Roger Blowey Chris Walton

Gloucester

Fifth International Symposium on DISORDERS of the RUMINANT DIGIT

August 24 - 25, 1986

Veterinary College, University College, Dublin
Dublin, Ireland

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Columbia, Missouri 65211, U.S.A.

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INTRODUCTION AND ACKNOWLEDGEMENTS FOR THE FIFTH SYMPOSIUM ON DISORDERS OF THE RUMINANT DIGIT

Following correspondence among previous symposia participants during 1984 and 1985, it was agreed that Dublin appeared to be an ideal venue for another Symposium. The late Dr. Harry Greene of the Dublin Veterinary College gave every encouragement until his untimely death at the beginning of this year. Although lameness is a major topic in the World Association of Buiatrics Congress in Dublin in August 1986, it was felt that a more informal meeting preceding the congress, in the style of the four previous symposia (Utrecht 1976, Skara 1978, Vienna 1980 and Paris 1982) would be the preferable format.

Dr. John Hannan, Dean of the Veterinary Faculty, personally took over the role of local organiser and has given me every possible assistance. He has given us these facilities free of charge, will make us very welcome, and I am extremely grateful to him and his colleagues in Dublin.

The following pages contain a list of the registered participants to Aug. 15, and the papers and abstracts received by that same date. It is intended to publish the full proceedings later this year, and to include the major points made in discussion, for which several hours have been set aside in Dublin.

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PROCEEDINGS OF PREVIOUS SYMPOSIA IN THIS SERIES HAVE BEEN PUBLISHED AS FOLLOWS:

"Abnormal foot conditions in ruminants" Werkgroep Klauwonderzoek Herkauers Utrecht, Netherlands, April 4-8, 1976 (first symposium under Toussaint Raven & Peterse).

"Report on second symposium on bovine digital diseases" Veterinary Institute, Skara, Sweden, September 25-28, 1978 (Andersson).

"Third international symposium on disorders of the ruminant digit" Klinik fur Orthopädie bei Huf- and Klauentieren, Vet. Med. Universität Vienna, Austria October 1-5, 1980 (Knezevic).

"Fourth international symposium on disorders of the ruminant digit" École Nationale Vétérinaire, Maisons-Alfort, France October 7-10, 1972, Société Française de Buiatrie (Espinasse).

The "Colour Atlas on Disorders of Cattle and Sheep Digit - international terminology": by Espinasse, Savey, Thorley, Toussaint Raven & Weaver, produced as a result of requests by the Paris symposium participants, will be on sale at the Dublin symposium and at the Buiatrics Congress, price about US $20.

"There are diseases which may be said to be natural to cattle and which are productive of a great deal of pain, and materially lessen the profit which we derive from these animals. There is not a farmer who has not had cows in his dairy that have lost, for a time, full half of their milk, on account of the pain which tender or diseased feet have occasioned. There is not a grazier who has not occasionally lost the advantage of three or four months feeding from the same cause. In the London dairies tender feet is often a most serious ailment; and compels the milkman to part with some of his best cows, and in very indifferent condition too."

William Youatt 1834: "Cattle: their breeds, management and diseases" London: Baldwin and Craddock, p. 304

FINAL PROGRAMME (subject to alteration) 2 August 1986

SUNDAY 24 AUGUST 1986

1400 Greetings and Introduction: Dr. A.David Weaver (Missouri, USA)
Dr. John Hannan (Dean, Veterinary Faculty, Dublin)
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1435 Discussion
1440 Murphy, P.A. (Ireland): "Digital problems in intensively housed fattening beef cattle" (p.7)
1455 Discussion
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1520 Cheli, R. & Mortellaro, C.M. (Italy): "Digital dermatitis today and tomorrow" (p.8)
1535 Discussion
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0915 Bergsten, C., Andersson, L., & Wiktorsson, L. (Sweden): "Effect of feeding intensity at calving on the prevalence of subclinical laminitis" (p.33)
0930 Peterse, D.J., Van Vuuren, A.M. & Ossent, P. (Netherlands): "The effect of the rate of daily concentrate increase on the incidence of sole lesions in dairy cattle" (p.39)
0945 Mortensen, K. (Denmark):" Effect of high concentrate feeding on digital health in dairy cattle" (p.47)
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1100 Smart, M.E.(Canada):" Relationship of subclinical laminitis and nutrition in dairy cattle" (p.49)
1115 Greenough, P.R. & Gacek, Z.J. (Canada):"A preliminary report on a laminitis-like condition occurring in bulls under feeding trials" (p.50)
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1400 Discussion
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1420 David, G.P. (GB): " Cattle behaviour and lameness" (p.68)
1435 Peterse, D.J. (Netherlands): "Claw measurements as parameters for claw quality in dairy cattle" (p.76)
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1535 (Open discussion period (venue, date, organisation of next meeting)
(Informal presentation of non-programmed slides
(Discussion of related topics
1555 Russell, A.M. (GB):"The influence of sire on cow lameness" (p.81)
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EPIDEMIOLOGICAL FINDINGS IN RELATION TO LAMENESS IN IRISH DAIRY CATTLE WITH PARTICULAR REFERENCE TO ENVIRONMENTAL FACTORS

ARKINS, S., The Agricultural Institute, Moorepark, Fermoy, Co. Cork, Ireland
Paper presented by Professor John Hannan

The paper forms part of a Ph.D. study to be published shortly. The author and Professor Hannan asked that an abstract should not, under these circumstances, be published in these symposium papers. A list of S. Arkin's previous publications can be obtained by contacting Professor Hannan. Sean Arkins is currently working in the University of Illinois, U.S.A.

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DIGITAL DERMATITIS TODAY AND TOMORROW

by

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INTRODUCTION

The title of this paper is "Digital Dermatitis Today and Tomorrow", since the spreading of this lesion in recent years calls for a particular attention and control on its future development. Prof. Cheli and I, after our publication on the subject made in collaboration with Dutch colleagues (10), have received reports of new cases not only from Italy but from all over the world. Besides in Italy we have recently observed a constant high incidence not only in cows, but also in heifers.

CLINICAL FEATURES

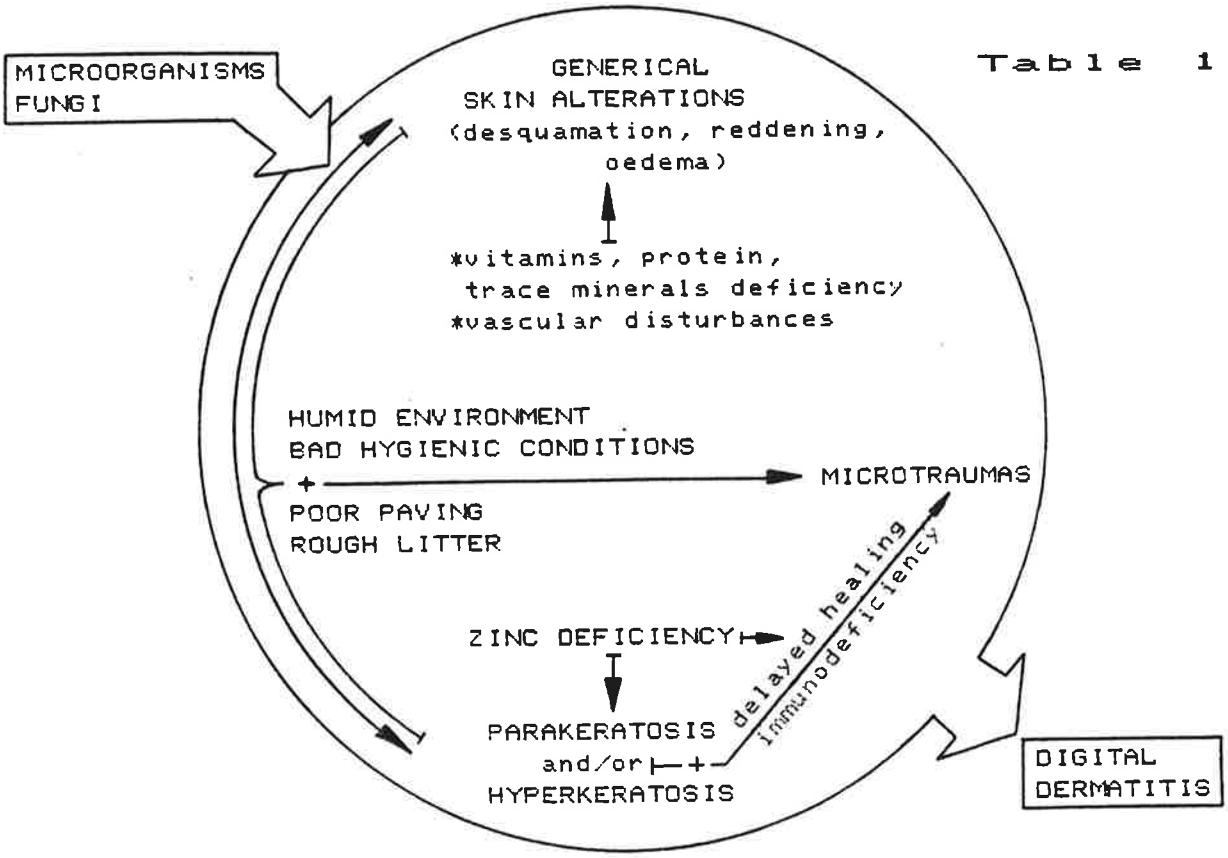
As you know, Digital Dermatitis (D.D.) consists in a skin phlogosis which affects the plantar, and more seldom, the dorsal part of the claw (mostly hind legs) (3, 4, 12).In particular it affects the digital skin above the coronet, more precisely in the transition area between the hairless skin of the interdigital space and the hairy skin, and we can observe often a spreading to the perioplic band, sometimes to the interdigital skin and, in rare cases, to the accessory digits (or dew claws). When the perioplic band is affected, the lesion is more serious because it involves the corium of the heel. Sometimes the phlogosis appears as a lesion with a specific ulcer characteristic, covered with abundant serous exudation and a tendency to turn into purulent exudation. We can in some cases notice the formation of superficial necrosis which can be related to a delayed discovery of the lesion.

On the basis of our experience we think that the interdigital area is seldom affected and, where it is, the affection develops only in a second time. What is certain is the polymorphism of the lesion.

From lesions typically ulcerative observed in the past years, we notice now the occurrence of proliferative forms. Between these two antithetical aspects, we have the strawberry-shaped lesion. The latter appears as a superficial lesion, well limited by the surrounding healthy tissue, situated right in the centre of the claw and equidistant from the two bulbs. As previously mentioned the strawberry aspect has both an ulcerative and a proliferative characteristic.

As far as aetiopathogenesis is concerned, after many years of investigations about the principal causes of D.D., researchers have not yet reached a univocal hypothesis. Until now the causes which seem to be predominant are: microorganism infections, micotic infections, nutritional disturbances, zinc and manganese deficiency (just to mention the most important trace elements), poor conditions of the paving of the stable floor and of the litter. In particular when the litter is made with maize stalks or other rough kinds of straw, it may irritate or even traumatize the soft tissue of the claw. With respect to nutrition the lack of zinc seems to play an important role in determining the lesion (8). Such lack can be ascribed either to the insufficient presence of the trace mineral in the daily food intake (primary deficiency) or to insufficient absorption and metabolism (secondary deficiency)(1). It is well known how a deficiency of this trace mineral causes some phenomena of parakeratosis (13,14). However, if this is true for deficiencies induced experimentally and only seldom clinically observed, the same cannot be stated for slight zinc deficiencies ascribed to nutrition. Yet blood checks carried out on various occasions on cows suffering from D.D. and on healthy cows, didn't reveal any substantial difference in blood zinc concentration (8). In the latest years, however,there has been an increasing tendency to integrate the diet with zinc supplements. But even in farms where cows have been given zinc supplements we have sometimes observed the occurrence, at the level of digital skin,of diffuse reddening, oedema, and eczema, all symptoms which might reveal an altered structure. This alteration may be associated either to a sub-clinical zinc deficiency or other deficiencies (e.g. trace elements other than zinc and vitamins) or to vascular troubles with unknown aetiology. Such an altered skin, when happens to be in a humid environment with bad hygiene conditions and a neglected litter, is particularly sensitive to the vulnerant action of a bad paving (slatted floor, concrete) or even more of a rough litter. One may therefore suppose that this contributes substantially to the occurrence of "solutions of continuity" which represent an ideal, though microscopic, vehicle for the ubiquitarian population of microorganisms which can finally carry out the strongest pathogenic action. The heterogeneity of the microbic strains, isolated through the various experiments carried out by Dutch colleagues (6) and ourselves (11,2), makes it very difficult to single out one specific microorganism responsible of a lesion where it is unanimously recognized that the bacteria component represents only the last phase of a process whose aspects are mostly unknown. In this context and in the optic of a finalized prevention, we wish to succeed in a near future in isolating the harmless bacteria from the ones surely responsible of the lesion. (Table 1 illustrates the above mentioned iter of D.D.).

Table 1



As to therapy it is no longer an insuperable problem. If once the only effective aid was represented by ample exeresis of the pathologic tissue, since 1981 (the year in which the first experiments of the Dutch colleagues were carried out) a very high percentage of lesions is surprisingly sensitive to an oxytetracycline hydrochloride and gentian violet association (5). We don't however deny the validity of other compounds marketed by the pharmaceutical industry to provide for the insufficient or lacking presence on the market of the above mentioned association. The compounds more easily available on the market are: chloramphenycole-gentian violet (spray); chloramphenycole-methyl violet (spray); chlorotetracycline - G.sodic penicillin - sulphamide (powder) and many others. As previously stated, these compounds are considerably less effective and require repeated treatments; whilst the association of oxytetracycline and gentian violet has given good results after one only application when uniformly sprayed on the lesion. Naturally before proceeding to the treatment, the part needs to be perfectly cleaned and dried and above all one must do a correct trimming to eliminate heel erosions, typical of the most inveterate forms. Thus a perfect isolation of the lesion can be obtained: a necessary condition and guarantee for a quick and definitive healing which generally takes place within 3-4 days after the treatment. Only in few cases the healing takes place after the 8th day. One more advantage is that the treated area does not need to be bandaged. Together with the most marketed products which require individual application, the Czecho-Slovak colleagues report excellent results recently obtained with a mass treatment of 5% formaldehyde baths (9). Our own experience and that of Dutch colleagues didn't achieve as good results, may be because the lesions we examined were more serious. At present at least 30% of the cases recently observed, especially when the surrounding tissues are affected (which occurs in cows) require a surgical treatment, traditional or not. Recently good results have also been obtained with crio-surgery (7). One should however resort to surgery only in extreme cases. Actually the post-surgical care involves many hours of work with consequent high costs; we therefore advise to evaluate each case carefully before choosing between a medical therapy and surgical excision. Of course great attention should be paid to prevention, especially by controlling high risk farms, which is not always easy, given the manifold aetiopathogenetic factors, more often suspected than singled out. It has been proved that copper sulphate and formaldehyde, effective in other lesions, don't represent a satisfactory prophylaxis in the case of D.D., which needs articulated prevention measures as the possible causes of the lesion are supposed to be a great many.

DISCUSSION

D.D. is a lesion which is spreading more and more not only in traditional stables but also in modern farms. Its high incidence (today about 25%) is however lower than it was when the first cases were observed by us in the past years (about 50%). The evident clinical polymorphism is unanimously accepted: we therefore observe small, circumscribed benign lesions with slight or no lameness as well as serious affections which spread also to the surrounding tissues. That is directly proportional to the hygienic conditions of the farm and this manifold aspect of the lesion sometimes causes some difficulty in diagnosing. The lesion is anyway fundamentally benign and the prognosis is constantly favourable.

Aetiopathogenesis is still unknown and the term "multifactorial" so widely used to define the causes of this disease obviously hides our ignorance about the specific responsible agents.

Therapy is easy on single subjects, whilst mass therapy is more problematical. In a near future we do wish to be able to carry out a mass therapy as effective as the association of oxytetracycline-gentian violet, which so far has proved to be the most successful in individual treatments. Even more important is prevention, which today is still too generical to give appreciable results. Hence the necessity to examine thoroughly and investigate "ex novo" further aetiologic aspects in order to achieve a proper prophilaxis. In this regard an epidemiological study on the lesion carried out with a greater collaboration among all world researchers might be of great help.

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(Leiter: OVR Prof.Dr.sc.O.Dietz)

English translation follows this paper

Untersuchungen zur anorganischen Zusammensetzung und zur Stabilität des Klauenhorns

von O.Dietz, J.Naumann und G.Prietz

Für die Erhaltung der Klauengesundheit spielt eine regelmäßige Klauenpflege eine entscheidende Rolle. Bei fachgerechten Pflegemaßnahmen im weitesten Sinn ist auf die Erhaltung und Verbesserung der Hornqualität zu achten. Nur Klauenhorn guter Qualität, d.h. ausreichender Widerstandsfähigkeit, sichert gesunde Klauen und wirkt sich positiv auf die gesamte Gliedmaßengesundheit aus.
Die Epidermis kann sich auf die unterschiedlich intensiv einwirkenden Belastungen durch einen differenzierten Grad ihrer Verhornung anpassen. Da diese Verhornung eine bestimmte Formbildung bedingt, ist für den Aufbau des Zehenendorgans die Umbildung von Schichten der Haut sowie bindegewebigen, knorpeligen und knöchernen Teilen von Bedeutung. So zeigt die Subkutis Verdickungen zum Beispiel am Ballen oder fehlt ganz zwischen Lederhaut und Klauenbein. Das Korium dagegen weist eine Vergrößerung des Papillarkörpers auf und stellt sich entweder in Gestalt leistenartiger Blättchen oder zottenförmiger Papillen dar (MICHEL und SMOLLICH, 1972; GÜNTHER, 1974).

