Hypotrichosis in Belted Galloway Cattle

UNDERSTANDING THE ISSUE

Purpose of the Slide Deck

This slide deck will provide the reader with a

1. Basic understanding of genes, phenotypes and inheritance
2. An understanding of Hypotrichosis and the impact of Hypotrichosis in Belted Galloway cattle
3. Galloways Australia proposed management approach

Disclaimer:

This information has been put together to aid the reader in understanding Hypotrichosis in Australia. It is based on knowledge available as at March 2024. It has been developed to promote open sharing of information on Hypotrichosis and the approach Galloways Australia is proposing at the time of writing.

The Committee does not provide any warranty, express or implied, over the contents of this presentation and takes no legal responsibility for errors, omissions or claims with respect to any actions taken in relation to the information contained.

The information is provided as is and is subject to change. The reader must consider all currently available information and make an informed decision related to their personal herd management.

What are Recessive Genes?

UNDERSTANDING INHERITANCE OF RECESSIVE GENES IN CATTLE AND WHY THEY ARE IMPORTANT

Definitions

Chromosome: Biological structure which carries gene information

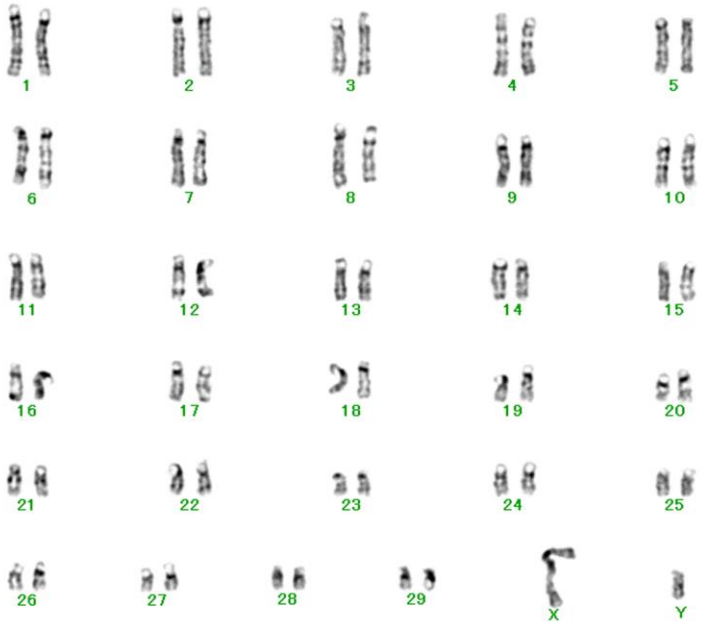
Gene: Information which is transferred from a parent to progeny to determine a characteristic.

Alleles: A matching pair of genes, one from each parent, which expresses the phenotype

Phenotype: The expression of a gene in an observable way. Example: Eye colour, hair colour, sex, skin colour, blood type.

Dominant: A gene which will always express a specific phenotype irrespective of the second gene type.

Recessive: A gene that will be masked by a dominant gene. The phenotype will only express when there are two exactly the same genes on the alleles.



Cattle have 30 pairs of chromosomes

- Chromosomes are paired threadlike structures made of protein which carry the genomic information of living organisms from cell to cell.
- Chromosomes reside in the nucleus of cells.

