

## Crop Ear – a highly variable defect of the outer ear

by Stephan Janz

A recurring topic which frequently exposes strongly held opinions among Highland Cattle Breeders in Germany is that of Crop Ear. Recent Crop Ear discussions prompted my preparation of some facts about the condition, including information from new genetic research in Switzerland, which I now provide in this article, and which I hope will be helpful.

### What is Crop Ear

**Crop Ear is a congenital defect of the outer ear with “a monogenic autosomal dominant mode of inheritance with variable expressivity” (Koch et al.). It is predominantly found in cattle of the Highland Breed, and is not associated with other defects or malfunctions.**

(Synonyms: cauliflower ear, notched ears, nicked ears, dock ears)

Since such a definition hardly slips off the tongue easily enough for natural conversation, I offer my explanation of it and also an elaboration of additional relevant factors.

Crop Ear is an **inherited defect of the outer ear**. The defect is inherited **autosomally**, i.e. it is not inherited on one of the sex chromosomes and can thus affect both sexes. It is inherited **monogenically**, i.e. only a single gene is responsible. It is inherited **dominantly**, i.e. a heterozygous carrier (in other words, an animal that has inherited the crop ear gene from one parent only) also exhibits the ear defect. The **phenotypic expression** is **variable**, i.e. with the same genetic makeup the externally discernible characteristics of the ear defect may differ greatly from animal to animal. The defect usually presents itself more or less symmetrically in both ears.

Crop Ear is found in **Highland** and **Ayrshire** cattle (and their cross-breeds), and sometimes in **Dexter** cattle.

*This last point is interesting for a reason that has nothing to do with Crop Ear: "notched ears" were first described in scientific literature in 1915 by a Japanese author (Yamane) who found this defect in Ayrshire Cattle exported to Japan from California. These Ayrshires carried bloodlines from an Ayrshire bull described as "dark brown and white with nicked ears" exported from Scotland to the United States in 1859. In the late 1950s Crop Ears were also found in Ayrshires (and crosses) in the USA and in New Zealand (MacDonald) and in shape, variability and genetic transmission these corresponded exactly with results of scientific research that was done on Highland Cattle for the first time much later in 1994 (Scheider et al.). Ayrshire Cattle, today a worldwide spread high milk-yield dual-purpose breed, originate from West Ayrshire, south-west of Glasgow. Writing in 1834 Youatt hints that the cattle found in Ayrshire are likely related to the "West Highland Cattle" and indeed the historically documented early occurrence of Crop Ears in Ayrshire Cattle (Youatt called them one "of the varied mingling breeds of the Lowlands") provides a strong indication that the Ayrshire breed indeed has one of its origins in West Highland Cattle (see also Wilson).*



*Apart from this, literary references to inherited ear deformities in domestic cattle, such as from Wriedt and Lush, contain only very sparse information, and the individual cases described by them differ significantly from Crop Ear. By current knowledge, therefore, Crop Ear is a genetic defect which apparently manifests only in Highland cattle and the distantly related Ayrshire cattle (and in their cross-breeds), and occasionally also in Dexter cattle, a small breed descended from the old Irish breed of Kerry cattle.*

*The fact that Crop Ear does not present itself in other Eurasian domesticated cattle breeds seems to indicate that it is a very old genetic mutation, which must have taken place a long way down the common family tree of the bovines generally referred to as Celtic cattle of the islands of the North Atlantic. (I admit that this is entirely a personal assumption, in accordance with Celtic mythology – see below –, but one for which I am unable to muster scientific witnesses.)*

No functional impairment whatsoever is reported anywhere in the available literature for the heterozygous variant. These animals are in fact completely healthy. There is speculation, however, regarding the homozygous variant as to whether specific localisation of a sound source may be impaired in these animals which otherwise appear to hear normally. Likewise, one may speculate whether water or flies can cause damage more easily in a grossly deformed ear. This is neither known nor reported upon.

### **What do Crop Ears look like? How do they feel to the touch?**

Crop Ears in one animal can look very different from Crop Ear in another. The defect usually occurs on both ears, but may not always be absolutely symmetrical. The condition is evident on the newborn calf and probably does not change much throughout life. The malformation ranges from a tiny V-shaped nick on the ear tip to deep crack-like notches the entire length of the earlobe, similar to a healed injury as for example in the case of a torn-off ear-tag (in which case the torn effect shows on one ear only). In the worst instances an irregular or split ear cartilage is considerably thickened, severely shortened, or both. In the mildest case, however, the effect at the apex of the ear may be so minimal that a cartilaginous thickened small dent is only traceable when palpated.