Die Verhornung der Epithelzellen, deren ständige Neubildung vom Stratum germinativum aus erfolgt, beginnt im Bereich der oberflächlichen, sich bereits abflachenden Zellagen und schreitet mit zunehmendem Abstand von der Epithelbasis fort. Aus dem Stratum germinativum ergibt sich somit ein kontinuierlicher Fluß von Zellen zur Oberfläche. Zellteilungsrate, Fließgeschwindikeit, Verformung und chemische Umwandlung (Auftreten von Keratohyalingranula) sind räumlich und zeitlich miteinander koordiniert. Der Übergang in das Stratum corneum ist beinahe unmittelbar.

Für die Hornqualität sind neben den organischen Bestandteilen und bestimmten Strukturbildungen die anorganischen Bestandteile von Bedeutung.

Mechanisch-physikalische Klauenhornuntersuchungen mittels eines Härteprüfers (NAUMANN, 1984) brachten die Abhängigkeit zwischen Hornfeuchte und Härte (Shore-A-Härte) zum Ausdruck (Tab.1).

Tabelle 1: Hornfeuchte und Shore-A-Härte

Hornfeuchte	o	26,6	35,o	39,8	47,1
Shore-A-Härte	94	83	79	77	75
in %	1oo	88	84	82	8o

Unter Härte wird der Widerstand verstanden, den ein Material dem Eindringen eines härteren Körpers entgegensetzt (NITZSCHKE, 1981).

Im Durchschnitt wurden für die Sohlenhornhärte beim Rind 53o ± 12o µm gemessen. Die Art der Aufstallung führte zu signifikanten Mittelwertunterschieden. Kühe, die auf Vollspaltenböden mit Liegeboxen gehalten wurden, zeigten härteres Horn als Tiere unter konventionellen Haltungsmethoden (Anbindehaltung, Stroheinstreu).

Das Wasseraufnahmevermögen (WA) von Sohlen- und Wandhorn kann individuell stark variieren. Sohlenhorn des Rindes erreichte in den Versuchen 48 ± 8 %.

Die Druckfestigkeit ist ein weiterer Anhaltspunkt für die Ermittlung des Widerstandes, den das Horn entgegenzusetzen vermag. Unter Druckfestigkeit wird der Druckwiderstand je Flächeneinheit verstanden, der sich einer gleichmäßig verteilten Druckbelastung in Richtung der Längsachse entgegensetzt (NAUMANN, 1984). Druckversuche sind Umkehrungen der häufiger verwendeten Zugversuche. Die bei den Messungen entstehende Druckspannungs-Stauchungs-Kurve zeigt mit ihrem Gipfel die Druckfestigkeit an. Unsere Untersuchungen ergaben, daß die Druckfestigkeit des Sohlenhorns bei Pferd und Rind nahezu gleich ist. Dagegen erwies sich beim Pferd das Wandhorn als doppelt so druckfest wie das Sohlenhorn. Bei älteren Tieren erhöhte sich noch die Druckfestigkeit des Wandhornes.

Beziehungen zwischen der Hornfeuchte und der Intensität des Hornabriebs stellt CAMARA (197o) fest. Nach NAUMANN (1984) wird als Abrieb der Gewichtsverlust (in mg) eines definierten Probekörpers verstanden, der unter einer konstanten Andruckkraft gegen ein sich gleichmäßig bewegendes Reibematerial mit einer bestimmten Angriffsschärfe zustande kommt. Abriebversuche am Klauenhorn bei Mastrindern ergaben höhere Werte gegenüber der Abrieb zu.

Die Bestimmung verschiedener Mengen- und Spurenelemente geht unter Angabe der Bestimmungsmethoden aus Tab.2 hervor.

Tabelle 2: Bestimmungsmethoden von Mengen- und Spurenelementen

Element	Bestimmungsmethode
P	Photometrisch nach Molybdat-Vanadat-Methode
Cl	Potentiometrisch
S	Katalytische Verbrennung mit nachfolgender Absorption und Titration
Na, K, Ca, Mg, Fe, Cu, Mn, Zn	Atomabsorptionsspektralphotometrie

Zum Vergleich sind die errechneten Mittelwertunterschiede der chemischen Untersuchungen zwischen Wand- und Sohlenhorn des Pferdes und Sohlenhorn von Rind und Pferd in nachfolgender Übersicht wiedergegeben (Tab.3).

Tabelle 3: Mittelwertunterschiede von Wand- und Sohlenhorn des Pferdes und Sohlenhorn von Rind und Pferd

	Asche	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	
Wandhorn/ Sohlenhorn Pferd	+	+	+	+	ns	ns	ns	ns	ns	ns	+	
Sohlenhorn Rind/Pferd	+	ns	+	ns	ns	+	+	+	ns	+	+	+

+ statistisch signifikant, 5 % Irrtumswahrscheinlichkeit
ns nicht signifikant

Innerhalb des untersuchten Materials wurde im Sohlenhorn des Rindes ein Aschegehalt von 9,4 $\pm$ 3,7 g/kg Trockensubstanz (TS) festgestellt. Je größer das WA des Hornes, je höher lag der Aschegehalt. Tiere in Laufstallhaltung und auf Spaltenböden zeigten geringere Werte als unter konventionellen Bedingungen. Im Untersuchungszeitraum hatten klauenkranke Tiere signifikant niedrigere Werte als klauengesunde.

Der Schwefelgehalt (S) betrug im Durchschnitt des Untersuchungsmaterials 454 ± 99 mmol/l. Kühe der Rasse Holstein-Frisian besaßen den höchsten und Fleischrassen den niedrigsten Schwefelgehalt.

Der Natriumgehalt (Na) steigt parallel zum WA. Im Sohlenhorn des Rindes wurden im Mittel 32 ± 14 mmol/l gefunden. Fleischrindrassen hatten signifikant weniger Na als Rinder der Niederungsrassen.

Klauengesunde Rinder zeigten einen höheren Kaliumgehalt (K) als klauenkranke. In Anbindehaltung auf Stroheinstreu konnte ein höherer K-Gehalt festgestellt werden als bei Tieren in Laufstallhaltung. Im untersuchten Material betrug der K-Gehalt 61 ± 32 mmol/l. Horn von Rindern mit einem mittleren WA haben den niedrigsten K-Gehalt.

Für Kalzium (Ca) wurde im Sohlenhorn beim Rind ein Gehalt von 12 ± 5,7 mmol/l gefunden. Kühe aus Laufstallhaltung mit Vollspaltenböden besaßen gegenüber Tieren aus konventioneller Haltung einen höheren Magnesiumgehalt (Mg). Im Mittel waren 8,1 ± 2,8 mmol/l für das Sohlenhorn des Rindes zu finden.

Bei Phosphor (P) kann ein Durchschnittswert von 7,9 ± 4,3 mmol/l für das Sohlenhorn des Rindes angegeben werden. Die höheren Werte wurden bei Klauenerkrankungen und Laufstallhaltung auf Spaltenboden nachgewiesen.

Durchschnittlich lag der Chlorgehalt (Cl) im Rindersohlenhorn bei 81 ± 2o mmol/l. Fleischrindrassen zeigten signifikant mehr Cl im Horn als die übrigen.

Für den Eisengehalt (Fe) wurden im Rindersohlenhorn 2,o ± 3,1 mmol/l nachgewiesen. Kühe unter konventionellen Haltungsbedingungen zeigten signifikant niedrigere Fe-Werte als diejenigen unter modernen Haltungsformen. Auch die Fleischrindrassen hatten einen deutlich geringeren Fe-Gehalt aufzuweisen als Rinder von Niederungsrassen.

Bei niedrigem WA waren auch die Kupferwerte (Cu) im Sohlenhorn der Kühe niedrig. Durchschnittlich wurden o,o45 ± o,o29 mmol/l gefunden. Rinder der Fleischrassen besaßen ebenso wie klauengesunde Kühe geringere Cu-Werte als die übrigen untersuchten Rassen bzw. klauenkranken Kühe.

Auch bei der Ermittlung des Mangangehaltes (Mn) fiel auf, daß die getesteten Fleischrassen signifikant weniger im Sohlenhorn besaßen als die übrigen Niederungsrassen. Mit zunehmendem WA erhöhte sich der Mangangehalt signifikant. Es ließ sich feststellen, daß klauengesunde Kühe weniger Mn im Sohlenhorn hatten als klauenkranke. Im Gesamtmaterial war ein Mittelwert von o,o32 $\pm$ o,o44 mmol/l auszuweisen.

Mit wachsendem WA steigt der Zinkgehalt (Zn) ebenso an wie der Kupfergehalt im Rindersohlenhorn. Der Durchschnittswert im Untersuchungsmaterial belief sich auf 1,1o $\pm$ o,5o mmol/l.

Die Zusammenhänge zwischen mechanisch-physikalischen und chemischen Parametern sind in den Tabellen 4-6 zusammengefaßt.

Es kann festgestellt werden, daß die individuellen Unterschiede in den Prüfergebnissen nicht gering sind. Eine weite Streuung der Werte war sowohl bei den mechanisch-physikalischen als auch chemischen Untersuchungen feststellbar, was auch an der Standardabweichung erkennbar ist. Dennoch sind deutliche Unterschiede zwischen einzelnen Versuchsgruppen bezüglich der mechanisch-physikalischen Belastbarkeit des Hornes gegeben, so daß sowohl die Hornqualität objektiviert werden kann, als auch Faktoren zu erkennen sind, die diese beeinflussen.

Soll Klauenhorn den mechanischen Umwelteinwirkungen bei Aufrechterhaltung der Funktion der Hornkapsel möglichst hohen Widerstand leisten können, sind zur Charakterisierung der Hornqualität folgende mechanisch-physikalischen Prüfergebnisse zu beachten:

- geringer Abrieb
- hohe Härte
- hohe Druckfestigkeit.

Die Korrelationskoeffizienten dieser drei Parameter bestätigen diesen Zusammenhang.
Für hohe Belastungsfähigkeit wären demnach folgende möglichst hohe Korrelationskoeffizienten (K) wünschenswert:

Abrieb	-	negative K
Druckfestigkeit	-	positive K
Härte	-	negative K

Aus den Untersuchungsergebnissen läßt sich weiterhin ableiten, daß eine gute Hornqualität durch all jene Umstände begünstigt wird, die Feuchtigkeit vom Horn abhalten. Sprödigkeit mit Verringerung der Elastizität der Hornkapsel darf nicht erreicht werden, was für unsere Klima- und Haltungsbedingungen wohl nur als Ausnahmebedingung zu erwarten ist. Vielmehr ist dem Gegenteil eine größere praktischere Bedeutung beizumessen. Unter Beachtung der Korrelationskoeffizienten ist zu resümieren, daß man nicht davon ausgehen kann, daß ein möglichst hoher Wert dieses oder jenes Elementes unter Umständen eine gute Hornqualität reflektiert. Bezüglich des Aschegehaltes ist festzustellen, je niedriger dieser, desto günstiger die Ergebnisse der mechanisch-physikalischen Prüfung. Dazu verhalten sich ebenso günstig der Gehalt von Na, K, Mg, Cu und Zn.

Vergleicht man die anorganische Zusammensetzung des Hornes mit pigmentiertem und unpigmentiertem Horn, kommt man zu der Erkenntnis, daß sich ein differenzierter Pigmentgehalt nicht in der anorganischen Zusammensetzung widerspiegelt.

In den nach CESARINI (1979) existierenden drei Melaninklassen enthalten die Eumelanine Kupfer und Zink. Ihr genauer Aufbau ist noch nicht bekannt.

Für die direkte Beurteilung der Hornqualität durch mechanisch-physikalische Prüfverfahren ist der Härtemessung aus folgenden Gründen die größere Bedeutung beizumessen:

- Die Härtebestimmung deckt sich am ehesten mit der Gesamteinschätzung der Hornqualität.
- Das mechanisch-physikalische Prüfverfahren benötigt den kleinsten Probekörper (halbpfenniggroße Hornscheibe von 6 mm Dicke).
- Der materiell-technische Aufwand ist gering.

Neben der bedeutenderen Bestimmung der Härte ist die Feststellung des Wasseraufnahmevermögens sinnvoll.

Überlegungen zur Verbesserung der Hornqualität müssen sich in erster Linie auf die Hornbildung an der Lederhaut konzentrieren. Auch scheint es effektiver Untersuchungen zur Hornqualität vorwiegend bei Vatertieren durchzuführen, da für das Rind in der Literatur genetische Einflüsse genannt werden.

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Tabelle 4

Korrelationskoeffizienten der mechanisch-physikalischen und chemischen Untersuchungsergebnisse sowie des Wasseraufnahmevermögens (WA) im Rindersohlenhorn (x 10⁻³)

+ = Signifikanz bei einer Irrtumswahrscheinlichkeit von 5 %; n = 241

	Härte	Druckf.	Abrieb	WA	Asche	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Härte	x															
Druckf.	-433+	x														
Abrieb	484+	-584+	x													
WA	429+	-292+	358+	x												
Asche	307+	-208+	254+	316+	x											
S	120	028	021	004	087	x										
Na	235+	-133+	144+	169+	322+	001	x									
K	190+	-197+	215+	207+	419+	162+	228+	x								
Ca	014	-040	065	121	279+	113	220+	132+	x							
Mg	119	-041	129	249+	055	055+	311+	250+	450+	x						
P	-083	143+	-019	060	069	069	137+	024	681+	3[illegible]8+	x					
Cl	392+	-203+	342+	352+	396+	183+	364+	280+	034	1[illegible]8+	-003	x				
Fe	-060	078	-024	-014	-029	-029	041	-101	008	-0[illegible]	[illegible]11+	074	x			
Cu	184+	-093	157+	189+	-010	-010	411+	026	143+	0[illegible]	[illegible]74+	217+	185+	x		
Mn	-069	020	077	223+	-019	-019	097	031	623+	3[illegible]6+	765+	-064	269+	202+	x	
Zn	181+	-026	131+	179+	244+	244+	360+	144+	146+	234+	091	310+	048	208+	064	x

Tabelle 5

Korrelationskoeffizienten der mechanisch-physikalischen und chemischen Untersuchungsergebnisse sowie des Wasseraufnahmevermögens (WA) im Pferdesohlenhorn ($x = 10^{-3}$)

+ = Signifikanz bei einer Irrtumswahrscheinlichkeit von 5 %; n = 67

	Härte	Druckf.	Abrieb	WA	Asche	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Härte	x															
Druckf.	-234	x														
Abrieb	017	-043	x													
WA	103	300^{+}	284^{+}	xx												
Asche	216	076	-009	-007	x											
S	222	003	-052	197	175	x										
Na	157	159	270^{+}	291^{+}	463^{+}	158	x									
K	187	088	-034	-059	710^{+}	073	339^{+}	x								
Ca	-220	217	239^{+}	243^{+}	022	119	-101	080	x							
Mg	114	-121	052	183	019	163	104	079	-116	x						
P	034	412^{+}	108	463^{+}	-096	200	256^{+}	-054	090	090	x					
Cl	351^{+}	042	274^{+}	427^{+}	608^{+}	091	739^{+}	464^{+}	-045	050	258^{+}	x				
Fe	-049	033	-113	277^{+}	049	004	049	-036	084	182	354^{+}	-161	x			
Cu	-039	190	126	399^{+}	212	-018	212	219	195	027	445^{+}	425	334^{+}	x		
Mn	-009	174	156	273^{+}	-052	277^{+}	-052	-044	227	187	287^{+}	-040	294^{+}	143	x	
Zn	124	124	081	429^{+}	275	094	027	-020	159	144	243^{+}	126	385^{+}	220	450^{+}	x

Tabelle 6

Korrelationskoeffizienten der mechanisch-physikalischen und chemischen Untersuchungsergebnisse sowie des Wasseraufnahmevermögens (WA) am Pferdewandhorn ($x = 10^{-3}$)