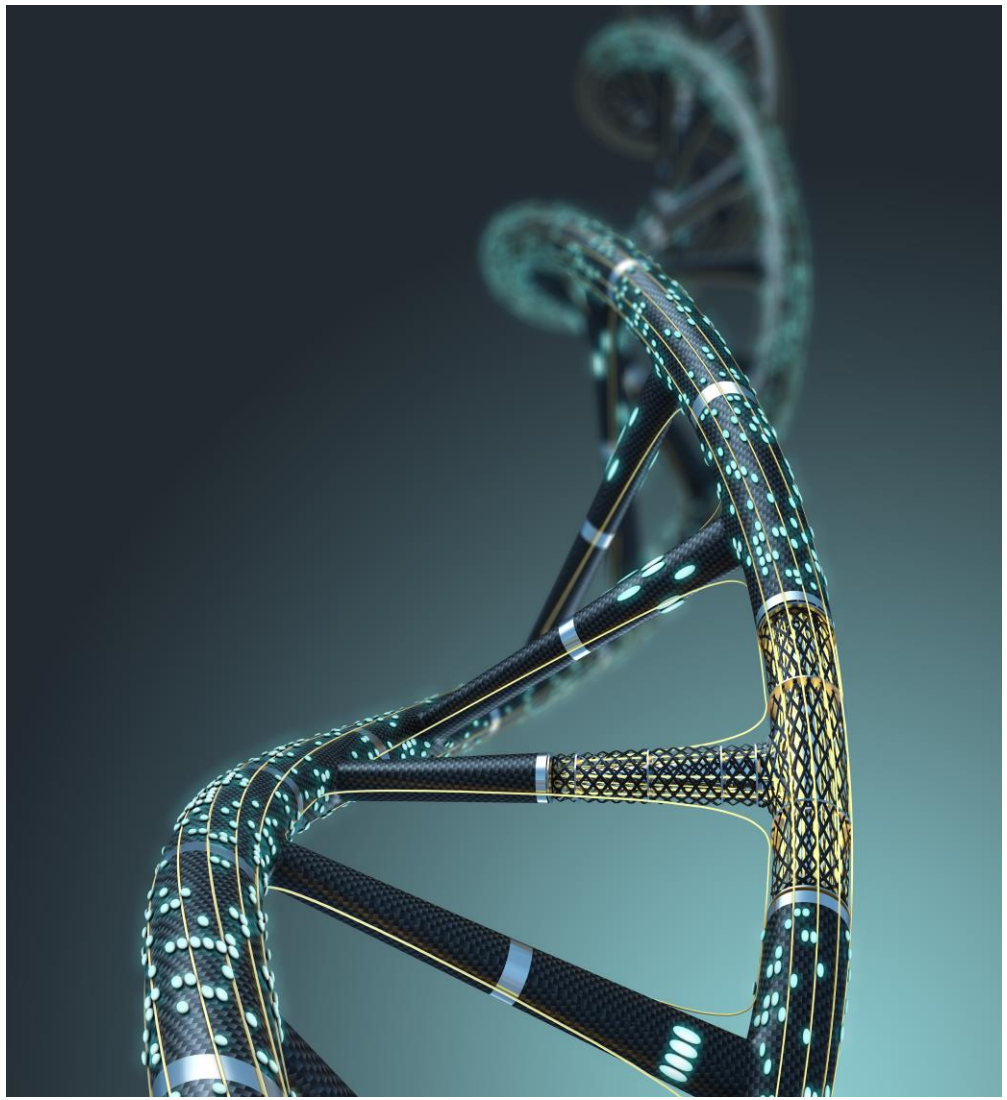
- Each pair contains two chromosomes,
  - one coming from each parent
  - so half an individuals genetic information is inherited from their female parent and half from their male parent.

- Cattle have 60 chromosomes in total (30 pairs).
- 1 of these pairs are the sex chromosomes
  - females have 2 X chromosomes,
  - males have 1 X and 1 Y.

- Humans, by contrast, have 46 Chromosomes (23 pairs).

Genes and evolution

- Genes, which are located along chromosomes, like beads on a string, carry the information for expression of different characteristics.
- Evolution, or change, occurs when random mistakes are made in genes structure.
  - Some changes are very deleterious and are immediately eliminated.
  - Some changes are minor and present in low frequencies.
  - Some changes however, are advantageous and give an increased survival rate to the individual carrying it. These genes will slowly increase in frequency.



Genes are paired along the chromosomes.

A dominant gene expresses it's characteristics when present in only one of the pair.

Example of dominant genes

- The belted gene
- The poll gene in Galloway cattle
- Black hair in humans

Example of recessive genes

- Red coat in Galloways
- Blue eyes in humans

A recessive gene requires two copies to be present to be expressed.
The red gene of Galloway and Angus cattle is used in the below example.

When both parents carry a recessive red gene the statistical probability of their offspring displaying a red coat by carrying 2 matching red genes **= 1 out of 4.**

Father appears Black

Statistical probability offspring of recessive gene expressing		
	Dam Black Gene	**Dam Red Gene**
Sire Black Gene	1. Black / Black = Black	2. Black / Red = Black
Sire Red Gene	2. Red / Black = Black	3. Red / Red = Red

Mother appears Black

Offspring may be Black or Red

Offspring outcomes:

1. 1 out of 4 will not have a red gene at all and will have a phenotype of (appear) black
2. 2 out of 4 will carry one red and one black gene and will appear black.
3. 1 out of 4 will carry two red genes and will appear red.