In most cases of Crop Ear, namely in the animals in which the ears have only a 1-2 cm deep notch, the defect is hidden under the profuse hair on the ears and therefore easily missed on visual inspection from a normal distance. Only the more severe mutilations with deep notches are readily evident when having a look at the cattle in natural circumstances (see pictures, also Cochrane). In many cases, therefore, Crop Ear is only found by deliberate manual palpation of both ears. Unless you conscientiously check each ear for normality, a minimal manifestation of the Crop Ear condition can easily escape detection, even when fitting ear tags to calves. If you do a meticulous manual check, however, most cases of Crop Ear should be discovered without recourse to specialist knowledge or invited experts.

There are two reasons for the fact that instances of Crop Ears can so be so different in appearance, and different to the touch.



One stems from the fact that an animal may have inherited the crop ear gene variant (let's call it "C" for this discussion) from both parents. This animal is designated as homozygous for this genetic characteristic, i.e. its complete set of genes contain the crop ear gene variant twice (CC). These homozygous animals exhibit the external characteristic "Crop Ear" to a more severe degree, i.e. deep notches / very stunted ears, and these animals **always** transmit a crop ear gene to their offspring.

Animals which have inherited the crop ear gene variant (C) from only one parent, and have inherited from the other parent a normal non crop ear gene variant (let's call the non crop ear gene variant "c"), are designated heterozygous for the crop ear attribute. These (Cc) animals' - that is those with gene sets which include both the crop ear (C), and the normal (c), gene variants - can pass on **either** the crop ear variant (C) **or** the normal ear variant (c) to their offspring. These heterozygous animals exhibit to a less severe degree the external attribute of Crop Ear, i.e. the characteristic notches which are not so easy to see, and which one often has to palpate to determine any presence of the condition.

To complete the picture: normal animals are homozygous for the normal non crop ear gene variant (cc), having inherited the normal ear gene from both parents. Therefore if a normal

(cc) gene carrier mates with a homozygous crop ear carrier (CC), the offspring will **always** be heterozygous regarding the ear gene (Cc or cC) and therefore – see above – have Crop Ears of a less severe degree.

If a normal (cc) gene carrier mates with a heterozygous (Cc or cC) carrier, **either** the homozygous situation of (cc) may result in the offspring – i.e. offspring which are genetically free of Crop Ear and therefore free of external crop ear attributes; **or** the heterozygous situation (Cc or cC) may result.

So far, these facts are straightforward – and what has been set out above corresponds with Mendelian heredity theory and the state of knowledge hitherto.

However, the fact that cropped ears vary, both in appearance and to the touch, is linked to a second peculiarity of the inheritance of this characteristic, and that brings us to recent news about Crop Ear.

### Recent News About Crop Ear

What's new is that a team of Swiss scientists has addressed the task of analytically identifying the crop ear gene DNA, and those scientists published their results in October 2013 (Koch et al). The crop ear gene has been identified and its presence can now be detected in individual animals by means of a test.

The work has further confirmed the autosomal dominant mode of inheritance previously inferred from family tree analysis (MacDonald, Scheider et al.), albeit with a slight but not insignificant correction, which may explain why debates about Crop Ear tend to be hopelessly controversial and usually finish up a blind alley.

According to our understanding hitherto, Crop Ear was said to have an "incomplete dominant" mode of inheritance (or put another way, a dominant mode of inheritance with incomplete penetrance), which would mean that in some heterocygous individuals the attribute is not expressed phenotypically at all. This view no longer



applies according to recent findings by the Swiss team of scientists. Their report now speaks of a “variable expression” of the dominantly inherited characteristic, meaning that **every genetic carrier** of Crop Ear whether homozygous or heterozygous, **does exhibit the attribute phenotypically**, albeit with widely variable expression of the characteristic.

Thus one must acknowledge that there are various degrees of the severe and obvious Crop Ear category, most likely associated with a homozygous genotype, as well as various degrees of the finer and less obvious variants found on heterozygous animals.

However, what has not been investigated and what is not known is:

- which factors influence the variability of phenotypic crop ear characteristics in different animals with identical genotype.
- whether there are phenotypically fluid transitions from a minimal variant in a genetically homozygous animal and a maximal variant in a genetically heterozygous animal. There is presumably a continuum of phenotypic characteristics such that only the very fine minimal or the gross maximal variants may be categorised as heterozygous or homozygous with any degree of certainty (M. Mäkelä, personal correspondence).
- whether Crop Ear always appears symmetrically and identically in both ears. It may be possible that occasionally a difference between the two ears can exist to a greater or lesser degree. (Ü. Cochrane, M. Mäkelä, personal correspondence).
- whether crop ears change over the course of the life of the animal. My guess is they probably just grow along with the animal, and probably change little in shape and characteristic.

