive ($\sigma^2_a$) and phenotypic ($\sigma^2_p$) variance, heritabilities ($h^2$), and its standard error (s.e.) for preputial eversion (mm) in Brahman and Tropical Composite bulls at 12 (PEV12), 18 (PEV18) and 24 (PEV24) months of age.**

| Genotype | Trait (mm) | N | Mean | s.d. | $\sigma^2_a$ | $\sigma^2_p$ | $h^2$ | s.e. |
|---|---|---|---|---|---|---|---|---|
| Brahman | PEV12 | 1357 | 11 | 21 | 69 | 240 | 0.29 | 0.08 |
| | PEV18* | 1438 | 18 | 16 | 126 | 419 | 0.30 | 0.08 |
| | PEV24 | 1430 | 26 | 25 | 182 | 627 | 0.29 | 0.07 |
| Tropical Composite | PEV12 | 1939 | 11 | 22 | 128 | 480 | 0.27 | 0.07 |
| | PEV18* | 2104 | 10 | 21 | 100 | 429 | 0.23 | 0.06 |
| | PEV24 | 2081 | 12 | 25 | 211 | 623 | 0.34 | 0.06 |

* Results previously reported by Corbet *et al*. (2013).

**Genetic correlations between preputial eversion measured at 12, 18 and 24 months of age.** Table 2 shows that genetic correlations between preputial eversion measured at 12, 18 and 24 months of age in BRAH and TCOMP bulls were consistently high ($r_g > 0.8$). The weakest genetic relationship was between preputial eversion at 12 and 24 months in BRAH ($r_g = 0.82$) which is likely to reflect the changing incidence of non-zero results for the trait with age, and provides additional support for the trait being evaluated later for bulls of that genotype. As Brahman bulls tend to be marketed as 2 year olds, the opportunity will be there to evaluate preputial eversion in large contemporary groups, at 18 – 24 months of age, and prior to bull sales and their first mating.

**Table 2. Genetic correlations ($r_g$), and their standard errors (s.e.) between preputial eversion measured at 12, 18 and 24 months of age in Brahman and Tropical Composite bulls.**

| Preputial eversion (mm) | | Brahman | | Tropical Composite | |
|---|---|---|---|---|---|
| Trait 1 | Trait 2 | $r_g$ | s.e. | $r_g$ | s.e. |
| PEV12 | PEV18 | 0.96 | 0.07 | 0.98 | 0.03 |
| PEV12 | PEV24 | 0.82 | 0.11 | 0.98 | 0.03 |
| PEV18 | PEV24 | 0.95 | 0.07 | 0.92 | 0.04 |

**Genetic relationships of preputial eversion measured at 12, 18 and 24 months of age with key female reproduction traits.** Table 3 presents the genetic correlations of preputial eversion measured at 12, 18 and 24 months in BRAH and TCOMP bulls, with key female reproduction traits. These suggest that lower preputial eversion was genetically associated with lower age at puberty and higher lifetime annual weaning rates for bulls of both genotypes. These results are consistent with those reported by Johnston *et al*. (2014*b*) for PEV18, (also presented in Table 3). For BRAH, genetic correlations of PEV12 with female traits were of lower magnitude than those at 18 and 24 months, suggesting that if the trait were to be exploited as a genetic indicator of female reproduction, measurements at 18 to 24 months would be more effective. Genetic relationships of preputial eversion with LAI were strongest at 18 months for TCOMP and at 24 months for BRAH ($r_g$ = 0.52 and 0.44 respectively). For both genotypes, measurements of preputial eversion at 18 months of age ($r_g$ = -0.71 and -0.88 for BRAH and TCOMP) displayed the strongest genetic relationships with LAWR. Standard errors were sufficiently high for these however, (due to low heritability of the female trait) that these differences were not statistically significant to those observed for PEV24 ($r_g$ = -0.46 and -0.62 for BRAH and TCOMP).

**Table 3. Genetic correlations ($r_g$) and standard errors (s.e.) of preputial eversion at 12, 18 and 24 months of age (PEV12, PEV18 and PEV24) in Brahman and Tropical Composite bulls with female age at puberty (AP), lactation anoestrous interval (LAI) and lifetime annual weaning rate (LAWR) (units of measurement in parenthesis).**

| Preputial Eversion (mm) | Female Reproduction | Brahman | | Tropical Composite | |
|---|---|---|---|---|---|
| | | $r_g$ | s.e. | $r_g$ | s.e. |
| PEV12 | AP (days) | 0.15 | 0.15 | 0.23 | 0.16 |
| | LAI (days) | -0.09 | 0.19 | 0.51 | 0.19 |
| | LAWR (%) | -0.23 | 0.28 | -0.61 | 0.26 |
| PEV18 | AP (days) | 0.33* | 0.13 | -0.05* | 0.16 |
| | LAI (days) | 0.13* | 0.16 | 0.52* | 0.25 |
| | LAWR (%) | -0.71* | 0.27 | -0.88* | 0.33 |
| PEV24 | AP (days) | 0.29 | 0.14 | 0.34 | 0.16 |
| | LAI (days) | 0.44 | 0.18 | 0.26 | 0.19 |
| | LAWR (%) | -0.46 | 0.27 | -0.62 | 0.27 |

* Results for PEV18 previously reported by Johnston *et al*. (2014*b*).

## CONCLUSIONS

This study has shown that some level of preputial eversion was evident in 45% the BRAH bulls at 12 months of age, and that this increased to 71% by 24 months. If the condition is seen as unfavourable by breeders of Brahman cattle, these results show that opportunities exist to apply selection to improve the trait. This study has also confirmed the efficacy of preputial eversion measured in Brahman and Tropical Composite bulls as a genetic indicator for female age at puberty, lactation anoestrous interval and lifetime annual weaning rates. In Brahman, there was evidence that measurements of the trait at 12 months may be less effective as an indirect descriptor of female reproduction than those collected at 18 - 24 months. Compared to female reproduction traits, preputial eversion is easy to measure and these results suggests it would be a useful trait to add to the genetic evaluation for tropical breeds.

## REFERENCES

Barwick S.A., Johnston D.J., Burrow H.M., Holroyd R.G., Fordyce G., *et al*. (2009) *Anim. Prod. Sci.* **49**: 367.

Barwick S.A., Johnston D.J., Holroyd R.G., Walkley J.R.W. and Burrow H.M. (2014) *Anim. Prod. Sci.* **54**: 97.

Burns B.M., Corbet N.J., Corbet D.H., Li Y., Crisp J.M., Venus B.K., *et al*. (2013) *Anim. Prod. Sci.* **53**: 87.

Corbet N.J., Burns B.M., Johnston D.J., Wolcott M.L., Corbet D.H., *et al*. (2013) *Anim. Prod. Sci.* **53**: 101.

Gilmour A.R., Gogel B.J., Cullis B.R. and Thompson R. (2009) 'ASReml user guide. Release 3.0.' VSN International: Hemel Hempstead, UK.

Johnston D.J., Barwick S.A., Corbet N.J., Fordyce G., Holroyd R.G., *et al*. (2009) *Anim. Prod. Sci.* **49**: 399.

Johnston D.J., Barwick S.A., Fordyce G., Holroyd R.G., Williams P.J., *et al*. (2014*a*) *Anim. Prod. Sci.* **54**: 1.

Johnston, D.J., Corbet N.J., Barwick S.A., Wolcott M.L. and Holroyd R.G. (2014*b*) *Anim. Prod. Sci.* **54**: 74.