+ = Signifikanz bei einer Irrtumswahrscheinlichkeit von 5 %; n=9

	Härte	Druckf.	Abrieb	WA	Asche	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Härte	x															
Druckf.	-118	x														
Abrieb	394	-118	x													
WA	588	-365	377	x												
Asche	145	043	-124	-516	x											
S	388	-343	400	097	487	x										
Na	444	-181	290	495	-046	-161	x									
K	243	-138	736+	029	469	641	280	x								
Ca	-330	228	-333	-169	-125	-314	-504	-437	x							
Mg	-185	258	407	-637	373	385	-469	454	036	x						
P	-578	307	-362	-927+	395	-323	-259	-118	260	525	xx					
Cl	-067	531	-163	231	-769	-486	-158	-321	-430	-500	-302	x				
Fe	-123	197	187	-178	-175	365	-509	-142	173	446	112	-196	x			
Cu	-068	-332	226	463	-720	-057	131	-300	005	-267	325	109	575	x		
Mn	083	-068	178	191	-292	475	-455	-185	128	131	-306	005	894+	651	x	
Zn	-079	-805+	393	[illegible]	[illegible]	311	-482	-096	308	331	-221	-487	765+	626	797+	x

Translation 26

Sektion Tierproduktion und Veterinaermedizin der Humboldt-Universitaet zu Berlin, Chirurgische Tierklinik, Zentrale Roentgenabteilung
(Leiter: OVR Prof. Dr. sc. O.Dietz)

Inorganic composition and physical properties of bovine digital horn

O.Dietz, J. Naumann and G. Prietz

Regular hoof-trimming plays an important role in the maintenance of healthy bovine digits. The maintenance and improvement of horn quality depends on professional care in its widest sense. Only good quality digital horn, ie of adequate resistance, guarantees healthy claws and plays a positive role in maintaining health in the limb as a whole.
The epidermis can adapt itself to a variety of severe stresses by its differentiated degree of keratinisation. As this keratinisation requires a specific change of structure, the changes occuring in the different layers of the skin, as well as in connective tissue, cartilage and bone are of significance. The subcutis is for example thicker in the heel bulbs, and is entirely absent between the sensitive laminae and the distal phalanx. The corium usually has a thickened papillary layer and forms either plank-like leaves or villous papillae (Michel and Smollich 1972; Guenther 1974).
Keratinisation of the epithelial cells, which are continuously produced from the Str. germinativum, begins near the superficial flattened basal cells and progresses rapidly with increasing distance from the germinal epithelium. The Str. germinativum produces cells which move progressively towards the surface. The rate of cell mitosis, their speed of movement, alteration in shape and chemical composition (keratohyalin granules) are all coordinated in terms of space and time. The alteration to the Str. corneum is almost immediate.
Horn quality depends on the inorganic components, as well as organic and structural properties.
Physical examination of digital horn with a hardness tester (Naumann 1984) showed a relationship between horn moisture content and hardness (Shore A hardness) (table 1):

Table 1 Horn moisture and Shore A hardness

Horn moisture	0	26.6	35.0	39.8	47.1
Shore A hardness	94	83	79	77	75
in %	100	88	84	82	80

Hardness is defined as the resistance of a material to penetration by a harder object (Nitzschke 1981). The mean bovine sole horn hardness was 530±120 µm. The type of housing caused significant changes in mean values. Cows kept on slats with cubicles (SC) in loose housing had harder horn than cattle kept in conventional tied stalls and with straw bedding (TS). The moisture uptake capacity of sole and wall horn can vary considerably. Cattle sole horn had values of 48± 8%.
Resistance to pressure indentation is another indicator of horn quality, and is the pressure per square unit opposing an evenly distributed pressure acting along its long axis (Naumann 1984). Pressure recordings are the opposite of traction tests. Our experiments showed that the resistance to pressure of bovine and equine horn was very similar. However equine wall horn was twice as resistant as sole horn. The values increased with age.
Camara (1970)showed a relationship between horn moisture and the degree of wear.. Naumann (1984) defined wear as the loss of weight (mg) undergone by a specific sample occuring against a constantly rotating abrasive material of specific quality and having a specific pressure. Wear tests on digital horn from beef cattle had higher values than other breeds. Increasing moisture content increased the wear rate.
Horn analysis for macro-and trace elements was carried out using various methods:
P Photometric by molybdate-vanadate method
Cl Potentiometry
S Catalytic, followed by absorption and titration
Na,K,Ca,Mg,Fe,Cu,Mn and Zn: Atomic absorption spectrophotometry

For comparison purposes, table 3 (below) gives the mean differences in chemical analysis between wall/sole horn of the horse and sole horn of horse/cattle.

Table 3 Differences in mean values of wall and sole horn of the horse, compared with sole horn of horse and cattle

	Ash	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Wall/Sole horn horse	+	+	+	+	ns	ns	ns	ns	ns	ns	+	+
Sole horn horse/cattle	+	ns	+	ns	ns	+	+	+	ns	+	+	+

+ statistically significant at 5% level; ns not significant

Cattle sole horn contained 9.4±3.7g ash / kg dry matter. Ash content increased with water content. Animals in free stalls and on slats (SC) had lower values than cattle housed conventionally (TS). In the study period, cattle with digital disease (DD) had significantly lower ash values than healthy cattle (HD)
S content: mean 454±99 mmol/l, higher in Holstein Friesians, lower in beef cattle.
Na content: values strictly related to the moisture content, mean value in bovine sole horn was 32±14 mmol/l. Beef breeds had significantly lower values than Holstein Friesians.
K content: Values were higher in HD than DD cattle, higher in TS than SC. Mean content was 61±32 mmol/l. Cattle with medium moisture content in sole horn had lowest K values.
Ca content: 12±5.7 mmol/l
Mg content: 8.1±2.8 mmol/l (higher in SC)
P content: 7.9±4.3mmol/l (higher in DD and in SC)
Cl content: 81 ±20 mmol/l (higher in beef breeds)
Fe content: 2.0±3.1 mmol/l (lower in TS, much lower in beef breeds)
Cu content: 0.045±0.029 mmol/l (lower in lower moisture content. lower in both beef breeds and HD than in dairy breeds and DD)
Mn content: 0.032 ± 0.044 mmol/l (lower in beef breeds, higher with increased moisture content, lower in DD)
Zn content: 1.10± 0.50 mmol/l (higher with increased moisture content)

The relationships between physical characteristics and chemical analysis is shown in figs. 4-6 (see last pages).

Individual variations in test results were not small. A wide range of both physical and chemical parameters was evident as shown in the standard deviations. Obvious differences in physical resistance were recorded between different test groups, making possible both objective measurements of horn quality and of those factors influencing quality.
If digital horn is to offer a high resistance to mechanical stress to maintain normal function of the horny capsule, the following qualities are desirable: low wear rate; high degree of hardness; high resistance to indentation.
The correlation coefficient of these parameters confirmed these relationships. High correlation coefficients (K values) are also desirable for good weight-beraing qualities:Wear -ve K; resistance to indentation+ve K; hardness -ve K.
The results also show that good horn quality is promoted by all factors keeping moisture from the horn. Splitting of the horn with loss of horn elasticity should not occur, and is very exceptional under our (GDR/DDR) climatic conditions. In summarising the correlation coefficients, one cannot assume that a high value of this or that element will be reflected in good quality horn under certain circumstances.
The lower the ash content, the better the results of mechanical testing. The content of Na,K, Mg, Cu and Zn also reflect favourable conditions.
Compparison of the inorganic composition of pigmented and unpigmented horn showed no significant differences. Cesarini (1979) found three melanin classes contained the eumelanins Cu and Zn. Their precise structure is not known.
For direct estimation of horn quality by mechanical means the degree of

hardness is the most important for estimation because:
1. hardness correlates best with the overall estimation of horn quality;
2. the test method requires the smallest sample of material (a disc about 8 mm diameter, 6 mm thick);
3. the equipment and running costs are low.
Apart from determination of hardness, estimation of the moisture content is also sensible.
Consideration about possible improvements in horn quality must be primarily concentrated on horn formation by the corium. It would appear that more useful examinations could be done by concentrating on male breeding stock, because geneticinfluences have been cited in the veterinary literature.
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Table 4

Correlation coefficients of physical and chemical estimation and of water uptake capacity of cattle sole horn $(x = 10^{-3})$

+ = significant at 5% level n = 241

	Hardness	Elasticity	Wear	Moisture	Ash	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Hardn.	x															
Elast.	-433+	x														
Wear	484+	-584+	x													
Moist.	429+	-292+	358+	x												
Ash	307+	-208+	254+	316+	x											
S	120	028	021	004	087	x										
Na	235+	-133+	144+	159+	322+	001	x									
K	190+	-197+	215+	207+	419+	162+	228+	x								
Ca	014	-040	065	121	279+	113	220+	132+	x							
Mg	119	-041	129	249+	055	055+	344+	258+	450+	x						
P	-083	143+	-019	060	069	069	137+	024	681+	328+	x					
Cl	392+	-203+	342+	352+	396+	183+	364+	280+	034	138+	-003	x				
Fe	-060	078	-024	-014	-029	-029	041	-101	008	-053	141+	074	x			
Cu	184+	-093	157+	189+	-010	-010	411+	026	143+	096	174+	217+	185+	x		
Mn	-069	020	077	223+	-019	-019	097	031	623+	326+	765+	-064	269+	202+	x	
Zn	181+	-C26	131+	179+	244+	244+	360+	144+	146+	234+	091	310+	040	200+	064	x

Table 5

Correlation coefficients of physical and chemical estimation and of water uptake capacity of equine sole horn ($x = 10^{-3}$)

+ = significant at 5% level   n = 67

	Hardness	Elasticity	Wear	Moisture	Ash	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Hardn.	x															
Elast.	-234	x														
Wear	017	-043	x													
Moist.	103	300+	284+	xx												
Ash	216	076	-009	-007	x											
S	222	003	-052	197	175	x										
Na	157	159	270+	291+	463+	158	x									
K	187	088	-034	-059	710+	073	339+	x								
Ca	-220	217	239+	243+	022	119	-101	080	x							
Mg	114	-121	052	183	019	163	104	079	-116	x						
P	034	412+	108	463+	-096	200	256+	-054	090	090	x					
Cl	351+	042	274+	427+	608+	091	739+	464+	-045	050	258+	x				
Fe	-049	033	-113	277+	049	004	049	-036	084	182	354+	-161	x			
Cu	-039	190	126	399+	212	-018	212	219	195	027	445+	425	334+	x		
Mn	-009	174	156	273+	-052	277+	-052	-044	227	187	207+	-040	294+	143	x	
Zn	124	124	081	429+	273+	094	027	-020	159	144	243+	126	385+	220	450+	x

Table 6
Correlation coefficients of physical and chemical estimation and of water uptake capacity of equine wall horn ($x = 10^{-3}$)

+ = significant at 5% level   n = 9

	Hardness	Elasticity	Wear	Moisture	Ash	S	Na	K	Ca	Mg	P	Cl	Fe	Cu	Mn	Zn
Hardn.	x															
Elast.	-118	x														
Wear	394	-118	x													
Moist.	588	-365	377	x												
Ash	145	043	-124	-516	x											
S	383	-343	400	097	487	x										
Na	444	-181	200	495	-046	-161	x									
K	243	-133	736+	029	469	641	280	x								
Ca	-330	218	-333	-149	-125	-314	-504	-437	x							
Mg	-185	230	407	-637	373	385	-469	454	036	x						
P	-578	307	-362	-927+	393	-323	-259	-118	260	525	xx					
Cl	-067	531	-163	231	-769+	-486	-158	-321	-430	-500	-302	x				
Fe	-123	197	187	-178	-175	365	-509	-142	173	446	112	-196	x			
Cu	-068	-332	223	463	-726+	-057	131	-300	005	-267	325	109	575	x		
Mn	083	-068	178	191	-292	475	-455	-185	128	131	-306	005	894+	651	x	
Zn	-079	-805+	393	186	155	311	-482	-096	308	331	-221	-487	765+	626	797+	x

PATHOGENESIS OF LAMINITIS IN CATTLE 32

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ABSTRACT

A review of recent research concerning the pathogenesis and the pathophysiology of laminitis is presented. Hypotheses discussed are based on the assumption that results obtained from equine experiments are valid for cattle too.

Circulating toxins, e.g., from mastitis, metritis, or coecum/rumen acidosis may cause acute laminitis directly by damage of the capillary endothelium or indirectly by the associated coagulopathy and released vasoactive mediators. Allergic reactions, as precipitation of immune complexes during acute glomerulonephritis, may cause acute laminitis too and in both situations the clinical severity of the disease is influenced by the level of stress factors such as too little exercise, mechanical trauma, overburdening, etc., that predispose the animal to laminitis. The possible pathophysiology at which the many different factors converge may be summarized as follows: Laminitis induced experimentally, e.g., by coecum/rumen acidosis is assumed to be caused by latent , reversible shock with initiating peripheral vasocontraction and possible coagulopathy. The hypoxy of the capillary system provokes autoregulatory or similar vasodilation with the aim of keeping up the flow. Ischaemic or endotoxin-derived injuries of the endothelia plus bradykinin-like substances increase the capillary permeability and, ultimately, the tissue pressure in the unyielding digit. As the intraungular tissue pressure increases the capillary flow decreases, pain is intensified, and capillaries, arterioles, and arteriovenous shunts are dilated to a maximum while a post-capillary contraction or blockage is retained either because of pain or thrombes. The stagnation of blood and development of edema and further increased intraungular tissue pressure creates a vicious circle, as the flow in the capillary system stops when the tissue pressure has reached the diastolic pressure while exudation and haemorrhage can proceed until the systolic pressure is reached.

Chronic laminitis with subclinical debut is not likely to be elicited by one single factor as circulating endotoxins, as the disease intensity is too low compared to the severe clinical symptoms of endotoxemia. The cause of chronic laminitis with subclinical debut should rather be considered as a combination of predisposing factors leading to changed vascular reactivity and inhibition of normal keratin synthesis. Besides the already mentioned factors hormonal changes as prolonged stress, metabolic changes, e.g., because of fatty liver and changed nutrient supply, and immunologic changes could participate in the induction of the low intensity chronic laminitis with subclinical debut.

Effect of feeding intensity at calving on the prevalence of subclinical laminitis

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According to Peterse (1980) subclinical laminitis occurs at almost every calving when defined as haemorrhages in the sole horn, sole ulcers (pododermatitis circumscripta) and slight laminitic rings in the hoof wall. The prevalence of haemorrhages in the sole is approximately 60 per cent in Swedish dairy cows (Andersson and Lundström, 1981). Higher prevalences of haemorrhages in the sole and/or sole ulcers have been found due to high concentrate rations at calving (Peterse, 1979) or during the first month of lactation (Livesey and Fleming, 1984; Peterse et al. 1984). The present investigation was aimed to increase the knowledge about the influence on subclinical laminitis of feeding intensity at calving, when using Swedish feedstuffs. Fifty Swedish Red and White cows (25 primiparae) were randomly selected to experimental or control groups. All animals were given 7,5 kg dry matter roughage (hay and silage) daily. The increase in feeding intensity in both groups started 21 days before expected calving. At calving, control primiparae were given 3 kg and older cows 4 kg concentrates, which contained 70 percent grain and 30 percent protein feed. Corresponding amounts for experimental animals were 7 and 9 kg respectively. Two days after calving the amounts of concentrates were gradually increased so that all animals were fed 10-12 kg of concentrates daily according to milk yield from two weeks after calving. The hoofs were trimmed 3-4 weeks before and 12-13 weeks after calving. The soles were photographed at the time of trimming. All slides were judged at one occasion. Every sole was graded from 0-5 according to the degree of lesions. A total point was formed for each animal by adding the individual sole points. This preliminary report evaluates the change in total points from first to second trimming in twenty cows. There was no significant difference between experimental and control groups. The overall mean total point increased from 1.8 (S.D.=2.8) to 5.1 (S.D.=4.2) between the trimmings. There was a tendency to a more pronounced increase in the experimental group. The insignificant difference between groups in the present investigation may possibly be explained by the fact that both groups were given high concentrate rations compared to those used by Peterse (1979).

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Effects of Feeding Intensity at Calving on the Prevalence of Subclinical Laminitis

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INTRODUCTION

Clinical laminitis usually occurs during the peripartal period (Nilsson, 1963; Andersson, 1980). More often the disease exists as a less serious, subclinical variant, characterized by haemorrhages in the sole, by sole ulcers, and by weakly developed laminitic rings in the hoof wall (Peterse, 1980).

Andersson and Lundström (1981) reported sole haemorrhages in 60% of a random sample of cows from a Swedish slaughter-house, agreeing with Peterse (1980) who had also noted that such haemorrhages are common in cows without clinically manifest symptoms.

The relationships between levels of feeding intensity and certain digital lesions (e.g. laminitis, haemorrhages in the sole, sole ulcers) have been studied by several authors. Livesey and Fleming (1984) found that a low fiber diet resulted in laminitis and sole ulcers in 68 and 64% of the cows, respectively. When supplied with high fiber rations only 8% of the animals subsequently showed signs of laminitis. The incidence of sole ulcers was equally low. Peterse et al. (1984) reported the incidence of sole ulcers in cows receiving relatively small amounts of roughage and high amounts of concentrates to be about twice (58 versus 27%) that of animals receiving mainly roughage.

The aim of the present investigation is to determine how the official Swedish feeding standards, which stipulate relatively high amounts of concentrates a the time of calving, affect the occurrence of subclinical laminitis. The results are preliminary and are based on only a part of the total material.