“**Incomplete penetrance**” (from previous understanding of the condition) or “**variable expression**” (according to the Swiss team) - may sound like genetic gobbledygook or scientific hair-splitting but what it really means is:

**A genetic carrier exhibits the attribute on its ear. And an animal that exhibits nothing on its ear is not a genetic carrier.**

No doubt this statement will meet with opposition, most probably because of the difficulty in identifying some cases of Crop Ear. Again and again one hears of the birth of crop-eared animals which, to the dismay and disbelief of the breeders, are honestly thought to be descended from parents completely free of Crop Ear. This is a perplexing situation for the breeders, and I do not know whether any such cases have actually been seriously and expertly documented. Prof. Drögemüller, the head of the aforementioned Swiss team of scientists asserts: “Animals with a copy of the mutation, genotype CE-1, always have deformities in their ear lobes, even if those deformities are highly variable and sometimes extremely difficult to detect” (personal correspondence).

Matti Mäkelä, a Finnish Highland cattle enthusiast who, out of personal interest (not to say obsession – he would not mind me suggesting) has doubtless grabbed more Highland cows by the ears than any other person, similarly states that there were cases where the defect “was so minimal that I had great difficulties to identify any anomalies in the ears. I think that it really is possible to make a wrong decision by palpating the ears.” (personal correspondence).



In other words, in specific individual cases the distinction between a minimal variant and a normal ear can indeed be very difficult to detect and define. Such a case is presumably rather rare, but, thanks to the advances made by the Swiss team, in unclear or contentious cases the question can readily be resolved safely and unambiguously by means of a **genetic test**. (This test can be undertaken at the University of Berne, Switzerland, using blood, hair, sperm or tissue samples. It costs 75.00 euros and takes 2-8 weeks. Application forms and further details may be downloaded from

[http://www.genetics.unibe.ch/unibe/vetmed/genetic/content/e2885/e3144/e290715/files290716/AntragKruppohren\\_ger.pdf](http://www.genetics.unibe.ch/unibe/vetmed/genetic/content/e2885/e3144/e290715/files290716/AntragKruppohren_ger.pdf))

### **Crop Ear, Gaelic Folklore and the Highland Breeders**

Like many mythologies Celtic mythology embraces the existence of a mysterious creature called a water-bull ( ref. Maier ). The survival of legends through the oral tradition in Scottish Gaelic folklore makes it impossible to date the arrival of water-bulls, or the Tarbh Uisge, which for centuries appeared unpredictably in and around the sea and lochs of the Hebridean Islands and West Highlands of Scotland. However, the folklore has preserve comment on both behaviour and appearance of the Tarbh Uisge. Seemingly the Tarbh Uisge itself is rarely seen, it emerges from the water at night and covers ashore cows, and the resulting progeny are very easily identified as those sired by a water-bull. Such a mythical bull is called Tarroo-Ushtey in the Isle of Man, and there are also water-bull myths in Germany, but the Hebridean Tarbh Uisge is distinct in that it is given specific attributes: Tarbh-Uisge is a large black bull with velvety fur, he has no ears and his calves have slotted ears. When the explorer Martin Martin, on his journey to the Hebrides in 1695 visited the Isle of Skye he documented this legend writing " There are several calves that have a slit at the top of their ears; and these the natives fancy to be the issue of a wild bull that comes from the sea or fresh lakes; and this calf is by them called *corky-fyre* "(Martin ). In the extensive collection of "Popular Tales from the West Highlands" (Campbell) an island resident reported in 1862 that he had "often seen bulls feeding about the lake sides with the cattle, and the cows often had calves. They are `corcach´, short-eared, a cross between the water-bull and a land-cow ". And A. Carmichael, who collected Gaelic songs, rhymes and legends in late 19<sup>th</sup> century, wrote "These notch-eared cattle - ` Torc Chluasach ' - are frequent in the Western Isles and are spoken of as `Slioc a Chroidh Mhara', the descendants of the fabled sea cattle." A pious man, the Rev. Alexander Stewart, distances himself in his 1885 book "Twixt Ben Nevis and Glencoe" from such "ridiculously childish and absurdly impossible" things such as water bulls and progeny with malformed ears and held to ridicule the fact that "the initiated still pretend to point out cattle with more or less of this questionable blood in them, in almost every drove of pure Highland cows and heifers you like to bring under their notice".

It is not difficult to recognize in these mythical creatures our own Crop Ear animals : Tarbh - Uisge , the bull without ears , apparently a homozygous animal; corky-fyre , the heterozygous offspring with the split ear tips. Clearly the natives of the Hebrides and the Western Highlands have been familiar with these ear deformities ever since the ancient times when poorly understood facts and events of everyday life – namely



human and animal diseases – led to the creation of explanatory myths and legends, embellished in different localities and circumstances and preserved by oral tradition.