Colour has been used for explanatory purposes only

Statistical offspring of recessive gene expressing		
	Dam Black	Dam Red
Sire Black	Black / Black = Black	Black / Red = Black
Sire Red	Red / Black = Black	Red / Red = Red

Both parents as carriers
1 in 4 will express red and will pass on the red gene,
2 in 4 will be a carrier

Statistical offspring of recessive gene expressing		
	Dam Black	Dam black
Sire Black	Black / Black = Black	Black / Black = Black
Sire Red	Red / Black = Black	Red / Black = Black

Only the sire is a carrier
Cannot express as red but 2 in 4 will be a carrier

Statistical offspring of recessive gene expressing		
	Dam Black	Dam Red
Sire Black	Black / Black = Black	Black / Red = Black
Sire Black	Black / Black = Black	Black / Red= Black

Only the dam is a carrier
Cannot express as red but 2 in 4 will be a carrier

If only **one** of the parents carries the recessive red gene, **none** of the offspring will have a phenotype (express) of red.

However, statistically, **half** of them will carry the red gene.

This means that

- a recessive gene can be present in low numbers in a population without being expressed.
- With each generation, the probability of the recessive gene being present diminishes, **unless** there is a genetic advantage conferred by the gene, such that individuals with that gene are more successful surviving or in breeding.

Linebreeding

- Linebreeding tries to increase the frequency of a particular wanted gene phenotype. (*Inbreeding is the same as linebreeding but usually unintended and results in unwanted phenotypes*)
- Crossing animals known to carry a recessive gene to each other increases the probability of offspring carrying the recessive gene on both their chromosomes and thus expressing the wanted phenotype.

In our examples we have deliberately used a simple example of hair colour. However, the actual phenotype may be the result of multiple genes, example a spotting gene, a hair colour gene and a hair curling gene.

Downside to line breeding

Unfortunately,

- Genes that are located closely together on a chromosome tend to stay together, even if unrelated in function.
- This means recessive genes that do not confer an advantage but are closely located on their chromosome to a gene that is advantageous will probably continue to be reproduced.

Attempting to increase the frequency of a **wanted** recessive gene may result in other **unwanted** recessive genes also becoming more frequent.

Hypotrichosis

WHAT IT IS, IMPACTS AND WHAT WE KNOW

Hypotrichosis

- Presents in various breeds including Angus, Hereford, Jersey/Guernsey and now Belted Galloway.
- Is an autosomal, **recessive genetic** disease meaning an animal can be
  - free of the Hypotrichosis gene
  - a carrier – carries one gene and does not express the phenotype or
  - diseased – expresses the phenotype.
- Has a simple genetic basis similar to the red colour example.
- Expresses as total or partial loss of hair at or shortly after birth. (Research articles suggests some subsequent short hair regrowth and ongoing subsequent loss can occur).
- Can be associated with low birth weight, poor growth, detrimental effects on internal organs and susceptibility to environmental stress leading to death.

There are various scientific articles describing Hypotrichosis (HY) in cattle, a web search for Hypotrichosis in cattle will find articles with more information.

The Hypotrichosis problem

On the animal

- Hypotrichosis causes partial or total lack of hair.
- Lack of hair increased susceptibility to environmental stress, pests, cold, heat, and sunburn, in some cases causing death.
- Reduced birth weight, failure to gain weight and affected internal organs can also occur.
- Hair is an important characteristic of all Galloways including Belties and is a key to their longevity and other economically important features such as feed efficiency and marbling.

On the breeder

- Stud Belted Galloways are valuable commodities. The breeder's stock will lose value if an animal has partial or total hair loss, is poorly grown or fails to thrive.
- Faces a significant ethical question on breeding an animal with reduced environmental tolerance.
- May become a legal issue, where breeders unknowingly purchase HY animals from breeders who do know their HY carrier status.

The Hypotrichosis problem

On the breed

- If left unchecked, disease causing recessive genes[1] exponentially build up in the background until suddenly it is common for carrier sires and dams to be mated and the expression of the defect is suddenly common.
- A disease "explosion" is the result, in this case increasing numbers of Belted Galloway with total or partial hair loss.

On associations

- Currently being discussed and recognised as an issue in US, and Swiss Societies.
- If not actioned, now
  - Testing of entire herds and increased costs to breeders
  - May become a legal issue.

On Galloways Australia

- Currently, virtually no known potential HY Carriers in Galloways Australia Herdbook and testing of known carrier extended progeny is being undertaken.
- If no action taken it is likely to increase in Australia.