MATERIALS AND METHODS

Fifty-four Swedish Red and White cows from two different experimental herds were included in the study. Thirty-six of the animals were primiparae. The others were up to 8 years old. They were randomly divided into two groups. The control group consists of 26 animals (16 primiparae) and the experimental group of 28 (20 primiparae). The results presented here are based on data from 20 animals.

The daily amounts of diet roughage were equal in both groups throughout the experimental period (ca. 7.5 kg dry matter hay and grass silage). The concentrates included 20-30% protein feed and 70-80% grain.

About 3 weeks before expected calving, after a period of some weeks during which no concentrates or only small amounts had been offered to the animals, diet concentrates were successively increased. At calving the primiparae and the older cows of the control group were given 3 and 4 kg of concentrates, respectively. The corresponding figures for the experimental group were 7 and 9 kg.

After calving, the daily ration of concentrates in the diet was further increased to reach 10 kg for primiparae and to 12 kg for older cows at 16 days post partum in both groups. Thus the postpartal increase in diet concentrates was more rapid in the control group than in the experimental group. Thereafter, food rations were adjusted to milk yield.

The hoofs of all animals were trimmed 3-4 weeks before expected calving, 5-6 weeks post partum, and 12-13 weeks post partum.

To evaluate the health of the hoofs as objectively as possible all soles were photographed at each trimming with an Olympus OM2 camera with a 50 mm macrolens and ring-flash attachment. A colour slide film 50 ASA was used.

A large number of slides were examined during each evaluation session. The evaluator did not know whether slides were of experimental animals or of control animals.

Haemorrhages in the sole were graded according to a 1-5 point scale. (The value of zero indicates a sole free from lesions). The colour intensity and extensiveness of the lesions were considered. One, 2-3, and 4-5 points were used to designate slight, moderate, and serious lesions (including sole ulcers), respectively. The sum of point for all eight hoofs was calculated for each cow. She was then placed in one of three point classes: 0-2 points, class I; 3-6 points, class II; and 7 points or more, class III.

RESULTS

Table 1 shows the distribution in total point classes, for the two groups together, on each of the three trimming occasions. There was clearily an increase in total points from the first to the third trimming.

Table 1. Distribution in total point classes before and after calving (n=20).

Total point class	3-4 weeks pre partum		5-6 weeks post partum		12-13 weeks post partum	
I (0-2 points)	16	(80%)	13	(65%)	6	(30%)
II (3-6 points)	3	(15%)	5	(25%)	9	(45%)
III (7- points)	1	(5%)	2	(10%)	5	(25%)

The most serious lesions in separate hoofs, given 4-5 points, were only found among cows in the experimental group.

The mean total points 3-4 weeks before calving was 1.75 in the experimental group and 1.88 in the control group. At trimming 12-13 weeks post partum the means were 5.17 in the experimental group and 5.00 in the control group.

DISCUSSION

The amount of material hitherto analysed is too small to permit statistical analysis. There were, however, tendencies towards more severe lesions after calving in the experimental group. The greater difference in mean total points between the first and third trimming in the experimental group and the fact that the most serious individual lesions were found only in the experimental group indicate that the higher prepartal feeding intensity may have led to a more severe inflammatory reaction in the corium. These results are mainly in accordance with those presented by Peterse (1979).

Overall, the intensity and extensiveness of the haemorrhages in the sole showed a marked increase between 3-4 weeks pre partum and 12-13 weeks post partum. Considering horn growth, it seems reasonable to assume that lesions of the sole horn, which are found at trimming about 12 weeks postpartum, originate from inflammatory processes in the corium during the peripartal period. In addition to high rates of feeding during the peripartal period, the lesions may also be triggered by other factors (e.g. age, stable conditions, hormonal influence). Additional studies are in progress at our institute to investigate the importance of such factors.

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THE EFFECT OF THE RATE OF DAILY CONCENTRATE INCREASE ON THE INCIDENCE OF SOLE LESIONS IN DAIRY CATTLE

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SUMMARY

In an experiment the effect of the feeding management after calving on the incidence of haemorrhages on the sole was studied in 30 Dutch Friesian heifers. A rapid and slow daily increase of concentrate were compared.

Feed intake, ruminal fermentation parameters and blood concentrations of lactic acid and endotoxin were registrated.

Load distribution between the lateral and medial hind claw was measured and the hind claws were scored for presence of lesions.

It is discussed why no differences between the control and experimental group could be observed.

INTRODUCTION

One of the serious lameness problems in Dutch dairy cows is the occurrence of haemorrhages in the sole of the hind lateral claws. These can be observed both in heifers and older cows during the first part of the lactation period. In serious cases there is a short period between calving and the lameness symptoms. At inspection the haemorrhages are very extended and not concentrated to the white line and the typical sole-ulcer localization.

This constant interval between calving and lameness caused by such sole lesions is obvious in all surveys. The reason for this connection is not clear but it is supposed that the laminitis process which can produce these haemorrhages, is induced by the management during the calving and post-calving period. An aspect that changes very substantially is the nutrition. In Dutch circumstances a ration of nearly 100% roughage (wilted grass-silage) before calving alters within the fortnight after calving to a ration with more than 10 kg of concentrates. The adaptation of the ruminal fermentation is critical and the ratio's roughage-concentrate is often too narrow in this period.

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The need was felt to test the effect of the postcalving feeding management on the laminitis incidence in an experimental situation, which should be rather similar to circumstances in practice.
In an experiment were compared heifers fed a rapid increasing amount of concentrate to heifers with a more gradual increase of concentrate in their ration.

MATERIAL AND METHODS

For the experiment 2 x 12 Dutch Friesian heifers without and 2 x 3 heifers with a rumen canula were used. Before the experiment they were housed in a cubicle stall with a full concrete floor. One week before calving they moved to a stanchion barn and 6 weeks after calving they returned to the cubicle barn.
All animals were fed individually in two equal meals. Before calving rations for both groups were equal, being roughage ad libitum and 1 kg of concentrate per day. Roughage was a mixture of maize silage and wilted grass silage (50/50 on a dry matter basis), and contained 385 g dry matter (DM)/kg, 668 g digestible organic matter (DOM)/kg DM, 21 g nitrogen (N)/kg DM and 126 g starch/kg DM. The concentrate was a commercially obtained pelleted compound mixture, containing 883 g DM/kg, 760 g DOM/kg DM, 35 g N/kg DM, and 186 g starch/kg DM.
One day after calving all animals received 3 kg of concentrates. From then on the concentrate offered to the heifers in the experimental group was daily increased with 2 kg, while the animals in the control group daily received 0,5 kg extra. Maximum concentrate intake was 10 kg per day.
The claws were inspected 1 week before and 6, 8 and 10 weeks after calving and scored for sole lesions (Peterse, 1980). Also the load on the lateral and medial claws was measured before and 8 weeks after calving with help of a double force-plate apparatus (Ossent a.o.).
Feed intake was daily and milk production weekly registrated.
Rumen fluid samples were taken from the cannulated animals one day prepartum and on the (first) day they consumed 3, 5, 7 and 10 kg of concentrates. Rumen samples were taken at regular hours, starting immediately before feeding concentrate in the morning, until 7 hours after this meal, and analysed for pH, volatile fatty acids (Robinson et al., 1986), D- and L-lactate (enzymatic tests, Boehringer, Mannheim, FRG) and endotoxins (LAL-test).

Immediately before rumen sampling, blood samples were collected from the jugular vein (Vacutainer, Becton-Dickinson), and analysed for D- and L-lactate and endotoxins.
It was considered to investigate the (acetyl)histamin concentration in the rumen blood and urine but analytical problems and the poor expectation after other results from the experiment were worked out, cancelled this part of the study.
Six weeks after calving the fistulated heifers have been slaughtered and the claws, especially the pododerm has been pathologically and histologically examined.

RESULTS

At the inspection of the claws before calving none or very minor haemorrhages were noticed but after calving the situation changed and a for Dutch circumstances rather high frequency of sole-lesions was observed (table 1). However both in the experimental and in the control group.
In table 2 the load distribution between the lateral and medial claw before calving and after calving is shown.
Before calving certainly no overloading of the lateral claw could be observed but after calving the situation changed adversely for the lateral claw.
The differences in feed intake between both groups are visualized in figure 1. Although roughage intake in the experimental group was less than in the control group, the proportion of concentrate in the diet never exceeded 65 percent. Three animals of the control and four animals of the experimental group refused concentrate on one or two occassions.
Rumen fermentation characteristics were not different between treatments ($P > 0,05$), except for pH-values, being significantly lower for the experimental treatment when feeding 5 kg of concentrates (6,1 versus 6.5). Hours pH < 6.0 were also significantly different on this day (figure 2).
DL-lactate concentrations in the rumen peaked between 30 and 90 minutes after feeding. Slightly over 50 percent was D-lactate. The highest concentration measured was 19.6 mmoles DL-lactate/l. in one heifer from the experimental group receiving 7 kg of concentrates/day. D-lactate was not observed in blood plasma. Plasma levels of L-lactate varied around 0.6 mmoles/l.
Endotoxins could been indicated in nearly all rumen samples independent of

sampling day after calving or sampling time after feeding. On the contrary all blood samples were negative. The sensitivity level has been 0,5 ng. The pathological examination of pododerm parts from the wall and the sole gave hardly information. Slight hyperaemia was noticed in one heifer from the experimental and one from the control group.
Milk production and its contents of fat and protein did not show substancial differences; 22,0 FCM for the control and 22,7 for the experimental group.

DISCUSSION

In contradiction with our expectations no difference in sole lesion incidence between the experimental group and the control group could be observed. The incidence in the control group was too high and in the experimental group too low. In both groups 3 heifers with sole ulcers were found. Normally the frequency in such heifers scored according the same system is 15% (Peterse, 1980). The main reason for the lack of difference is that the expected aimed difference in feed intake is not obtained. Extreme situations of an overconsumption of concentrate in ratio of the roughage did not happen, thus preventing serious disturbances in rumen fermentation, as confirmed by the results from the cannulated animals. Hours pH < 6.0 was relatively high in both treatments, but did not apparently lead to digestive disorders. D-lactate and endotoxins, may be essential agents in the laminitis process, have not been observed in blood samples.

Reasons for the balanced intake may be the individual, guarded feeding and good craftmanship of the stockmen who have observed and corrected deraillements in a very early stage. Another possible reason could be the composition of the ration. The concentrate mixture was rich in protein and, as a consequence, ingredients with a relative low content of readily fermentable carbohydrates were chosen. This may have resulted in a more gradual fermentation in the rumen (De Visser & De Groot, 1981).
At the other hand the high incidence of sole lesions in the control group has to be explained. In this connection can be referred to other experiments in which two levels of concentrate feeding were compared. In both experiments the high concentrate (±10 kg) groups had more sole ulcers (Peterse a.o., 1984).

Quantity seems to be important. However it makes not clear along which pathway the laminitic process happens.
Loading of the lateral claw is probably a attributing factor but in this experiment overloading was certainly not the reason for the high incidence of the laminitis symptoms.

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Table 1. Incidence of sole-lesions in heifers fed a rapid or a slow increase in the concentrate ration after calving

number of lateral hindfeet with	"rapid"	"slow"
no lesions	2	1
minor lesions	4	6
serious lesions	14	14
sole-ulcers	4	3
total	24	24

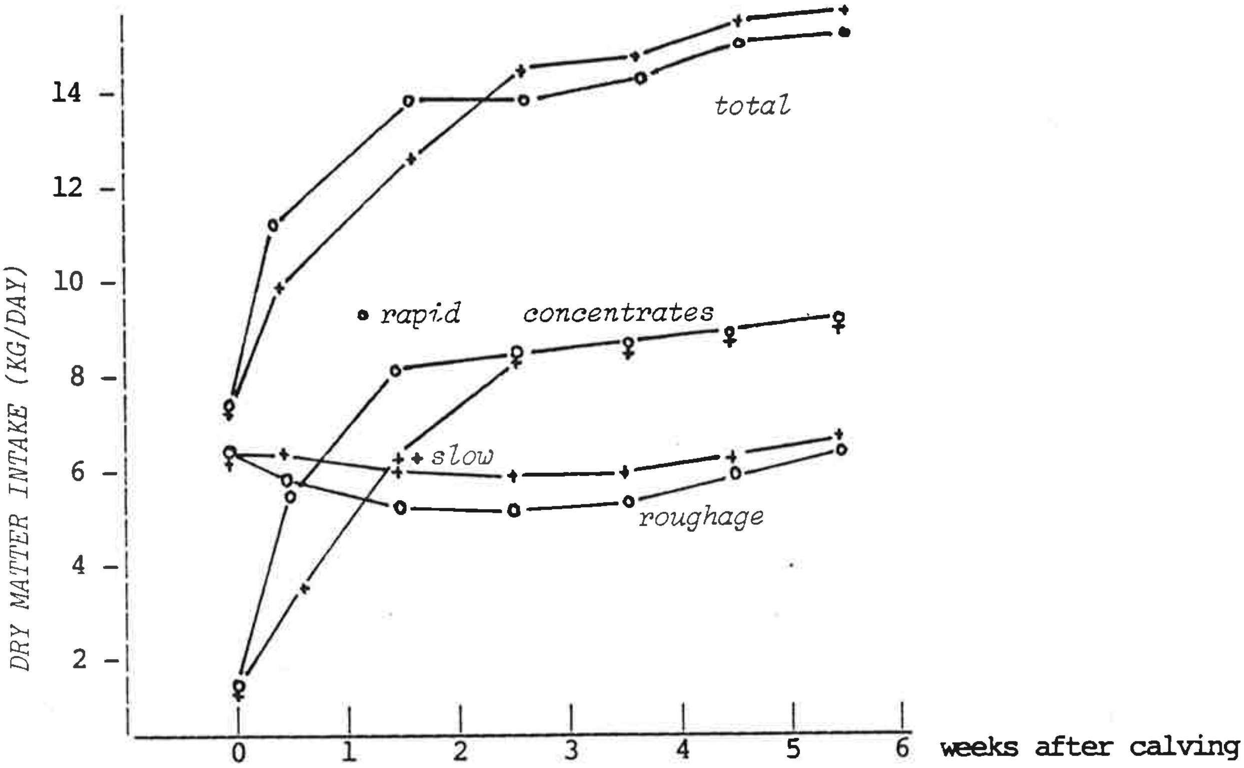
Table 2. Loading and sole lesions in hind outer claws

Degree of sole lesions after calving	Number of digits	Loading of lateral hoof expressed as percentage (Mean ± SD) of the total load on the hind foot, before calving	and after calving
absent or minor	14	42 ± 14	57 ± 13*
moderate	21	43 ± 15	47 ± 14
severe (partly with sole ulcers)	13	49 ± 11	53 ± 13

* significant increase ($p > 0.05$)

Ossent a.o.

Figure 1 : Dry matter intake of heifers fed a rapid or a slow increase in the concentrate ration after calving



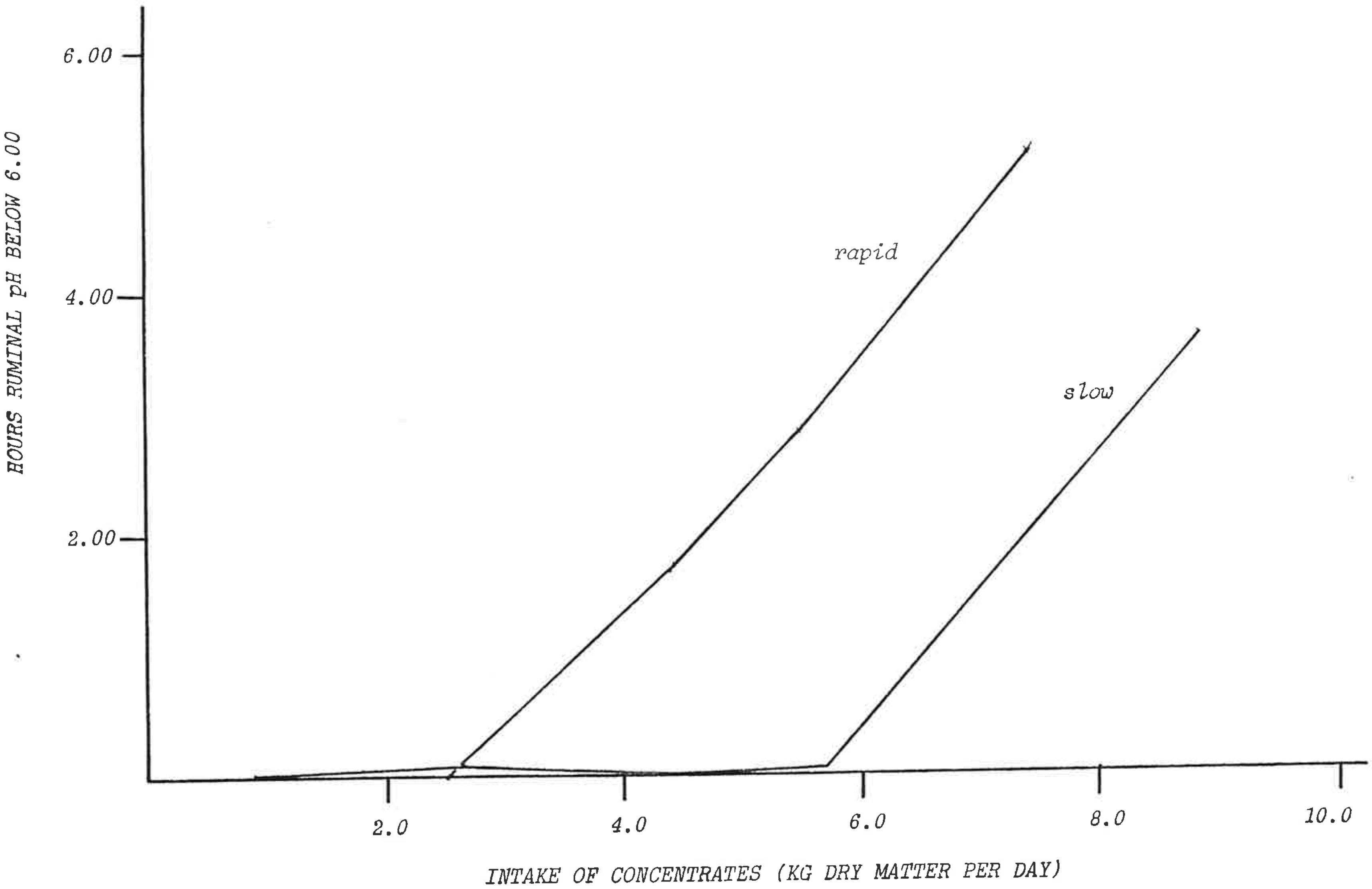


Figure 2: Hours pH < 6 in heifers fed a rapid or a slow increase in the concentration ration after calving.

