Observations on Claw Abnormalities in Beef Cows

PART ONE: Physical Characteristics and Claw Growth

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Summary

Sandcracks have been classified under five different categories or 'types'. Several possible causative mechanisms can be identified including the weight of the animal, the presence of horizontal defects and bending of the dorsal surface of the claw. In two groups of heifers it was found that the rate of claw growth is approximately 0.46 cm per month during the summer months and 0.32 cm per month during the winter. Applying these growth rates to the position of a horizontal defect relative to the skin/horn junction permits the date on which the defect was formed to be estimated. The incidence of horizontal defects is exceptionally high in some herds of beef cows and was found to vary from 29 to 100% of the animals in six of the herds in the study.

Introduction

Longitudinal or vertical fissures (sandcracks), as well as horizontal fissures, were defined at the Symposium on Abnormal Foot Conditions in Ruminants in Utrecht in 1976 (Espinasse *et al,* 1984). At the time sandcracks were thought to be associated with dry conditions and perhaps sandy environments (Blowey, 1993). In dairy cows the incidence of the condition is reported to be very low (0.4% of lameness causing lesions) in the UK (Murray *et al,* 1996). The literature contains few objective references to the condition as it occurs in beef cows. Hand *et al* (1992) report a prevalence of 22.7% affected animals in 11 herds in Alberta. They also reported that 80.6% of the cracks affected lateral claws of the front feet; an observation reported earlier by Westra (1981).

The term 'hardship groove' has been used by cattlemen to refer to a mark in the wall of the claw running more or less parallel to the skin/horn junction (Greenough *et al,* 1990). In intensively fed beef bulls (Figure 1) and in steers at slaughter (Figure 2), a similar lesion referred to as a 'weaning groove' is observed. The horn proximal to the groove is different in appearance from that distal to it.

The hardship and weaning grooves are classified as horizontal defects. Horizontal defects are observed in a number of other forms (Greenough, 1997) such as, fissures (Figure 3), bent claws (Figures 4 and 7), buckled claws (Figure 9), thimbles (Figure 5) and broken toes (Figure 6).. The term 'bent claw' should be differentiated from a 'buckled claw.' A buckled claw is created when a change in direction of the claw wall has taken place at one or more horizontal defects. A bent claw is one that has a concave dorsal surface. This distinction may be useful if each phenomenon is found to have a different etiology.

Peterse (1980) describes and classifies concavity of the dorsal surface of the claw in dairy cows in relation to the appearance of 'ridges.' Peterse (1985) also reported that deformation of claw shape takes place in dairy cows during lactation. Toussaint-Raven (1989) refers to 'growth rings,' buckled dorsal wall, and dull wall horn.

Claw growth has been measured at two locations in dairy cows. The first location is on the abaxial wall close to the abaxial groove. The mean abaxial growth rate is reported to be 0.4-0.5 cm per month (Prentice, 1973; Peterse, 1980; Manson and Leaver, 1989). The growth rate of the dorsal border is reported to be slower (Prentice, 1973; Clarke and Rakes, 1982; Hahn *et al,* 1986). Growth rate is faster in young animals, up to second lactation, than in mature animals (Prentice, 1973; Glicken and Kendrick, 1977; Hahn, 1979). Growth is more rapid during the summer months (Vermunt, 1990). This may be due to variations in the photo-period or temperature(Wheeler *et al,* 1972) or to nutrition (Clarke and Rakes, 1982; Rakes and Clarke, 1982). Greenough *et al,* 1990 found that mean growth rate of the soles of the claws of steers fed intensively was 2.5 times more rapid than a control group fed hay.

Materials

Starting in June, 1994 with one herd which was subsequently visited on five occasions the front feet of the cows were examined. A second herd was examined

in October, 1994 and visited later spring and fall until October, 1997. The study in these two herds was supported by Hoffman-La Roche Ltd. and had the primary objective of investigating the value of biotin in reducing the incidence of vertical fissures (Campbell *et al,* 1996). The feet of animals in 10 other herds were examined on at least one occasion in a supplementary study supported by the Saskatchewan Agricultural Development Fund.

Methods

The front feet of all cows and the hind feet of most cows were examined and a detailed record of lesions observed was made. A protocol for data collection was gradually developed to accommodate the various parameters emerging as the project progressed. Furthermore, as the study was conducted with commercial herds, time available for examination was limited by other farming operations and extremes in weather. These factors account for some differences in the number of observations made in different herds.

Sandcracks were classified as being one of the following five categories.

Type one. Involving the coronary band and some adjacent wall (Figure 7).

Type two. From the skin/horn junction to the middle of the claw (Figures 8 &9).