1. *All autosomal, recessive genetic disease can have this impact. It is why testing for Alpha Mannosidosis occurs*

What we know

Around 10 years ago the Registrar saw a bald, new born Beltie calf near the Scottish Borders and researched the condition. It was not at that time known in Australia.

September 2023 – World Galloway Congress

- During a presentation on recessive cattle diseases at the University of Bern (CH) a HY discussion was held.
- Subsequently, it's understood an ABGA Beltie breeder reported unknowingly breeding a calf presenting with HY.

What we know continued

December 2023

- ABGA President informed Galloways Australia Registrar of a HY presentation on 18 December 23, but did not include any details on potential carriers – Sires or Dams. Noting that Department of Primary Industry testing several months before had confirmed HY in the ABGA herd.
- The GA Registrar contacted Swiss and US Belted Galloway Societies for more information on HY and carriers.
- No response from the Swiss Society to date.
- In US, Belties involved in ET programs are screened for HY i.e. assume "elite" Belties.
  - Since 2015: 1418 Belties tested; 157 were carriers (11%) BUT, names of carrier animals have not been kept.
  - There is no single record of US Belties whose semen has been exported to Australia.

Feb/March 2024

- The Registrar contacted all major Galloway associations requesting advice on their HY experience with Belted and solid Galloways and advising on need for HY testing prior to semen or embryo GA registration.
- Ongoing discussion with University of Bern Professor.

Regional impacts

USA

- HY is an issue in the US, now 13.4% of tested animals are positive as carriers.
- US Belties claim no list of known HY carriers kept but a view regarding a particular potential carrier expressed.
- No list of US semen or embryo exports to Australia exists.

UK

- Potential UK HY calf observed in the 2010's
- UK has not had "explosion" of HY (yet)

Australia

- DPI testing confirmed a HY expressed Beltie born in Australia
- **Both the Dam and Sire must be HY carriers.**
- No Australian breeder knowingly introduced or used HY affected bulls or imported semen.
- Carriers of HY, if known to other societies and not identified, more broadly pose ongoing risk to breeders.
- Review of the Galloways Australia Belted Galloways indicated the Herdbook is virtually clear of potential HY carrier progeny. All known Galloways Australia potential carrier extended progeny are being tested.
- No HY observed.

Why we believe the Galloways Australia herd is not badly impacted:

Facts:

- A HY Belted Galloway calf or calves have been born in Australia not to a Galloways Australia herd.
- To express the recessive disease both the Dam and the Sire must carry the recessive gene.

Assumptions:

- HY is new to the Australia's Belted Galloway herd, the recessive gene must come from either embryo transfer or more likely imported semen.
- The most likely country the imported animal is from is the USA given the numbers of US HY carrier animals and lack of recorded result details.

Why we believe GA herd is not badly impacted

Australian Herd Research:

- After the Swiss Conference September 2023 it was identified that a HY calf was born in Australia. The calf or calves were **not** registered but would have been from registered parents.
- During late 2023 and early 2024 the Galloways Australia Registrar, reviewed the public records of over 200 pedigrees and identified a number of animals where both the dam and sire genetics were from imported US stock and identified, with a high level of confidence, a US carrier bull.
- It is likely that the original imported US semen used was at the time an unknown carrier for HY.

Without confirmed knowledge of the actual sires and dams involved some doubt must remain impacting on testing regimes

Management Approach

ERADICATION IS POSSIBLE

Eradication is the objective

Hypotrichosis is an autosomal, recessive genetic disease.

HY can only be transmitted via the parents genes.

HY cannot be transmitted via any other means.

The Australian experience with Alpha Mannosidosis has proven that autosomal, recessive diseases can, with appropriate herd management strategies, be eradicated from the Australian Belted Galloway herd.

In the case of Alpha Mannosidosis, the UK accepts imports from Australia as disease free, with no additional testing. This is a significant commercial advantage and should be the aim for all Australian societies.

Australia is in an enviable position to control the import of genetics into the country. We have no land borders where animals could cross accidentally and strict import regulations. However, full eradication is only possible from the entire Australian Belted Galloway herd with the support of other breed associations.

Galloway Australia's Objective

Objectives

1. Eradicate Hypotrichosis in the Galloways Australia Belted herd
2. Influence control strategies in the broader Australian Belted herd towards the same objective by open discussion and disclosure of all known information to association members without fear or favour.