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THE EFFECT OF HIGH CONCENTRATE DIET ON THE DIGITAL HEALTH OF DAIRY COWS

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The abstract for this paper will be appearing in the proceedings of the Sixth International Conference on Production Disease in Farm Animals, to be held in Belfast, Northern Ireland in the first week of September 1986.

The experimental work was conducted on dairy cattle, 10 of which were fed a relatively low concentrate ration throughout lactation, while another 12 cows were given twice the weight of concentrate feed. Comparison was made of hoof growth and shape, haematological, enzyme, mineral, lactate and endotoxin changes, as well as variations in ruminal pH, lactate, VFA and endotoxin.

These results will be discussed in relationship to the potential profitability of energy-rich concentrate feeding of dairy cows.

12 Kg

pH Rumen < 6

VFA – ↑ and more propionic acid
[illegible]

+ gastroenteritis.

Treatment laminitis

* Tylan per os

not b.cidal (endotoxin rel)
gram +ves in rumen

* Lasix
Pethidine
Fluid per os

not corticosteroids cos → v. constriction.

not flunixin – inhibits p.g. rel. which prod v. dilation

not ph. but. – inhibits p.g.

Abstract

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A SHORT REPORT ON SUB-CLINICAL LAMINITIS IN NEW ZEALAND

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Hitherto in considering the nutritional factors involved in the etiology of subclinical laminitis, emphasis has been placed on the carbohydrate and fibre components of an animals ration. Some workers mention the level of protein in the diet as being possibly implicated but no objective information is available.

In New Zealand the cattle are fed entirely on grass, therefore, it is impossible for concentrate feeding to be implicated. The incidence of lameness can be extremely high upto 15% of a herd affected in any given year. The New Zealand veterinarians associate the causes of lameness to (a) high rainfall and (b) the trauma caused by animals walking on roadways upto 3.8 km per day. On being shown slides of lesions that European workers consider characteristic of sub-clinical laminitis the New Zealanders readily re-evaluated their own position and indicated that the syndrome was present in their country. Input from grass management scientists revealed that under warm conditions changes occurred in the quality of grass following prolonged rain. The fibre content of grass dropped a level less than 15% of the total dry matter content and the protein level could increase to over 24% of the total intake.

It is suggested that these subjective/anecdotal observations may be of value to research workers interested in studying the nutritional etiology of the subclinical laminitis syndrome.

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"The Relationship of Subclinical Laminitis and Nutrition in Dairy Cattle: A Canadian Experience"

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Nutritional factors can have an effect on the hoof structures and can eventually manifest themselves in changes in the hoof wall. Subclinical laminitis in dairy cattle has been recognized as a nutritional problem. Sudden engorgement of a carbohydrate-rich diet at calving, excess oil cakes or protein-rich concentrates are some of the nutritional factors involved.

The purpose of this paper is to present the nutritional factors that were implicated in a dairy herd with a high incidence of subclinical laminitis in the lactating cows. Three to four weeks after calving the cows would develop a mild shifting hind leg lameness and the owner noticed hyperemia above the coronary band of the hind feet. When the feet were examined, growth arrest lines were present in the hoof wall, false soles, separation of the white line, mild to severe interdigital dermatitis and heel erosions and hemorrhage into and discoloration of the sole horn were evident. The cows also had a high incidence of interdigital fibromas.

Sixty-four percent of the cows were in their first lactation. At calving, the cattle were put on a total mixed ration, composed to cereal silage, barley, brewers wet grains and a protein supplement. The lactating cows were housed in free stall barns.

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A PRELIMINARY REPORT ON A LAMINITIS LIKE CONDITION OCCURRING IN BULLS UNDER FEEDING TRIALS

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INTRODUCTION

Each year over three hundred bulls enter the Saskatoon Feed testing station and each year about forty percent of the group meet the standards set for food conversion, back fat thickness and testicular circumference. Of these successful bulls upto twenty five percent are rejected by "evaluators" on the basis of unsound conformation. In October of 1985 we were asked to evaluate the "feet and legs" of bulls undergoing feeding trials.

Our assignment, therefore, was to define, in objective terms the reasons for the culling.

Because it had been suggested that poor limb and hoof conformation was likely to be an important consideration our initial efforts were directed towards developing a system for measuring the conformation of the bulls under trial.

MATERIALS AND METHODS

Three hundred and twenty-four bulls from six breeds all born in 1985 entered the Saskatchewan R.O.P. station in November 1985. After one week of acclimatization they were placed on ad lib feeding. The ration consisted of barley silage fed at a ratio of 3.75 to 3.21bs of silage to 1lb of concentrate mix. The ration on a dry matter basis had 50% roughage and 50% concentrate. The formulation contained 15.5% protein on a dry matter basis from Oct. 31 and 13.5% protein from Jan. 1 to March 25.

A data collection system developed by Mills (Mills et al. 1986) was modified to our "clindat system" which would be suitable for computer analysis. All of the bulls were marked at selected anatomical points and photographed. The transparencies produced were projected onto a digitization pad, the data was fed directly into the computer and processed. The results of this analysis will be reported at a later date.

On March the 27th, 1986, 141 bulls that had met the standards described above were examined by two individuals who had considerable experience in judging the conformation of beef cattle.

The evaluators rejected 22 bulls of which 2 had clear conformational defects, 2 were lame because of injury and one appeared to have epiphysitis.

FINDINGS

The evaluators justified their decisions in terms of conformational deficiency. It was our opinion that all of the deficiencies described as being defects in conformation were, aberrations of gait. These aberrations of gait were indistinguishable from those associated with laminitis in cattle. The following are our observations:

1. Three animals carried one or both limbs well under the body i.e Camped under or "protracted the limb" (evaluators comment - sickle hock).

2. Two animals bore weight only on the outer hind claw (evaluators comment - bow legged).
3. Three animals extended the fore limbs unusually far forward "protraction of the limb" (evaluators comment - needed hoof trim).
4. Five animals "knuckled at the pastern" (maintained flexion of the metatarso-phalangeal joint throughout weight-bearing) of the hind limb. This appeared to be a distinct effort to avoid bearing weight on the heels (evaluator comment - bad on the hind feet).
5. The remaining animals had a "stilted" gait.

Aberdeen Angus bulls were much less troubled by hoof problems than were the other breeds. Black horn is considered by many to have qualities superior to that of light colored horn.

An analysis of the data revealed the following:-

i) of 33 charolais 12% (4) were rejected for aberration of gait,
ii) of 39 herefords 10% (4) were rejected for aberration of gait,
iii) of 23 simmentals 21% (5) were rejected for aberration of gait.

Our observations confirmed those of the lay evaluators in respect to those animals that they had rejected. However, we observed twenty other animals showing suspicious aberrations of gait but to a lesser degree than the rejected bulls.

Although 22 animals were rejected on "feet and legs" only three laminitic animals were slaughtered, the remainder were returned to the owner presumably for private sale. However, of the original 324 bulls we were able to examine the hind hooves of a total of 65 bulls. The following was observed in the specimens examined:-

1. Check Lines - 92% incidence. We are defining a check line as a groove running more or less parallel to the coronary band.

2. Check Bands - 92% incidence. We are defining a check band as the region between the check line and the coronary band (or another check line) that differs in texture from the horn of the distal extremity of the hoof.

TABLE 1

Breed	(Total)	Width of Band at dorsal surface(av)	Width of band at abaxial groove(av)
Angus	(13)	2.53 cm	3.3 cm
Charolais	(9)	2.88	3.93*
Hereford	(17)	2.59	3.67
Shorthorn	(3)	2.83	4.00
Simmental	(18)	2.73	3.71
Maine-Anjou	(2)	2.75	3.95

* Three of the specimens did not show check line/band

3. Hemorrhages of the wall and sole Numerous hemorrhages were observed in the walls of the hooves of the bulls. We classified the hemorrhages into three groups on the basis of appearance.

Group One - Discrete An area of red discoloration of the wall of the hoof that does not exceed 1 cm in diameter.

Group Two - Diffuse An area of pinkish tinge affecting an ill defined area.

Group Three - Linear Similar in width and appearance to the discrete hemorrhage but extending as a band several centimeters long running parallel to the coronary band.

TABLE II

		Number of hemorrhages observed in individual claws of 65 bulls							
		NONE		1		2		3	
Breed	(TOTAL)	Med	Lat	Med	Lat	Med	Lat	Med	Lat
Angus	13	11	12	1	0	1	1	0	0
Charolais	12	2	3	5	4	5	3	0	2
Hereford	17	2	2	6	5	7	9	2	1
Maine-Anjou	2	0	0	1	2	1	0	0	0
Shorthorn	3	1	1	2	2	0	0	0	0
Simmental	18	0	0	7	6	8	10	3	2

The data set down in Table II demonstrates a trend which may or may not be repeatable. Most conveniently the findings may be summarized in the following manner.

88.50% of the claws of 13 angus bulls showed no hemorrhages
21.00% of the claws of 12 charolais bulls showed no hemorrhages
11.75% of the claws of 17 hereford bulls showed no hemorrhages
0.00% of the claws of 2 maine-anjou bulls showed no hemorrhages
33.00% of the claws of 3 shorthorn bulls showed no hemorrhages
0.00% of the claws of 18 simmental bulls showed no hemorrhages

Two additional groups of purebred bulls were on feed trials. The feeding was identical to the R.O.P. bulls with the exception that in one group oats were used and in the other barley.

2.50% of the claws of 20 purebred bulls fed oats showed no hemorrhages
5.25% of the claws of 19 purebred bulls fed barley showed no hemorrhages

As a control we harvested the claws of 14 cross-bred bulls and 14 cross-bred steers. These animals had received creep feed prior to weaning and were fed a ration that was initially lower in energy than the R.O.P bulls but approximately comparable in protein content. Significantly less silage was fed throughout the feeding period. The detailed ration changes were approximately as follows.

Sept. 24/85	80% silage	15.0% Barley	5% Canola*		
Oct. 31/85	50% silage	35.0% Barley	5% Canola	10.0% Hay	
Jan. 3/86		27.5% Barley	15% Canola	57.5% Hay	
Feb. 21/86		60.0% Barley	10% Canola	5.0% Hay	25% Straw
Feb. 24/86		70.0% Barley	5% Canola	5.0% Hay	20% Straw

*canola = rape

The claws of the controls showed the following:

85.75% of 14 cross-bred steers showed no hemorrhages
68.00% of 14 cross-bred bulls showed no hemorrhages

4. Erythema and edema of the coronet or peri-coronal epidermis
Usually the discoloration of these areas is pink but occasionally they take on a blue, cyanotic appearance, this phenomenon was observed in some of the living animals.

We were unable to produce any evidence regarding histological changes in the corium of the digits examined. A section of the hoof taken through the areas of hemorrhage showed that the bleeding had taken place into the substance of the horn. The hemorrhages in the wall sloped diagonally through the wall from a point of origin at the corium distally through the stratum medium to the stratum externum. Similar sections through the sole showed that hemorrhages had occurred at intervals giving an appearance similar to the rings in a tree. We also noted that the lines of hemorrhage that occurred in the bearing surface of the heel merged with the areas of erosion that occurred in the heels of some of the animals.

ECONOMIC SIGNIFICANCE OF FINDINGS

It is our opinion that the majority of the bulls that were culled for conformational defects had no such defects but were affected with laminitis. Most veterinary texts indicate that an animal that has once been affected with laminitis will be susceptible to a recurrence of the condition. The Saskatoon bull testing station is one of several in Canada all of which feed rations comparable to that used in Saskatoon. There has been no indication that a laminitis like condition has been observed in any other Canadian bull testing station. The possibility that the phenomenon might be observed in other feeding stations is at least tenable on the grounds that the feeding regimen is comparable.

The animals passing through the Register of Performance (R.O.P.) stations represent a substantial part of Canada's genetic pool. If locomotory unsoundness were to be a significant problem in this genetic pool significant economic losses would be involved.

The practice of "fitting" young bulls for bull sales is widespread. This practice involves intensive feeding in order achieve heavy weight gains by the time that the animal enters the second year of its life. Many of these heavy young bulls find their way into community pastures. (These are areas set aside for the benefit of ranchers who send cattle there in the spring hopefully to retrieve them pregnant in the fall).

Figures on the number of bulls disposed of, from community pastures in Saskatchewan, over a five year period due to foot and leg problems are available. The problems do not include injury, footrot or corns, but do include deformities that may be inherited.

TABLE III

Year	Total Bull herd	Total Culls	Lameness Culls
1982	1456	355	72
1981	1541	361	80
1980	1772	375	90
1979	1692	306	81
1978	1573	327	68

The rate of attrition due to lameness seems to be high. The relationship between the practice of "fitting" young bulls for bulls sales with a high incidence of lameness in later life has not been studied.

DISCUSSION

The presence of check lines and check bands has been reported in the literature (Peterse, 1980). In our current study it seems that the check line was formed either at the time the animal was introduced to feed or at the time of weaning. In future studies we propose to evaluate the weaning protocol in order to investigate possible correlations between the techniques employed and the severity of the check line/band. The data recorded in Table I, we believe, indicates that in a period of approximately 140 days the average growth of horn on the dorsal surface of the hoof was approximately 2.75 cm (5.8 mm/month) and at the abaxial groove 3.75 cm (8.12 mm/month). These figures suggest that the rate of horn production may be greater in this sample of animals than has been previously regarded as normal for adult animals.

The R.O.P bulls, plus the thirty-nine additional bulls on independent feed trials were all fed rations containing a large amount of silage. These animals all showed hemorrhages. The group of bulls and steers that were fed much less silage were also less troubled by hemorrhages. It is interesting to note that good quality silage contains high levels of lactic acid. We could postulate that if at the same time a high energy ration was fed the levels of lactic acid could become dangerously high. The currently accepted theory concerning the etiology of laminitis suggests that lactic acidosis plays an important role.

Our subjective evaluation of the aberrations of gait that we observed suggested to us that the clinical manifestation of laminitis in cattle can be more complex than it is in the horse. The phenomenon of knuckling at the fetlock was particularly interesting because in each case the animal failed to bear its full weight on the heel suggesting that pain was present. We have observed laminitis occurring in one claw on several occasions. In this study it appeared that several animals were bearing more weight on a lateral than medial claw giving the bow legged appearance noted by the evaluators.

The number of hemorrhages observed in the claws of the limbs examined, we believe, is likely to be significant. The hemorrhages must be a historical record of an event that took place some weeks or months prior to slaughter. Our reasoning is that the hemorrhages occur in layers between apparently normal horn. Logically, therefore neither the hemorrhage nor the check line/band are obviously directly connected with the aberrations of gait. The bulls were maintained in corrals on soft bedding and the aberrations of gait were only apparent when the animals walked on a concrete roadway. The sole of all the hooves were thick in comparison to the hooves of other bulls and steers examined at random from slaughter house material. This could imply that the ration stimulated horn growth to such an extent that weight bearing was transferred from the wall to the center of the sole. This possible change of weight bearing may have been incidental in precipitating the clinical signs observed.

Our observation linking layers of hemorrhages with the lines of erosion of the heel we believe could be an important finding. The etiology of heel erosion has been difficult to substantiate but we suggest that our observation does establish the suspected relationship between laminitis and erosion.