Type three. From the skin/horn junction to the bearing surface (Figure 10).

Type four. From the centre of the claw to the bearing surface (Figure 14).

Type five. Involving only the central region of the claw wall (Figures 15,16,17 and 18).

The degree of severity of a sandcrack is defined by its width, i.e., 2mm=1; 4mm=2;6mm=3; 8mm=4; 10mm=5.

The position of a horizontal defect was measured relative to the skin/horn junction. The dorsal surface of the claw was selected as the location at which measurements should be taken. The reason for this decision is that the time period for the claw to grow out is in excess of 12 months compared to less than six months at the abaxial site. A photograph was taken of every sandcrack. The photograph was a full lateral exposure and included a metric scale and the identification of the animal.

The weight of the animal was recorded if a weigh scale was available. The body score for the animal was recorded.

Results

a) Rate of Claw Growth

In a group of 57 first-lactation heifers (herd #2), it was found that the average rate of claw growth per month between May 15, 1997 and October 31, 1997 was 0.464 cm..054. In this group the range of growth rate varied from 0.35 to 0.56 cm per month.

Nine first-calf heifers (herd #3) were marked in October, 1994 and the location of the mark measured in June, 1995. The average growth rate over the eight winter months was 0.32 cm per month.

Table 1. Average position of the groove in herd #10. The groove observed in the spring is displaced by a second groove which is observed in the fall.

Exam Date	Letter denotes year of birth Age in years at examination date (# of animals) A	B	C	D	Average spring position of groove (cm)	Average fall position of groove (cm)
06/01/94	3.4 (9)				4.7	
10/05/94	3.8 (28)					3.1
		2.8 (44)				3.4
06/01/95	4.4 (55)				4.6	
		3.4 (69)			4.7	
			2.4 (29)		4.5	
10/25/95		3.8 (35)				3.5
			2.8 (28)			3.7
				1.8 (16)		Nil
05/5/96		4.4 (14)			5.6	
			3.4 (9)		5.4	
				2.4 (17)	6.2	

Table 2. Average position of groove in herd #3 over 2.5 years

Date of measurement	Period over which the measurement was made	Distance of defect from Skin/horn junction
June 1, 1994		5.4 cm
October 5, 1994	4 months	3.3 cm
June 1, 1995	8 months	4.9 cm
October 25 1995	3.75 months	3.5 cm
June 5, 1996	7.25 months	5.9 cm

Table 3. Average position of groove in May/June 1996 in seven other herds

Herd Identification	*# of animals with a groove* Sample size (#)	Average distance of groove from skin/horn junction (cm)
#12	52 (73) 71%	3.6
#5	76(105) 72%	4.2
#11	48 (48) 100%	4.2
#7	36 (69) 52%	4.3
#8	20 (32) 62%	4.4
#3	21 (72) 29%	5.7

Table 4. Prevalence of sandcracks within age groups

Herd ID	Breed	Herd size	First Lact	Second Lact	Third Lact	Fourth Lact	Fifth Lact	Sixth Plus	Average incidence
#1	Charolais	48	10	67	69				56
#2	Hereford-X	109	3	24	38	86	85	73	59
#3	Char-X	72		0.7	2.9	2.9	10.8	33.8	51.8
#4	Mixed breeds	113		25.0	42.31	17.65	46.15	60.00	39.82
#5	Hereford	105	0.0	20.00	23.08	22.22	41.18	51.28	35.24
#6	Mixed breeds	68	0.0	11.11	10.00	50.00	60.00	46.42	33.88
#7	Black Angus	69	0.0	11.76	46.15	58.33		28.57	31.88
#8	Charolais	32	0.0	0.0	33.33	50.00			31.25
#9	Mixed breeds	88	0.0	0.0	12.50	15.38	50.00	62.07	30.68
#10	Hereford	75	0.0	0.70	6.3	2.6	18.2		28.00
#11	Mixed breeds	28	0.0	7.10	0.0	3.6	3.6		12.3
#12	Red Angus	73	0.0	0.0	0.0	3.85	0.0	25.00	4.11