Issues facing

Issues

- Lack of publicly available information particularly from Australian Belted Galloway Association and US Belted Galloway associations (e.g. no list of imported semen, records of HY testing).
- Confusion among members caused by lack of knowledge, personal concerns, downplaying of significance of disease impact or mixed messaging.
- Human nature to protect and defend personally held beliefs at the expense of the breed. We believe that some people fear the results of testing or the release of information, thinking that they will be considered ‘bad’ or their reputation will be impacted. Our position remains that we do not believe any breeder has knowingly imported deleterious genetics or would continue to use once known.
- Ability to test imported semen especially when rare.

Galloways Australia's current approach

At the October 2023 meeting of the Committee HY was discussed and the following immediate actions were undertaken:

1. sought information to confirm the identity of any HY imported animals from associations with impacted members.
2. increased Galloway Australia's membership awareness through Presidents Bulletin and targeted information.
3. under existing Rules of Registration for deleterious conditions and conditions of membership the Registrar
   - requested testing of any suspect animal (those with imported genetics on both dam and sire)
   - Implemented HY testing for all new progeny from international genetics prior to registration.
4. sought scientific advice and assistance from internationally recognised advisors on HY, HY testing and its ability to be controlled in Australia.

Longer term management

Longer term options

The Committee are considering longer term management options including:

1. Changes to the Galloways Australia Rules of Registration to expressly note HY as a condition which must be tested for prior to using progeny of imported animals (AI/Embryo born animals).
2. Consider and develop management options to maintain a list of imported animals that are established to be free of HY through:
    i. The individual import being individually cleared of HY genes (Semen genetic testing is the most accurate method)
    ii. cleared progeny method (statistical probability methods) (minimum number of progeny that must be tested to provide a statically reliable result is 6).
3. Continue to work with other association to eradicate the disease.

The Committee noted that a full testing program of the entire Belted Galloway herd was not in the interests of members given the current anticipated low genetic carrier pool in Australia and the ability to prevent further spread.

Risks to our eradication objective

The biggest risk preventing achievement of the Galloway Australia's eradication objective are:

- A lack of an agreed standard Australian approach across Belted and Galloway associations in Australia resulting in:
  - increased confusion and anger from breeders,
  - increasing complexity in transferring animals between associations, and
  - failure to eradicate the disease in Australia.
- Disease spread amongst:
  - non registered animals if not recognised and controlled quickly
  - the general Galloway herd due to misunderstanding of Galloway breed genetic and experimentation with cross breeds.

The information in this PowerPoint has been prepared specifically to address a number of these concerns and to set out the Galloways Australia position publicly.

Risks in the Galloways Australia approach

1. Impacts of testing on costs to members. Galloways Australia provides low cost membership and life time animal registrations. In comparison to other associations we do not believe it will be significantly onerous for members to test individual animals were required ($25-$45 per test). Testing for other conditions is already required and not an issue. We are also not advocating a whole herd testing regime unless additional information alters our assumptions on HY.

2. Removal of some genetics from the herdbook. Animals which are carriers need to be identified and managed for long term objectives to be met, this may meet some resistance among members.

3. Perceived lack of support for the diversification of the Belted Galloway Herdbook. Galloways Australia recognises that diversity is a critical component of genetics to prevent inbreeding (unwanted recessive genes due to limited gene pool). However, diversification should be possible without introducing long term genetic issues.

4. Potential for fraudulent testing to be conducted or falsification of herdbook or breeding records. While low, there is a risk that records outside the control of Galloways Australia could be falsified. However, we do not believe that any member would knowingly use or breed from an animal with a disease or falsify records.

5. Potential litigation. There is a potential for breeders of animals, deemed in Australia to be carriers of the disease, to raise litigation threats. We believe this risk to be low. An animal which is proven by Australian testing to be a carrier, would be a carrier irrespective of where it was tested, and to knowingly sell an animal with a deleterious condition could equally cause legal action.

Next Steps

The Galloways Australia committee, continues to monitor the situation, determine and test potential carriers and address the concerns of members.

We will keep members informed of any new developments

If you have any questions feel free to reach out to the Committee Members as listed on the Galloways Australia website.

Reference: Alpha Mannosidosis in the UK

Dr Harriet Bunning (UK) has created a guide to Alpha Mannosidosis based on the UK Belted Societies approach and management. https://www.beltedgalloways.co.uk/guide-to-alpha-mannosidosis/

Consideration to using this approach as a secondary option – Testing of Bulls only should reduce any risks to the Australian herd but will not eradicate any maternal carriers leaving a small risk the disease remains undetected in the herd long term.