CONCLUSIONS

The study of the conformation of 324 bulls at a R.O.P station led to the observation of clinical signs indistinguishable from laminitis. Many of the observations made were unexpected. The sample size and experimental design cannot be considered adequate to permit definitive conclusions. Nevertheless, the observations made have raised a number of questions that warrant further study.

The information gathered will undoubtedly contribute to the development of a future experimental design. The current study occurred as a result of a fortuitous accident.

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FILM NOTES OF MAIN POINTS

Digital diseases in cattle*/

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Digital diseases are very common ammong cattle; however, they are often overlooked in practice. For example, in a Swedish study of slaughtered dairy cows only about 25 per cent of the animals had hoofs entirely free from disease symptoms. Trimming is the chief preventive measure used to treat most hoof disorders.

General symptoms of hoof disorders

Common symptoms include:

- changing the load from one foot to another
- standing in the manure-gutter
- standing with the toe portion of the hind hoofs on the edge of the stall mat
- lying for unusually long periods
- difficulties in rising
- deviant hoof shapes (e.g. overgrown toes and asymmetrical hoofs)

Interdigital dermatitis

Characteristics

- superficial local inflammation in the horn corium with a greyish smeary exudate
- *Bacteroides nodosus* involved in the etiology
- most often a herd problem

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*/ A short presentation of the main content of a film

Treatment

. trimming and local medical treatment

. improvement of the environment

. footbath if necessary

Horn erosion

Characteristics

. progressive interdigital dermatitis

. V-formed spreading erosion from the interdigital skin out into the bulb

. lameness

Treatment

. trimming and excision of damaged horn and local medical treatment

. bandage if necessary

. improvement of the environment

. footbath if necessary

Laminitis

Characteristics

A diffuse aseptic inflammation in the hoof corium. Most common in newly-calved and newly stabled heifers.

Subacute form:

. no primary clinical signs

. serum exudation and haemorrhages in the sole after 2-3 months

. poor horn quality

Acute form:

. pain in the hoofs

. stiffness and a load-relieving stance

. reduced appetite

. occasional fevers

Chronic form:
. less dramatic symptoms over a longer period
. laminitic rings
. broadened lamellar border
. haemorrhages in the sole horn
. fissures in the white line
. rotation of the pedal bone

Treatment
. keep the animal on soft surfaces
. administration of antiinflammatory and analgestic drugs
. trimming
. nutritional corrections

Hoof ulcer

Characteristics
. ulcers penetrating the sole
. poor keratinization
. great risk of secondary infections
. easily developing into granuloma if not treated

Treatment . trimming to establish correct loading
. excision of all defective horn tissue
. bandage
. wooden block or hoof shoe

Interdigital phlegmon

Characteristics

- swollen hoof
- lameness
- fever
- Fusobacterium necrophorum and other ubiquity microorganisms involved

Treatment

- narrow spectrum antibiotics administered parenterally
- excision of necrosed tissue

Fracture of the pedal bone

Characteristics and treatment

- pain in the injured hoof when twisted
- hoof shoes used both as a diagnostic aid and as therapy

Interdigital hyperplasia (Limax)

Characteristics

Chronic irritation in the skin caused by:

- interdigital dermatitis
- too wide splaying to the hoofs

Treatment

- bandage or steel wire to keep the splaying hoofs together, (diminish the swelling)
- operation if necessary (local intravenous anesthesia, excision, thermocauterisation, bandage)

Verrucous dermatitis

Characteristics

- unknown etiology
- wart like growths in the interdigital skin, in the pastern joint or in both areas

Treatment

- operation as described for interdigital hyperplasia

Claw abscess

Characteristics

- local inflammation caused by penetration of the horn by a foreign body

Treatment

- draining
- antibiotics administered if necessary

General comments

Inadequate treatment:

- common in practice
- implies a great risk of complications; in particular, serious secondary infections can develop

Footbath Recommended dosage:

5-7% Cu SO_4 or Zn SO_4

Conclusion

Correct diagnosis and treatment during the early stages of digital diseases can spare many cows considerable suffering. Their productive life can be prolonged and large financial losses can be avoided.

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Observations on Lameness in a Hampshire U.K. Practice

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INTRODUCTION

I am in large animal practice on the Hampshire/West Sussex borders in the U.K. This paper is given in the traditions of the B.C.V.A. Practioner Papers, in other words it is high on observation and opinion, and low on factual corroboration of that opinion, but at least it should stimulate some discussion and I would hope some further research work.

Our practice area is an interesting one for the study of lameness. We still have a number of herds on the traditional straw-yard system of Winter housing, and a number on cubicles - of various types. Some herds have a continuous lameness problem, some a temporary lameness problem, and some never seem to get a lame cow. As a practioner I feel our first question ought to be WHY? i.e. what factors are common to herds with problems, and what are common to those without problems. Based on this approach I come to slightly different conclusions about the etiology of lameness than those currently in favour.

I propose to discuss our two most problematical types of lameness - white line abscess and pododermatitis circumscripta, and to describe certain farms in our practice which have or have had a problem with these conditions.

OBSERVATIONS (1)

Firstly, white line disease. This is our most common problem, accounting for over 35% of the lameness cases treated by the practice. I would say this figure is artificially high, because it is a condition which farmers themselves find difficult to treat.

I am convinced the most important etiological factor is cows being made to move on poor conditions underfoot and more especially on concrete surfaces which have started to break up and which have large numbers of loose sharp stones on the surface.

I have taken as examples three typical farms - all three are low-cost enterprises with low levels of concentrate feeding, and self-feed forage systems.

FARM A. This is a 110 cow, Autumn calved Friesian herd on self-feed silage with maize gluten meal fed at 5kg/day maximum. Lameness incidence this year was 30%, with 60% of these being white line abscesses. The abscesses have occurred mainly in older cows, but have not, on the whole, been associated with overgrowth of feet. The silage clamp floor is badly eroded.

FARM B. This is a 150 pedigree Friesian cow herd, Summer calved, and fed on ad lib silage and flat-rate concentrates at 3kg/day maximum. The concrete silage barn floor was a hand-mixed, do-it-yourself affair, and was very badly eroded. Incidence of white line abscess last Winter was 30%.

FARM C. This is a 110 cow, Autumn calved, Friesian herd grazing kale in early Winter and going onto self-feed silage after Christmas. Concentrates are fed flat-rate at a maximum of 4kg/day. Lameness incidence last year was 35%, with white line abscesses accounting for 70% of this figure. The track to the kale fields is covered with flints, and the silage floor is badly eroded.

DISCUSSION (1)

Baggott and Russell (83) and Baggott (82) state that white line disease is more common in older Shorthorn and Friesian cows in herds of more than 100 cows where feet are wet longer than six hours a day. They suggest that foot overgrowth, wet conditions and chronic laminitis may weaken the white line and exascerbate the normal spreading of this area which occurs during locomotion and render disease more likely to occur. Whilst I agree with this in principle we have got many herds which satisfy most of the above conditions and which do not have many cases of white line disease. The primary culprit in all our herds with problems is underfoot conditions and more specifically the Hampshire flint.

Despite the excellent advice obtainable from the Cement and Concrete Association many farms have very poor concrete surfaces. Deterioration can occur as a result of frost damage or as a result of the action of silage effluent and this leads to loose aggregate being present on the surface of concrete and at the bottom of holes which appear in concrete. Concrete aggregate is of various types. In our area it is obtained from pebbles dredged from the sea bed off-shore. This contains many very sharp edged flints and the presence of these, I am sure, is the primary reason on our high-incidence farms for white line disease occuring.

Incidentally, we find that the institution of routine formalin foot bathing or foot trimming has very little effect on the incidence of white line disease. The answer I am sure is either to lay and maintain concrete properly - using more suitable sources of aggregate - or else to use alternative surfaces such as tarmac for silage clamp floors.

<u>OBSERVATIONS (2)</u>

Pododermatitis circumscripta (Solar Ulcer). At the moment, thankfully, we have no clients with what could be described as a herd problem with this condition. In my opinion the herds in our practice which have had problems with solar ulcers have all had conditions prevailing which have resulted in cows standing around on hard unyielding surfaces for long periods, with low levels of exercise and very short overall lying times. None of our herds on the straw yard system have or have had a problem with solar ulcers, whatever the level of concentrate feeding. I would like to look at four clients in the practice which have had a herd problem with solar ulcers over the last four years.

FARM D. This client took over the management of a herd of 150 straw-yarded, Autumn calving Friesian cows from his tenant, and put in a complete new system, with concrete lipless cubicles and a new computerized parlour. He fed silage ad libitum and concentrates at a maximum flat rate of 6kg/day. In the first three months of running the new system 25% of the cows developed solar ulcers. It was very noticeable that cubicle usage was very low. Cows spent a large amount of time standing around looking at the cubicles wondering what they were for. We advised that a temporary heel board should be placed behind the cubicles, that the amount of straw bedding used should be doubled, and that a major effort should be made to train cows to use the cubicles, with persistent non-users being culled. Subsequently cubicle usage increased noticeably, and the numbers of cows with ulcers reduced to only occasional cases.

FARM E. This client had the tenancy of two dairy farms, and in late Summer 1983 he gave up the tenancy of one farm and purchased the other, merging his two herds into one unit. They were housed in a well established cubicle house with compacted chalk cubicle beds and fed silage in a feed passage and concentrates on a "to-yield" system at 0.25kg/litre. Following the merger a major problem developed with approximately 25% of cows developing solar ulcers. These were mostly in the cows which had moved farm. Again it was noticeable that cubicle usage was low, presumably as a result of social stresses affecting the cows' behaviour patterns. During subsequent Winters, and without instituting any routine foot care programme, incidence of solar ulcer has reduced to less than 5%.

FARM F. In September 1984 this client moved his herd of 70 straw-yarded Autumn calving Friesian cows from a straw-yard system to a home-made, chalk based, chopped straw bedded cubicle unit. During the first Winter 50 (70%) of the cows went lame, and 90% of these had solar ulcers. Cubicle usage was very poor, with cows spending large amounts of time aimlessly standing. In subsequent Winters the incidence of solar ulcers has been low, proportional to a marked improvement in cubicle usage. No routine foot trimming or foot bathing is carried out.

FARM G. This farm has a herd of 90 mainly Autumn calving Friesians housed on tarmac based cubicles with sand as bedding. They are fed silage from a forage box and newly calved cows receive gradually increasing quantities of concentrates up to a maximum of 10kg/day. Late last December a group of nine heifers was introduced into the herd. They calved during January, February and March. Eight of this group (88%) developed solar ulcers. The incidence of solar ulcers in the remainder of the herd was only 2%. The heifers were introduced into an established herd, with a fixed social structure, and the herdsmen remarked that they seemed to spend a lot of time standing around and were reluctant to lie down.

DISCUSSION (2)

Many authors including Rusterholz (1920) and Zantinga (1973) have emphasised the anatomical and traumatic factors involved in the etiology of solar ulceration. Others, including Livesey (1984), Nillson (1966) and Pinsent (1981) have pointed to the importance of laminitis. David (1983) postulated that a decreased lying time on new concrete cubicles may be important. Baggott and Russell (1983) found that predisposing factors for the development of solar ulcer included: - Lack of exercise, bruising of sole by the pedal bone, housing on concrete, high body weight, wet conditions, abnormal hoof shape, unfavourable hind leg conformation, and laminitis. They also state that the condition is more common in bought-in cows. Other workers have emphasised the need for routine foot trimming, and have shown that this reduces the incidence of solar ulcer.

My experience in practice would suggest that various environmental and social factors can result in cows standing immobile on unyielding surfaces for long periods. I suggest this leads to a pressure necrosis of the germinal tissue (and possibly the formation of emboli in small digital vessels). This leads to the formation of poor quality horn. The situation would obviously be much worse if the cow's size, conformation and foot shape led to the lateral digit taking more of her weight. Furthermore, if the cow is standing for long periods, her feet will be wetter, and have more contact with micro organisms, than a cow which spends more time lying down.

In my opinion overgrowth of feet, and particularly the laying down of excessive solar horn in the axial part of the lateral digit, is a reaction to the above factors. This has the effect of increasing the pressure applied to the critical area and worsening the situation. Thus foot trimming becomes essential to reduce weight bearing by the lateral digit. I am sure if we looked after cattle correctly routine foot trimming would be much less necessary. Certainly we have many clients who never trim a cow's foot, and who very rarely get one with a solar ulcer.

I accept that excessive standing time is not the whole story, and that nutritional and disease induced laminitis is often an important factor, although it might be an interesting exercise to see what effect a high concentrate diet and consequent acidotic rumen fermentation has on the behaviour and lying time of cows.

I have not sufficient experience to see how the importance of "standing time" could be proved experimentally. It would seem to require either some complicated electronic gadgetry or a large number of keen, sleep deprived veterinary students.

I feel sure we ought to think more from the cow's point of view. We should feed her a diet which promotes rumination and a healthy rumen pH, we should give her adequate exercise, on a surface which won't physically damage her feet, and we should provide and encourage her to use a comfortable bed on which she can contentedly lie.

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CATTLE BEHAVIOUR AND LAMENESS

THE INFLUENCE OF THE ANIMAL BUILDING INTERACTION ON THE INCIDENCE OF LAMENESS IN DAIRY CATTLE

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Introduction

It is now well accepted that lameness in dairy cattle is a multifactorial disease. Epidemiological factors associated with the development of digital lesions include nutritional, environmental and genetic factors. The association between animal behaviour and the development of a high incidence of digital disease has been reported by Dewes (1978) and Murphy (1978). Rowlands et al (1983) reported an association between housing systems and the development of Pododermatitis circumscripta. The objective of this paper is to outline, by reference to specific field investigation, some aspects of management, animal behaviour and building design which may influence the incidence of lameness in a herd where pododermatitis circumscripta and associated lesions appear as the predominant digital conditions.

Clinical Features

Two case studies were selected from a total of fifteen performed since 1982 where pododermatitis circumscripta was the predominant lesion. These are described below. These cases were chosen because they illustrated the main features found in nearly all the investigations. The implications of the findings in these cases are discussed.

Case 1

This involved a mixed dairy and arable farm where the dairy herd comprised of 44 Friesian cows and no followers. Heifers were purchased as replacements. The herd calved from October to March and had an average yield of 6,000 litres. Prior to the Winter of 1982 the cows have been housed in wooden, earth based cubicles and bedded on long straw. A new cubicle house was erected in the Summer of 1982 which contained concrete based lipless cubicles measuring 7' 0" x 3' 8" with divisions of the Newton Rigg design. Sawdust and shavings were used as litter. The animals were milked through a herringbone parlour. Silage and 4 lbs of barley were fed in a central feed passage twice daily for M + 11 kg of milk. 18% CP dairy cake was fed twice a day in the parlour for production at a rate of 0.33 kg per litre.

The only significant changes in feeding practice was the replacement of B.O.C.M. 144 compound feed by rolled barley in the out of parlour ration.

During the winter of 1982/83 at least 40 cases of lameness were treated by the attending veterinary surgeon. The causative lesion was nearly always pododermatitis circumscripta which in many cases was bilateral. 8 cows were culled because of chronic lameness.

Only 4 treatments for lameness had taken place the previous year, therefore in the winter of 1982/83 the lameness incidence had increased tenfold. This sudden dramatic increase in incidence suggested that some management change had occurred prior to the winter of 1982/83 which had been the major predisposing factor.

The most obvious change in management was the construction of the new cubicle house. The farmer himself had observed that when gates were accidentally left open nearly all the cows had gone to lie in the old cubicle house. Because of the adoption of a liquid slurry handling system, sawdust and shavings were used as bedding and difficulty was experienced in getting these to build up to any depth on the concrete lipless cubicles.

In this particular case it was thought that a reduction in resting time in the new cubicle house could be the major factor responsible for the development of sole ulcer in such a large proportion of the herd. Consequently the advice given to prevent a reoccurrence of the condition concentrated on improving the lying time of the cows. To this end the shavings and sawdust were replaced by straw bedding. The main idea was to build up an effective soft bed on the concrete. In addition the headrail was moved from 14" from the front of the cubicle to 7". An attempt was made to improve hoof conformation by a programme of prophylactic hoof trimming prior to housing. In addition, a footbath was installed and the cows passed through 5% formalin once or twice weekly. No changes in feeding were made.

In the Winter housing period of 1983/84 only 4 cows became lame and these were all cows which had been lame with sole ulcers the previous Winter. No new cases of sole ulcer occurred. The farmer also reported that the cows were much more contented and seemed to lie in the cubicles for much longer than previously.

Case 2

This involved a commercial dairy herd of 80 Friesian cows and followers which were mainly autumn/winter calving. The herd was loose housed in cubicles which were concrete based and measured 7'0" x 3'9".

Approximately ten days after calving and moving from a strawyard to the main cubicle house five out of a group of 12 heifers were noticed to be very lame. The animals appeared to be tender on all four feet although the hind feet appeared to be worst affected. One animal was eventually slaughtered on humane grounds. The other affected animals were moved to a strawyard where a considerable improvement was noted.

The lesions seen in the slaughtered animal consisted of separation of the horn at the skin/horn junction of the heel of the outer claw of the hind foot with underunning extending to the mid sole region. On removal of this section of horn an ulcerated area was revealed. There was necrosis rupture of the deep digital flexor tendon and a septic pedal arthritis. Bacteroides melaninogenicus was isolated from the ulcerated area.