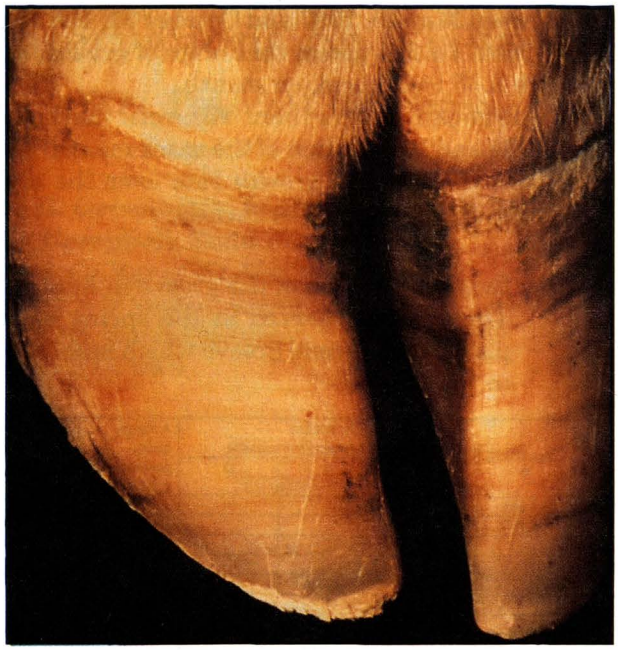

Figure 1. The claw of a bull aged 12 months after four months of *ad lib* feeding with a high-energy balanced ration. Note the difference in the appearance of the claw wall proximal to the coronary band in comparison with the distal portion of the wall. The line of demarcation corresponds to the time of weaning.

Figure 2. The claw of a steer fed barley and straw. In this case the horn close to the coronary band appears rougher and occupies more of the claw wall than seen in the preceding picture. This suggests that the poorer ration of the steer was associated with a longer period on feed.

Figure 3. The front claws of a second lactation heifer. The appearance of the distal portion of the claws is normal. Slight deterioration in appearance occurs in areas closer to the coronary band. The distal groove would be referred to as a 'hardship groove' and would be a typical reaction to the stress of calving. The mark closest to the coronary band is a fissure which represents a time when the production of claw wall ceased completely for a short period.

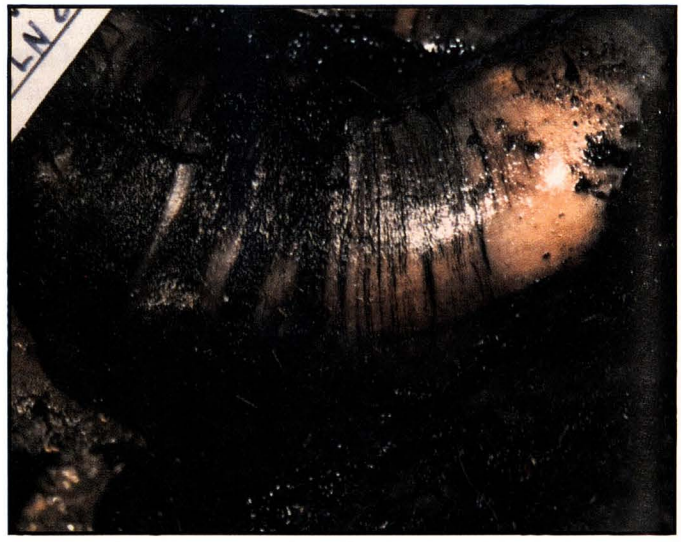

Figure 4. A 'bent' claw refers to a claw, the dorsal surface of which is concave. This is a second-lactation heifer in which the appearance of the claw has deteriorated over time. The deterioration closest to the coronary band is associated with a type-one sandcrack (one involving mainly the coronary band).

Figure 5. A second lactation heifer with a thimble. A thimble is formed when a fissure ruptures at the bearing surface and remains attached to the wall only by a small portion around the dorsal flexure. This is usually a very painful condition.

Figure 7. This type-one sandcrack is more or less confined to the coronary band. This claw is 'bent' (concave) and a disturbance in the centre of the wall is present.

Figure 6. This cow has a broken toe which is the sequel to a thimble. In this animal two grooves can be observed, the most proximal of which is associated with a sandcrack that is difficult to classify as type one or two. Note the typical 'buckling' at the axial border of each groove.

Figure 8. The appearance of the surface of this claw is normal. The classification of the sandcrack seen here would probably be type one.

