Ectopic position of duplicated *c-KIT* gene, detected by FISH, is associated with color sidedness in Nguni breed (*Bos indicus* x *Bos taurus*)

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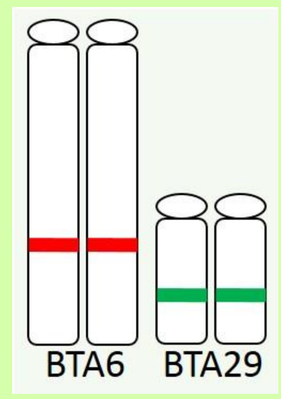
Introduction

Coat color in mammals is determined by a large number of genes, including *c-KIT,* which is responsible for color sidedness in a variety of cattle breeds [1-3]. It has been shown that a duplication of the c-*KIT,* which is located on chromosome 6 (BTA6), followed by its translocation to chromosome 29 (BTA29) is manifested by the sidedness. Such phenotype is also observed in African indigenous Nguni cattle, possibly derived from crossing between *Bos indicus* x *Bos taurus*.
Interesitingly, it is also known that the ectopic c-*KIT* copy number variation is associated with gonadal hypoplasia in Northern Finncattle and Swedish Mountain cattle [3].

The aim of the study was cytogenetically evaluation of the chromosomal position of the *c-KIT* gene in the Nguni breed.

Material and methods

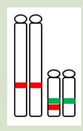
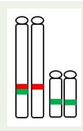
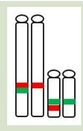
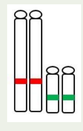
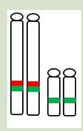
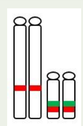
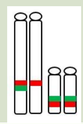
- Nguni cows (n=6) differed in the extent of black color sidedness
- Chromosome preparations obtained from short-term lymphocyte culture
- FISH procedure as described earlier [1 and 3]
- BAC probes derived from the RPCI-42 Bovine BAC library:
  - two BAC clones (RP42-160M9 and RP42-156I13) covered the region of interest on BTA6 (**red**)
  - two BAC clones (RP42-37P11 and RP42-116G80) specific to the region of interest on BTA29 (**green**)

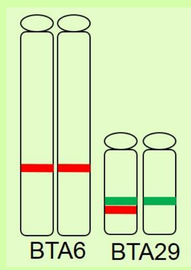


Results

FISH analysis revealed two different hybridization patterns in terms of signals produced by the probe harboring *c-KIT* gene. In cows with the advanced color sidedness two signals on BTA6 and a single ectopic signal on BTA29 were present (Fig. 1), while in cows with diminished sidedness two normal signals on BTA6 chromosomes and two ectopic signals on the BTA29 pair were observed (Fig.2). So far, two ectopic signals of *c-KIT* on BTA29 were not observed in other cattle breeds (Tab. 1).

Tab. 1. Comparative analysis of FISH patterns on BTA6 and BTA29 in different cattle breeds.

Breed	FISH pattern on BTA6 and BTA29	References
Belgian Blue, Witrik, Fogera, **Nguni (advanced color sideness)**		[1; this study]
Brown Swiss, Pustertaler Sprinzen, Vosgienne, Northern Finncattle		[1; 3]
Irish Moiled, Swedish Mountain, Domestic Yak; Northern Finncattle		[1; 3]
Western Finncattle		[3]
Eastern Finncattle		[3]
Nguni (diminished color sidedness)		[this study]
Northern Finncattle with gonadal hypoplasia		[3]



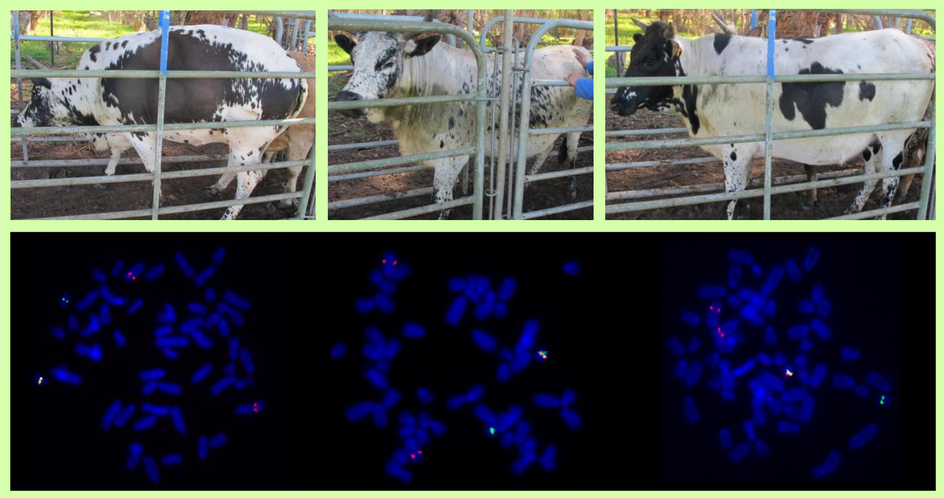


Fig. 1. Representative metaphase spreads from animals showing advanced color sidedness.

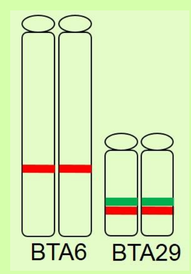


Fig. 2. Representative metaphase spreads from animals showing diminished color sidedness.

Conclusion

The extent of black color sidedness in the Nguni breed can be attributed to the ectopic position of the duplicated *c-KIT* gene on BTA29, and this may reflect its shared ancestry with the *B. taurus* lineage.

References

1. Durkin K. et al. (2012). Serial translocation by means of circular intermediates underlies colour sidedness in cattle. *Nature* 482: 81-84.
2. Brenig B. et al. (2013). Molecular genetics of coat colour variations in White Galloway and White Park cattle. *Animal Genetics* 44: 450-453.
3. Venhoranta H. et al. (2013). Ectopic KIT copy number variation underlies impaired migration of primordial germ cells associated with gonadal hypoplasia in cattle (Bos taurus). *PLoS One* 8: e75659.

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