Histological sections from the affected claw indicated that the main lesions seen were restricted to the ulcerated area of the sole.

Lesions seen in the laminar and coronary corium were very mild and not consistent with those described by Maclean (1971) for acute, sub acute or chronic laminitis.

The feet of 2 recovering animals were axamined. Both showed signs of solear haemorrhage at the sole heel junction which was more marked in the outside claw.

The horn in these areas could be easily depressed by thumb pressure and there appeared to be some separation of the external horn from the underlying corium.

A freemartin heifer of similar age and bodyweight, fed identically but not moved to the cubicle house demonstrated no lameness or digital lesions.

Discussion

A common feature in many of the investigations carried out on herds which had experienced a sudden increase in the incidence of pododermatitis circumscripta was the alteration of or construction of new buildings prior to the "outbreak" which always occurred during the winter housing period.

Although the aetiology of sole ulcer is still subject to some debate, anatomical factors do seem to play an important part in several theories. Zantinga (1973) suggested that compression of the solear corium at the posterior axial border of the pedal bone is involved. Excessive compression solar corium was also suggested by Rusterholtz (1920) in his original theory. Nillsson (1966) indicated that thromboses caused by nutritional laminitic damage could be important, at theory which has received particular attention recently. Even though laminitis of nutritional origin may be involved, the very specific site of the lesion indicates that anatomical and mechanical factors do play an important part in its pathogenesis. The compression of solear corium caused by the basic anatomical flaw outlined by Zantinga maybe exacerbated by such factors as hoof overgrowth, poor hoof and leg conformation and erosive heel lesions as suggested by

Bömer (1958), Toussaint Raven (1969) and others. It also seems logical to assume that it is directly related to the amount of time that cows spend standing especially where under foot conditions are unyielding as is the case on concrete. It has been established that cows spend much less time lying down (resting time) on concrete cubicles without significant bedding (7 hours) than on Enkamat (14 hours). Not surprisingly resting time is markedly improved by the provision of a deep straw bed (14.1 hours Cermak 1983). The resting time will also be markedly affected in situations where the design of the cubicle divisions do not satisfy the space requirements of the animal.

The reduced cubicle acceptability and consequent reduced resting time in Case 1 was thought to be due to inadequate bedding being retained on the concrete lipless cubicle base, a problem commonly encountered with sawdust bedding. In addition incorrect setting of the headrail was also thought to have contributed. Common factors were found in many of 15 investigations referred to above which could reduce cubicle acceptability. These included:-

1. Concrete based cubicles with inadequate bedding
2. Short narrow cubicles
3. Insufficient "lunging" space for cows when rising
4. Incorrectly set headrails

Case 2 illustrates another facet of the animal building interaction. roblems associated with solear lesions, such as those described above, in heifers newly introduced to loose housing systems are common. The cause of the lameness in this particular case appeared to be severe aseptic haemorrhagic laminitis principally affecting the sole heel junction of the outside claw of the hind foot with eventual horn separation necrosis and infection in some severe cases.

The association between the emergence of the lesion and calving and entering the main herd tended to indicate that the causative factors were related to this event. Similar lesions have been described in New Zealand by Dewes (1978 and 1979) in groups of heifers after introduction into the main herd particularly following long periods of transportation. In these cases the lesions were attributed to traumatic damage to the feet caused by increased activity on concrete surfaces to which the heifers were unaccustomed. The increased activity was also related to behavioural interactions with other members of the herd. Nillsson (1966) described a form of overloading laminitis in heifers recently introduced to concrete surfaces.

Livesey (1984) reported lesions in heifers shortly after calving associated with feeding the diet with a low forage to concentrate ratio. The lesions were ascribed to laminitis of nutritional origin similar to that described by MacLean (1971). The lesions in this case would not appear to be associated with nutritional laminitis for the following reasons:-

1. Histological examination of laminar solar and corinary corium failed to show conclusive evidence of acute, subacute or chronic laminitis.

2. The feeding regime does not provide an excessive amount of concentrates and the forage to concetrate ratio is quite different to the 40/60 ratio described by Livesey (1984).

3. The existence of a freemartin heifer in the group fed and housed identically but not moved into the cubicle house which did not exhibit lameness or show any signs of lesions in the hooves.

In this case the traumatic aseptic pododermatitis and consequent ulceration and infection was thought to be caused by the following factors:-

1. The sudden introduction to concrete sufaces for the first time.

2. The increase activity and behavioural interactions following the introduction of new animals into an established dominance hierarchy.

3. The decreased resting time due to the unfamiliarity with cubicles.

The most logical preventive strategy would therefore appear to be:

1. Gradual acclimatization to concrete surfaces at least 6 weeks prior to calving.

2. Training of heifers to use cubicles prior to entering the main herd.

3. Keeping heifers in a separate group from the cows.

4. Correcting any overgrowth of the hoof which may have occurred in straw yards.

Although direct evidence is unavailable these cases demonstrate that an animal building interaction has probably contributed to an increased incidence of lameness. The survey by Rowlands etal (1983) indicated a difference in lameness incidence particularly that due to pododermatitis circumscripta between loose housed cubicle systems strawyards and pastured cows. These could be in part due to the factors discussed above.

It is clear that the behavioural needs and space requirements of dairy cattle in intensive loose housed conditions requires more study particularly in relation to specific diseases such as lameness. Murphy 1978 has shown a relationship between the incidence of lameness, mainly caused by white line disease, in beef cattle and the extra competition caused by reduced trough space. Inadequate understanding of the behavioural needs of a dairy cow in an intesive loose housed system will result in reduced resting time, increased aggression and stress. For nearly 20 years loose housed cubicle systems have been designed for the convenience of builders and farmers rather than the behavioural requirements and comfort of the cow.

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CLAW MEASUREMENTS AS PARAMETERS FOR CLAW QUALITY IN DAIRY CATTLE

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SUMMARY

After results of recent research about the relationship between claw measurements, frequency of claw disorders and stayability in the United States (McDaniel, 1984) a similar survey has been made among FH- and HF-heifers in the Netherlands.

The length of the dorsal wall of the lateral hind claw and the angle of the claw toe had the highest correlation with the seriousness of claw disorders.

Yet coefficients were too small to use these measurements as an indirect parameter for classifying the claw quality of progeny groups of sires for breeding purposes. Heritabilities for sole ulcer and interdigital dermatitis symptoms were calculated.

INTRODUCTION

Breeding of cattle with claws of high quality is often considered to be a good help against the lameness problems on dairy farms. Data from literature indicate genetic effects within breed on the incidence of 'foot rot', 'sole lesions' and 'sole ulcers' (Nielsen and Smedegaard, 1984; Petersen a.o., 1982; Peterse and Antonisse, 1981).

However, breeding organizations prefer easily obtainable parameters such as claw size measurements or visual judging of claws.

Recent information from McDaniel a.o. (1984) about an association between claw shape and economic characteristics such as (re)production, lameness and stayability has been the motive to start a survey among heifers on Dutch commercial farms in order to get an answer to the next questions:

* which heritabilities for lameness disorders do exist?
* is it possible to use claw size measurements or visual judgement for claw quality instead of claw disorder scoring systems?

In this report information is used from a recent publication by Smit a.o. (in press) and an additional but unpublished student report (Heeres, 1985).

MATERIAL AND METHOD

On 82 dairy farms the heifers in a lactation stage of 40 to 100 days have been inspected. They were all pure Dutch Friesians or crossed with Holstein-Friesians. At the moment of inspection they were housed in cubicle systems.

The same two persons (Smit and Verbeek) have inspected the hind claws after paring of the sole for symptoms of interdigital dermatitis and haemorrhages on the sole, which are considered to be symptoms of laminitis. The symptoms are scored according to a system described by Peterse (1980). Before paring dorsal length, heel depth and angle of the dorsal wall have been measured. Herd book inspectors have, after an extra instruction, judged the claw size.

The data have been collected in the months January till April in two succesive years. The next data sets were available after selection on to small progeny groups (< 4):

* 1,015 heifers scored for claw disorders
* 929 heifers measured and scored for claw disorders
* 469 heifers scored for claw disorders and judged by herd book inspectors

These data have been analyzed with help of the program LSML76 (Harvey, 1976; for details see Smit a.o.). After correction for influences like herd and month of inspection year correlations between the data sets have been calculated.

The parameter sole lesion score is defined in two ways: as sum of the scores on all localizations on the claw sole (the total score) and as a categorical variable for the presence or absence of a serious sole ulcer.

RESULTS

The frequency of sole ulcers was 16 per cent. But the symptoms of interdigital dermatitis which includes both symptoms on the interdigital skin and heelhorn erosion, were not very serious and did not much vary. The average angle of the dorsal wall was 48°, the average length of the dorsal wall 75 mm and the height of the heels 35 mm.

The heritabilities which have been calculated for the claw disorders are in table 1.

The genetic correlation between claw disorders and claw measurements is visualized in diagram 1. Steep claws have shown less frequently sole ulcers and less serious sole lesions. The length seems to have little influence on the incidence of these disorders. A high heel depth seems to be associated with sole ulcers but not with the total score. The standard errors of these estimations are considerable, especially for the interdigital dermatitis.

The genetic correlation between claw disorders and judgements is expressed in diagram 2. These correlation coefficients are low and have therefore little practical value.

Table 1. Heritabilities for claw disorders.

total score for sole lesions	0.32
sole ulcer	0.14
interdigital dermatitis	0.08

Diagram 1. Genetic correlation coefficients between claw disorders and claw measurements.

	total score	sole ulcer	interdigital dermatitis
angle dorsal wall	- 0.62	- 0.55	- 1.10
length dorsal wall	- 0.02	0.14	1.01
heel depth	0.19	0.61	0.25

Diagram 2. Genetic correlation coefficients between claw disorders and herd book judgements.

	total score	sole ulcer	interdigital dermatitis
angle dorsal wall	- 0.06	0.18	- 0.35
length dorsal wall	- 0.32	0.30	0.13

DISCUSSION

The frequency of 16 per cent sole ulcers is almost the same as found earlier under the same conditions in the same category of animals (Peterse, 1980). Also the findings of not many serious interdigital dermatitis in these group of heifers is according to the expectations. Due to the low incidence of this last named disorder the chances on a substantial heritability are low. This result corresponds with similar calculations in the Netherlands (Peterse and Antonisse, 1981) but not with Danish results. A heritability for 'footrot' of 0.13 in first to fifth parity cows is indicated there (Nielsen and Smedegaard, 1984) and of 0.27 in heifers (Petersen a.o., 1982).
In contradiction with our results they found, compared to interdigital dermatitis, the same or lower heritabilities for sole ulcers, 0.13 and 0.23, respectively.

The heritability for total score of the sole lesions of 0.32 is higher than that for sole ulcers (0.14), while both parameters express the same disorder. But transforming the categorical trait sole ulcer to a continue variable according to a method described by Meijering (1984) doubles the heritability (0.32).

The association between these disorders and shape or size of the claws is not convincing, certainly not if these aspects have been judged instead of measured.
A reason may be that in this survey two factors have been mixed up. A claw shape may express a predisposition but certainly also claw disorders influence claw shape (Toussaint Raven, 1973); for example, high heel depth can be a sequel of a sole ulcer. The moment of measuring has to be well defined. The possibilities are measurement before the first risk on lameness, thus before the first calving or after about 100 days of lactation when the risk-period has passed and a deformation in claw shape could be visible.

However, it has to be realized that the conception in which sole lesions are considered to be symptoms of laminitis includes that genetic predisposition for these lesions is not restricted to the claw shape or even to the inner structures of the claw. May be traits of liver function, digestion, appetite or others have a high association with sole lesions.

The conclusion is that selection on claw quality is certainly possible but only progeny testing on claw disorder symptoms can produce reliable information

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The influence of sire on lameness in cows.

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Introduction

The average milk yield of cows in the UK has approximately doubled in the last 40 years (1), mainly due to the selection and widespread use of bulls whose daughters give more milk than their contemporaries. It is well known that susceptibility to some cattle diseases, for example mastitis, is inherited (2). If it were possible to select bulls on the basis also of a lower susceptibility to disease in their daughters, the national incidence of these diseases, including lameness, might be reduced without adversely affecting milk production characteristics. This paper reports a preliminary attempt to make such a selection.

Materials and Methods

Detailed animal records have been kept using the COSREEL computer system (3) for about 5,500 cattle resident at IRAD during the period 1977-1984. These cattle lived in three dairy herds and a number of smaller experimental units, all under the same general management and veterinary care, and situated on the same estate on the Berkshire downs. Cattle often moved between herds, and most bulls were used in all herds.

For each bull, the number of cases of disease in his daughters and the total number of daughter years have been abstracted and used to calculate the incidence rate of disease in his daughters. However, the susceptibility of cows to each foot lesion was found to vary with age, whereas susceptibility to dystokia, hypo- calcaemia, endometritis, mastitis and ketosis varied with lactation number. As the distributions of the daughters by age and by lactation number varied between bulls, a correction has been made for this effect.

The milk yielded by each cow in each lactation was compared with the average yield of all cows in that lactation, adjusted for month of calving, and a percentage above or below average was calculated. This was adjusted for the gradually increasing yields of cows during the years under study, and the resultant percentages for each lactation in the cow's life averaged to give a lifetime lactation performance.

Results

The precision of estimates both of disease incidence rate and lactation performance is highest for bulls with the largest number of daughter corrected years or lactations on record. Of the 250 bulls used at IRAD during recent years, the 24 with most daughter corrected years are considered here. The incidence rates of solar ulcer in the daughters of each bull are shown in Fig 1; the rates in the daughters of the two bulls with most daughter corrected years differ by a factor of about 3, and an even wider range is shown by the other bulls. For each bull, the daughter incidence rates of the various diseases can be calculated, and an example for bull 176, whose daughters had the highest average milk yield, is shown in Table 1. If such a profile were available for many bulls, the selection for general use of those with satisfactory disease and production characteristics in their daughters would be possible. It is also possible to examine the correlations between the incidence rates of pairs of diseases, and between that of each disease and milk yield. In Fig 2, the daughter incidence rates of heel lesions and white line disease are plotted for 21 of the bulls, 3 having been eliminated from the correlation analysis because they had too few daughter corrected lactations to warrant inclusion. This shows a highly significant positive correlation between these two causes of lameness (r=0.824) indicating co-inheritance of susceptibility. Correlation coefficients for all combinations of these diseases, and of each disease with milk yield are shown in Table 2.

Discussion

The selection of bulls whose daughters are resistant to disease differs in some significant respects from selection for high milk yield. While both attributes are a function of the cows' anatomy and physiology, and might therefore be expected to show similar degrees of heritability, data on production are more easily collected than data on disease. Furthermore, while first lactation performance is a good predictor of yield potential, the incidence rate of the important diseases is low in the first lactation, and increases with lactation number. Even though sons of good cows and bulls are currently taken as candidate breeding bulls, their final selection still depends upon the lactation performance of their daughters. A similar process, as described here, is likely to be required for the selection of resistance to disease. Progress depends on having available a national animal recording system, such as COSREEL, which can handle the collection of the disease, production and other relevant data from farmers and veterinary surgeons dealing with a large number of cows in many herds over a long period. The use of bull conformation and biochemical markers has not been notably sucessful in improving cow health, perhaps because disease incidence data in their daughters which might correlate with the occurrence of these markers has been missing. Lameness and mastitis together are estimated to cost the UK dairy industry about £150 million per annum (4,5). If selection of bulls could reduce the incidence of these two diseases by for example 50%, considerable economic savings would be possible, which would justify many times over the cost and effort of establishing such a system.

An economic ranking order of bulls used commercially could be produced by calculating the value of milk produced and the total costs of diseases (treatment, loss of performance and early culling) for 100 daughters of each bull, using figures analogous to those in Table 1. The most profitable bull might not be the one with highest yielding daughters, but would have the best compromise between high yield and low disease rates. Bulls of low ranking could be culled when sufficient data had accumulated to confirm their position. The selection pressure against specific diseases could be increased by inflating their estimated cost in the ranking calculation. The tendency, although non-significant, for co- transmission of susceptibility to both lameness and mastitis may be fortunate as it would avoid conflict in selection against these two important diseases. Where conflict arose, progress would still be possible, but would be slower.

The patterns of disease transmission, especially those marked as significant in Table 2, are of research interest. The co-transmission, mostly significant or highly significant, of all studied lesions causing lameness suggests that there is a common pathway in their production, and the non-significant but consistent association of lameness with mastitis suggests that variations in the antibacterial properties of the keratin of hooves and of the teat duct might be involved. The inverse relationship between the transmission of the foot lesions solar ulcer and white line disease with hypocalcaemia may be related to mineral metabolism, but the association between heel lesions and retained placenta is difficult to explain. The consistent and occasionally significant negative association between all lameness lesions and milk yield, implying that high milk yields are transmitted with low rates of lameness, may reflect some interference of lameness with lactation. In addition, experimental investigation of these diseases might be aided by the availability of groups of cattle of known high or low susceptibility.