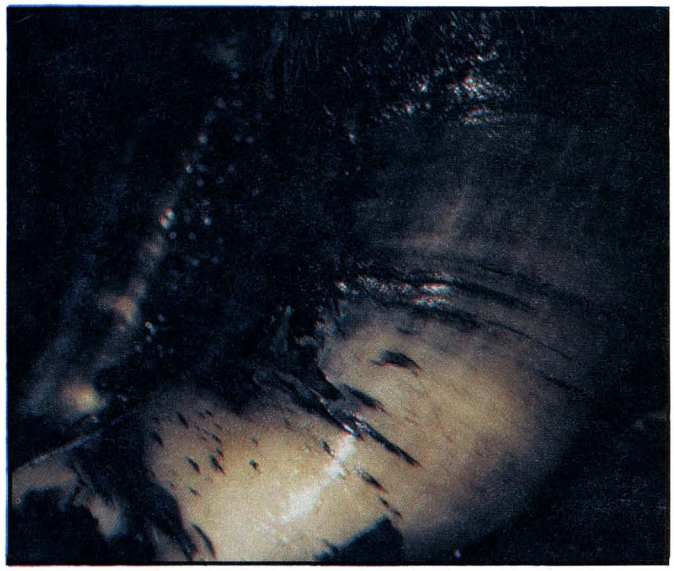

Figure 9. A type-two sandcrack extends from a groove or, in this case, grooves up to the coronary band. The appearance of the surface of this claw is normal. The claw is markedly 'buckled' around the axial borders of the two fissures.

Figure 10. A typical type-three sandcrack extends from the coronary band to the bearing surface. Frequently the dorsal surface of the claw is concave with this type of lesion resulting in reduced wear beneath the toe. This leads to the common misconception that sandcracks occur more commonly in large-footed animals.

Figure 11. Sandcracks can be repaired. The claw is trimmed in such a manner that weight is born only on the abaxial wall. The groove is then smoothed with a dremel tool.

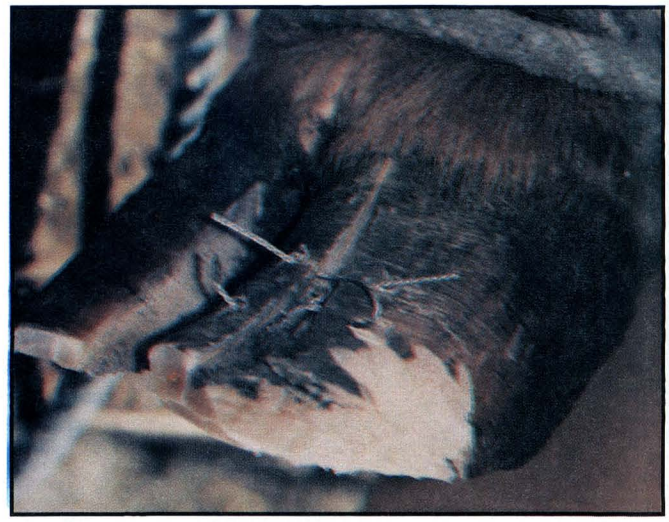

Figure 12. Holes are drilled in the walls of the smoothed crack and fetotomy wire laced across for reinforcement.

Figure 13. The lesion is then enclosed in methyl methacrylate.

Figure 14. One year later the condition has resolved into a type-four sandcrack. Natural resolution has been observed. The type-four sandcrack is, therefore, one that extends from the centre of the claw to the bearing surface.

Figure 15. Classified as a type-five crack, this photograph shows that rupture of the central region of the claw appears to be in progress.

Figure 16. A more typical type-five sandcrack which is confined entirely to the central region of the claw and is almost 'explosive' in appearance. Bending of the claw around the central disturbance is taking place.

Figure 17. A type-five sandcrack spreading proximally and distally from a groove.

Figure 18. A sandcrack extending proximally from a deep fissure.

Figure 19. A claw buckling around two grooves with a sandcrack extending proximally to the coronary band. The surface of the claw is rough in appearance.

Figure 20. The evolution of a sandcrack in a heifer. In the fall of the second lactation grooves, ridges and bending could be seen.

Figure 21. The following fall a sandcrack extended proximally from a groove (Type 2).

Figure 22. A year later the crack extended from the coronary band to the bearing surface (Type 3).

Table 5. Distribution of sandcracks by claw

Claws are numbered clockwise commencing at the front left lateral (FLL) claw. Note that numerous animals had more than one sandcrack (see Table 7).

Herd ID	*Claw 1* FLL	*Claw 2* FLM	*Claw 3* FRM	*Claw 4* FRL	*Claw 5* RHL	*Claw 6* RHM	*Claw 7* LHM	*Claw 8* LHL
#2 (109)	42	5	6	47	14	5	3	8
#1 (48)	21	2	0	21				

Table 6. Distribution of sandcrack by classification

Some animals had more than one type of sandcrack on several different claws.