If one researches into Crop Ear, one will find an abundance of references in Scottish Gaelic folklore. In the sparsity of early literature on Highland Cattle, however, there is no mention of Crop Ear and even after the establishment of the Herd Book there is only one reference to it in a booklet about the breed by J.Cameron in 1929, endorsed by the Highland Cattle Society, which noted that “dock ears” was an unimportant feature, known of for generations, and should now be bred out by using “full-eared” bulls. Surely this low-key mention of the ear deformity suggests that former cattle breeders were well aware of the condition and at the same time not overly concerned about it.

Una Cochrane, author of “A Keen Eye”, a comprehensive and beautiful book about Highland Cattle, has a large collection of old photographs and postcards of Highland Cattle from as early as 1903, which on scrutiny reveal a surprising number of cows and calves exhibiting the Crop Ear condition. It would seem that breeders at that time noticed the defect and thought of it as merely a minor cosmetic deformity unworthy of debate or serious action to eliminate it. Until the late 1980’s Crop Ear was not on the agenda in Breed Society circles. Donald MacDiarmid, the longtime much respected Herdsman of the old Leys Castle herd near Inverness, born and raised on the Isle of Skye, who had spent his whole life with Highlands said to me in 1991 that before his visit to Germany he had never knowingly dealt with animals with the Crop Ear condition. However, the defect must have been present, although evidently undetected, among the prestigious Highland herds that from the late 1970’s were exporting animals to Germany and Denmark.

When Crop Ear surfaced in livestock in Germany, Denmark, Australia, later followed by instances of it in Switzerland, and when outraged breeders in Australia complained about the expensive imported animals they had purchased being “malformed”, the Scottish Highland Cattle Society for the first time was forced to establish an official stance on the defect. (Interestingly, now there were voices in the HCS, attributed by rumour to breeders from the Isle of Skye, who argued that the Crop Ear condition should be considered a breed feature, and that it was evidence of particularly ancient, pure and true breeding.)

The current policy position of the HCS dates from 1989 and reads: “Crop Ear is not a sufficiently serious condition to warrant the exclusion from the Herd Book of bulls which are otherwise satisfactory. Notification of Crop Ear in bulls is compulsory. Breeders will be able to choose whether they wish to use a bull with Crop Ear.” This policy is reprinted each year in the Highland Cattle Society’s annual Highland Breeders Journal. The veracity of the entry into the registration system is not officially supported by mandatory bull approval or assessment.

In Germany there is no compulsory notification of the defect at birth, but stock bulls have to be inspected for approval and crop eared bulls are to be rejected – no matter how satisfactory otherwise.



It is not known how many crop ear animals there are in Germany . There are certainly not many, and according to my personal impression, it is a much lower percentage than 20-25 years ago. Therefore it is all the more surprising how much anger and bad feeling still erupts from time to time when an uninformed or ignorant novice breeder buys a slit-eared animal from a breeder who should know about the condition, who should have told his customer or who maintains he has never had crop ears in his fold. Then once again there will be those who make loud clamour for stricter rules and official enforcement of procedures and others who try to create a distinctive personal image by advertising their fold as crop-ear-free. Such a recurring kerfuffle seems rather pointless to me because

### **Crop Ear is not, in fact, a major problem**

and I would therefore like to conclude with a brief personal plea for a reasonable, measured and practicable approach to this relatively unimportant feature .

We should note that

- Crop Ear is a genetic defect, and is therefore no more relevant in a breed description than other genetic defects.
- we breed farm animals and not Show poodles, and Crop Ear, although in some instances unattractive in appearance, does not affect adversely the health, well-being and performance of the animal.
- it is pretty easy to get and keep your own stock crop-ear-free: all you need is some attention, some knowledge about the condition (no more than this article offers) and a butcher – careful selection of breeding stock as usual. There is no need for a new set of rules and you don't have to invite special inspections. A genetic test will only be needed in very rare cases.
- you can also breed successfully with a crop-ear animal if you consider that it is otherwise of exceptional quality.
- for meat production Crop Ear does not matter.
- those who want to sell breeding animals will get from a heterozygous cow as much as 50 % genotypically and phenotypically crop-ear-free offspring. These animals can be sold with a clear conscience and in case of doubt there is now the genetic test available.(The issue of enforcing regulations on the use of only crop-ear-free bulls I wish to leave unresolved for the time being, although I do think that the current gene pool of Highland bulls is sufficiently wide to keep healthy stock numbers globally without the use of crop ear bulls.)
- in any case it would be difficult to render the entire Highland cattle population absolutely genetically crop-ear-free without unreasonable and drastic administrative measures. Nevertheless, bureaucratic rules apart, in the interest of informed choice it is crucial that full knowledge about Crop Ears is commonplace among breeders. Hopefully this article will offer some help to established breeders and their individual policies. For newcomers it might provide a kind of check list for considerations when embarking on this choice of livestock.



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