This study needs to be repeated using a larger database so that more data can be gathered for the less well known bulls, and so that the effects of farm can be discounted.

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Figure 1

The incidence rate of solar ulcer in the daughters of 24 bulls.

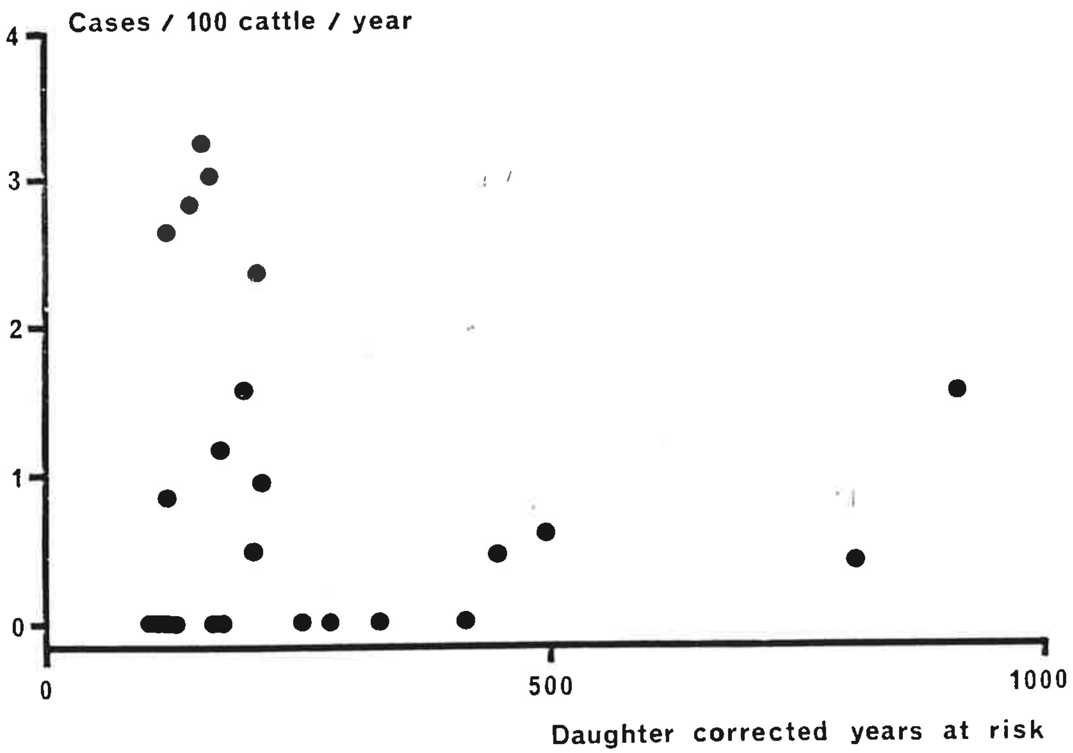

Figure 2

The incidence rates of heel and white line lesions in the daughters of 21 bulls.

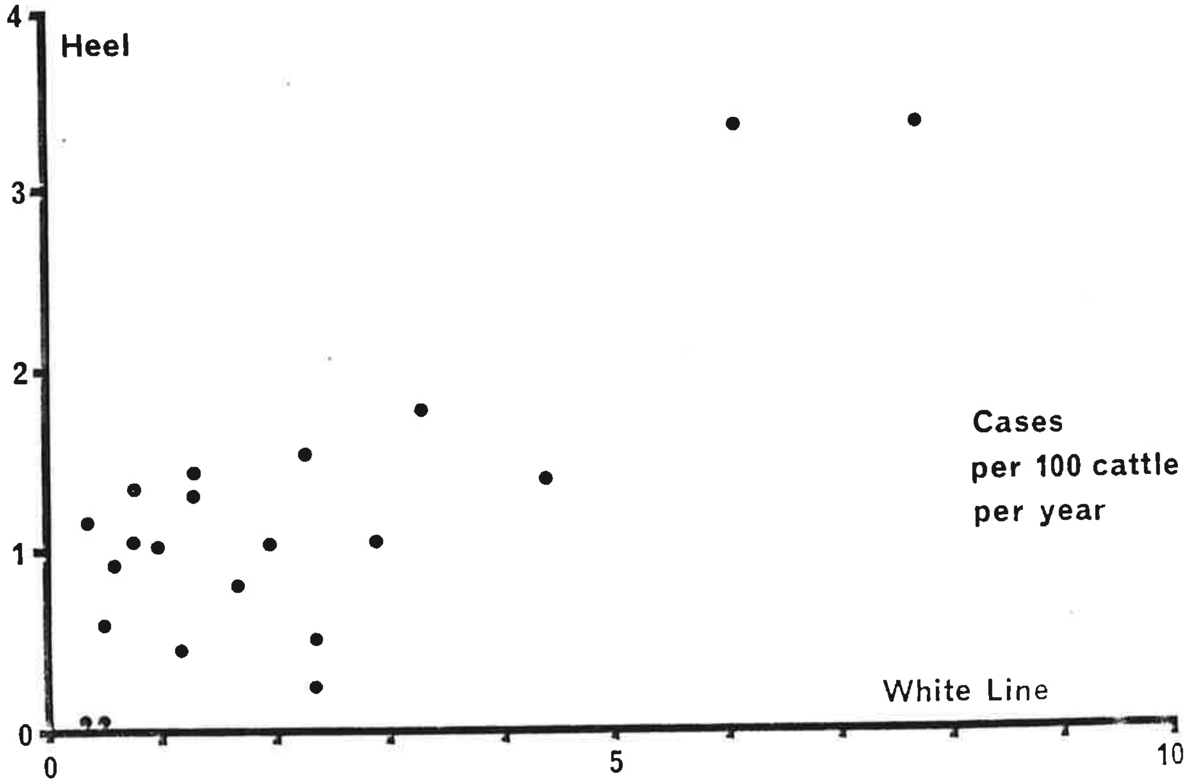

Table 1

The yield performance and incidence rates of diseases in the daughters of bull 176.

Bull 176	Cases per 100 cows per year
Dystokia	1.54
Hypocalcaemia	17.85
Retained placenta	0.49
Endometritis	9.25
Mastitis	14.03
Ketosis	1.03
Axial groove lesions	0.34
Foul of the foot	0.84
White line lesions	1.33
Solar ulcer	0.78
Heel lesions	1.30
Yield (% of normal)	112.16

	Dystokia	Hypocalcaemia	Retained placenta	Endometritis	Mastitis	Ketosis	Milk yield	Axial groove	Foul	White line	Solar ulcer
Heel	0.222	-0.326	0.512	-0.062	0.347	-0.055	-0.309	0.543	0.505	0.812	0.726
Solar ulcer	0.304	-0.451	0.359	-0.207	0.338	-0.161	-0.246	0.791	0.337	0.824	
White line	0.285	-0.522	0.423	-0.330	0.383	-0.111	-0.443	0.565	0.390		
Foul	0.065	0.124	0.361	0.277	0.162	-0.065	-0.188	0.366			
Axial groove	0.355	-0.303	0.263	0.188	0.244	-0.222	-0.176				
Milk yield	-0.362	0.614	0.014	0.351	-0.273	0.407					
Ketosis	-0.206	0.557	-0.011	0.051	0.087						
Mastitis	0.339	-0.251	-0.005	-0.125							
Endometritis	0.112	0.402	0.186								
Retained placenta	-0.151	-0.318									
Hypocalcaemia	-0.280										

Table 2

Correlation coefficients between diseases and milk yield in the daughters of 21 bulls.

Coefficients over: 0.43 significant at 5%
0.55 significant at 1%

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Prophylaxis: Breeding, Feeding, Housing and Hoof Trimming

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Introduction

Prevention of ruminant digital disease is the modern approach to this increasingly recognized and economically significant problem. Successful cattle breeders and feeders are no longer satisfied with successful treatment of a lame animal. They demand to know why the animal became lame and how to prevent further lamenesses in their herds. They are aware that when an animal becomes lame a financial loss has already occurred and treatment only limits the amount of loss. Only a small profit is realized per healthy animal under ideal conditions and a herd lameness problem very quickly leads to economic disaster. When treating a lame animal it is, of course, essential that treatment be successful but the prophylactic advice offered is often of far greater economic benefit to the cattle owner. In order to give sound advice we must be knowledgeable not only in cattle diseases but also many facets of cattle husbandry; such as breeding, feeding, housing, and hoof trimming.

Clinical Features and Discussion

Heredity

Many lamenesses could be prevented if proper attention were given to selecting breeding animals with correct foot and leg conformation. Greenough MacCallam and Weaver[1] list the following normal foot and leg angulations:

Tibiotarsal metatarsal - 129 to 134°
Radioulnar metacarpal - 180°
Pastern angulation to the ground, forelimb 50-55°
Pastern angulation to the ground, rear limb - 55-60°
Dorsal border of hoof with horizontal, forefoot - 50°
Dorsal border of hoof with horizontal, hindfoot - 55°

Wide variations in the size of medial and lateral claws predispose to lameness since the large claw bears a disproportionate amount of body weight and excessive trauma occurs. The hoof wall should be relatively straight, the bulb deep and sole concave.

Conformational defects of the digits often result in lameness and have a high degree of heritability.

Some heritable conditions such as mulefoot (syndactyly) are visible at birth while others such as vegetative interdigital dermatitis (hyperplasia interdigitalis) do not appear until later in life due to complicating causative factors.

Any animal exhibiting a serious genetic defect of the digits should not be used for breeding purposes.

Whenever a serious heritable defect occurs in the progeny of a bull being used for commercial semen production, the condition should be reported to the semen producer management so they will be aware of the fact and can take appropriate action. Cattle breeders should make use of the genetic information furnished by semen suppliers on bulls being considered for use in their herds.

In the past, when cows produced only one calf per year, they were not considered to be a very serious threat to the genetic pool if they carried a recessive gene for a locomotor defect. With the advent of embryo transfer and the possibility of hundreds of progeny from one cow in her lifetime, she too is now recognized as a potential gene-pool polluter.

Nutrition

Prevention and control of nutrition-related lameness is primarily based on the prevention of laminitis, because so many foot lamenesses are associated with compromised integrity of hoof structure, which is the result of laminitis. Laminitis almost always is associated with feeding a concentrated ration that is high in carbohydrates (starch), high in protein and low in long fiber. Abrupt change to such a ration, accidental access or long term feeding can all result in varying degrees of laminitis.

Prevention consists of feeding a 12 to 15% protein and at least 17% fiber ration on a regular basis.

All ration changes should be gradual and extreme care should be exercised to prevent accidental access to high concentrate rations. Buffering agents such as sodium bicarbonate added to rations at the one to two percent level have been beneficial in preventing laminitis and are widely used in dairy rations. Long term feeding of high concentrate rations is practiced in feedlot beef animals intended for slaughter at an early age. Many of these animals suffer from laminitis as they approach market weight but this causes little concern because of their short life span. In the case of high producing dairy cows, buffering agents during lactation and a high fiber and low concentrate ration during the dry period minimize the chances of laminitis developing.

Feed damaged by mold, ergot containing grain or endophyte contamined fescue may all cause lameness and should be fed with extreme caution, if at all.

Housing

Cattle maintained in a pasture environment have relatively few lameness problems but economics has dictated confinement of many intensified dairy and beef enterprises. Confinement has increased lameness problems many fold. Both walkways and freestalls in confinement systems have contributed to this increase.

Walkways are usually solid concrete or slats. Solid concrete floors are initially given a rough brush finish that provides good footing, but after several years of continuous cattle usage and mechanical cleaning with metal scrapers, the surface becomes so smooth and slippery that cattle walk very cautiously with short steps and on tiptoes to keep from falling. This manner of walking results in malformed and overgrown claws. Various methods are used to roughen these slippery floors. The most popular method is diagonal grooving of all surfaces where cows walk or stand.[2] Grooves ½"(12mm) wide, 3/8"(9mm) deep, and 3 ¼ (9.4cm) apart have been very satisfactory.

Other methods occasionally used to roughen slippery floors such as muriatic acid, hydrochloric acid, jack hammers, and scabblers, have not been as satisfactory. Various slat widths and gaps have been recommended. Pinsent[3] recommended that the slat width be 125 mm and the gap 40 mm. Slats should have a rough brush-troweled surface with tapered sides.

Free stall construction recommendations have also varied widely. Britt[4] recommended the following:

A 48"(122cm) stall width appears best for 1100 to 1400 lb[a] Holsteins. The minimum length should be 7½'(229cm) though 8'(244cm) stalls work very well.

Rear curb should not be over 10"(25cm) above the alley floor, and there should be a small lip not over 2" (5cm) at the rear of the stall to keep the bedding from being raked out by the cows. The floor of the free stalls should be at the same height as the curb, less the lip for bedding saving, and the front floor should be slightly higher than the rear of the stall. A 4% slope from front to rear has been satisfactory. Some stalls use a brisket board at the front floor that is 5'6" - 6' (165-180 cm) from the rear of the stall. This board sticks out of the floor 4-6"(10-15cm) and slopes away from the cow at a 45° angle. It also keeps the cow from lying too far forward in the stall.

a equivalent to 500-640 kg

Stall dividers made from looped pipe make it easier for cows to get up and decrease the chances for injury.

Free stall floors have been constructed of many materials, with concrete and clay being most frequently used. Based on cow usage when choices are provided, clay floors are apparently more comfortable than concrete but require more maintenance. Discarded automobile tires laid flat and the open spaces filled to one half the width of the tire with ground have recently been highly recommended.[5] Bedding or floor surface coverings vary widely; carpeting, rubberized material, straw, sawdust, wood shavings, and sand are used most often. Sawdust shavings and chopped straw bedding on clay-base free stalls was preferred by cows in Albright's study,[6] and cows had fewer feet and leg injuries. Albright also found that digit problems were higher in stanchion stalls than in loose housing barns.

It is not considered necessary to have a free stall for every cow, because not all cows use free stalls at the same time.[7] Increasing animals-to-free stall ratio above 4:3 is not recommended, because the average resting time is decreased at a greater ratio. Foot health is compromised when animals have to stand for extended periods of time on manure-covered concrete floors while waiting for a free stall to become available or while waiting for extended periods of time in a holding area to be milked.

Cows confined to a free stall barn with small concrete holding and feeding areas have their feet constantly bathed in feces and urine. Within a year or two the hoof softens, heel fissures develop, sole ulcerations appear and hoof growth accelerates. Animals soon become extremely lame, milk production drops and general health deteriorates.

Cows benefit by being removed from such stresses during the dry periods. They should be placed on ground exercise lots and fed a ration high in fiber and very low in concentrates. These exercise lots often become quagmires in high rainfall seasons. Some solutions are adequate drainage, creating ground mounds, spreading crushed rock, applying four tons of lime per acre, concreting heavily used portions of the lot and increasing lot size.

When low spots or entrances to buildings are filled with material to prevent the development of mud holes, one should use smooth stones rather than coal cinders or sharp stones, which would penetrate interdigital tissues or hoof soles.

Foot Trimming

Foot care should begin early in life. When heifer calves reach six months of age their feet should be examined and trimmed, especially if they are confined on soft footing such as built-up litter[8]. Heifers should have exercise if they are to develop strong feet and legs. Lack of exercise often results in weak pasterns and wide-spread claws.

Most yearling heifers should have their feet trimmed at least once if they are confined, but it is usually not necessary if they are grazing. When heifers are added to the milking herd as two-year-olds, an excellent opportunity arises to examine their feet for abnormalities and attempt corrective trimming if indicated.

Confined cattle will benefit from foot trimming at this time and at least once a year thereafter for the remainder of their lives.

Hoof trimming can be performed with the cow in the standing position, cast on the ground or restrained on a tilt table. The author prefers a tilt table but this facility is not always available and other restraint becomes necessary. Usual trimming equipment consists of long-handled hoof nippers, search knives (hoof knife), Allgau knife (hoof chisel), electric sander and a good pair of leather gloves. The author prefers to perform the basic portion of the surgery with the long-handled nippers, explore tracts and remove overlapping tissues or loose strands with a hoof knife and smooth the weight-bearing surface with the sander. Excessive use of the sander on the sole should be avoided because it may heat the tissues to a degree that produces necrosis. Feet should be trimmed as short as possible without penetrating the sole or making the sole so thin that the first sharp stone will penetrate it.

The medial claw is usually trimmed slightly shorter than the lateral claw since many cattle toe out and such trimming encourages correct placement.

The axial aspect of both claws should be trimmed shorter than the abaxial aspect producing a sole concavity. This permits the cloven foot to grasp or cut into the walking surface in a normal manner. It also causes most of the body weight to be borne by the hoof wall, concussion to be borne by the sole and forces the claws together rather than permitting them to spread apart. When an animal has too much set to its hocks as viewed from the side (sickle hocked) or weak rear pasterns, the toes of both rear claws should be trimmed as close as possible and the heel left long. The middle third of the sole and wall should be trimmed short so body weight is distributed equally between the heel and toe and a rocking chair effect is prevented.

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