Sandcrack *Classification*	Herd #1 *(44 cracks in 48 cows)*	Herd #2 *(130 cracks in 109 cows)*
Type one	4 (9%)	7 (5%)
Type two	7 (16%)	14 (11%)
Type three	21 (48%)	65 (50%)
Type four	5 (11%)	10 (8%)
Type five	7 (16%)	34 (26%)

Table 7. The average # of sandcracks per animal by age (four herds combined)

Age	1	2	3	4	5	6	7	8
Lesions per animal	0	1	1.42	1.48	1.52	1.71	1.71	1.71

Sandcracks were not present in the claws of first-lactation heifers except in the two herds with the highest incidence of the condition (#1 & #2).

Discussion

Sandcracks are associated with age, weight and fatness (Goonewardene and Hand, 1995). Our own observations confirm that as cows age they become heavier and are those most likely to be affected with a sandcrack (Campbell et al, 1996). This implies that an abnormal mechanical force is acting on the claw wall or that the tensile strength of the claw horn is unable to sustain that force.

Goonewardene and Hand (1995) suggest that over-conditioning cows at pasture is part of the problem. The possible etiology of claw abnormalities will be considered in part two of this paper.

The distinct majority of cracks occur on the front lateral claw (Table 5). The reason for this is unknown but we are of the opinion that differences in conformation and weight distribution are most likely causes.

Prior to this study it had been assumed that all sandcracks started as a type-one crack (Figures 4,6,7,8), that is, one starting at the coronary band. The two herds with the highest incidence of cracks (Table 6, herds #1 and 2) had examples of each type of crack. However, in both herds the prevalence of cracks involving only the coronary band (type-one) was less than those extending proximally from a horizontal defect in the centre of the claw (Figures 9,19,21).

Type-three sandcracks, those running from the coronary band to the bearing surface (Figure 10), are the most common type of fissure. Generally speaking, it was not possible to determine if they had originated from the coronary band or had been associated with an horizontal defect, although in many instances such a defect did exist.

The type-five crack presented the most intriguing problem in the entire study. Although classified as a crack, this type varied in severity from visible 'disturbances' in the centre of the dorsal wall (Figure 15) to an explosive reaction (Figure 16) or an obvious fissure (Figure 17). Type-five sandcracks were infrequently observed in the majority of herds. However, whenever they were observed, they gave a subjective impression that the central region of the claw had been subjected to mechanical tension or pressure or that the horn of the claw was of poor quality.

These observations raise the question, 'Do some cracks start from horizontal defects?' (Figures 18,19,20) and 'Are some cracks caused by the claw bending because the keratin has lost tensile strength?' (Figures 4 & 7).

For the purpose of discussion, it will be assumed that a relationship does exist between a horizontal defect and a sandcrack. In this event, it would be important to learn more about the cause of a horizontal defect. For example, if in spring a groove is found to be 4.28 cm from the skin/horn junction (on average), it will have grown at the rate of 0.32 cm per month for the previous eight winter months (for a total of 2.56 cm) and approximately 0.43 cm per month for the four summer months in the preceding year (for a further 1.72 cm). Thus the groove will have taken about one year to grow to the measured position. Although it cannot be claimed that measuring the movement of groove is yet an exact science, it would be reasonable to assume that the groove was formed around the time the cows were turned out to grass during the spring of the previous year. If the same procedure is applied to the groove observed in October, we can conclude that it was formed either when the cow calved early in the year or in response to extremely low temperatures or for a combination of both reasons. Plausible as the above method may seem, further study is needed. Horizontal defects can occur at any time of the year, and claw growth may be more variable in different age groups and under different systems of management.

Not all sandcracks are associated with a horizontal defect. Some cracks start in the coronary band of apparently normal claws. Cracks also occur in claws that are bent (Figures 4,7,9) many of which have changes visible in the characteristics of the surface of the keratin (Figure 4 & 6). It would be reasonable to conclude that there are several different mechanisms influencing the formation of a sandcrack.

Acknowledgments

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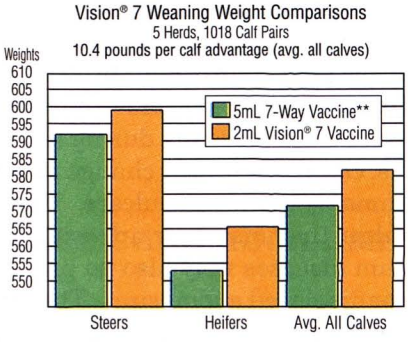

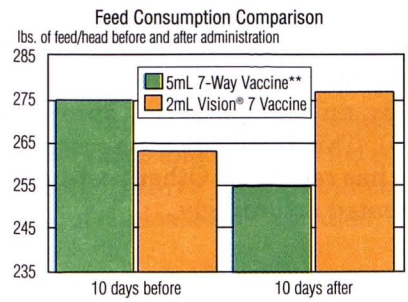

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