

CRAMPY OR PROGRESSIVE POSTERIOR PARALYSIS IN MATURE CATTLE^{1, 2}

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SUMMARY

Records from 12,387 dairy bulls of five breeds, and 448 beef bulls of four breeds, were studied to establish the frequency and age at occurrence of the crampy condition, and to determine if evidence of genetic influence existed. The 323 dairy and ten beef bulls which were affected represented all nine breeds. Chi-square analysis showed that the frequency of occurrence differed significantly ($P < 0.01$) among the dairy breeds. Death or last effective service of affected bulls occurred at a mean age of 10.02 ± 2.49 yr. Numerous familial relationships were demonstrated; differences in frequency of occurrence in sire groups, and in lines and line-crosses, were significant ($P < 0.04$ and $P < 0.01$, respectively). Thus, a genetic background of the condition was indicated strongly. Although multiple gene inheritance was not discounted, inheritance was suggested as a single recessive factor with incomplete penetrance.

A syndrome characterized by intermittent spastic contraction of the muscles of the rear legs and back of mature cattle of both sexes has been recognized for some years. It has been called crampy (krampfigkeit), neuromuscular spasticity, posterior paralysis, progressive posterior paralysis, spastic syndrome, stretches, and other names. The cause of this syndrome has not been established; however, a familial pattern of occurrence has been reported. Crampy has shortened the useful lives of numerous bulls and cows.

Crampy occurs in otherwise normal adult cattle. Symptoms become evident when animals are three or more years of age and usually are mild for the first few years. The earliest signs are slight muscle spasms which appear when animals arise, back up, or move suddenly. As the condition progresses the muscles of one or both rear legs go into spasmodic contractions that last for a few seconds to several minutes. Animals often extend or flex their legs, one at a time, during these episodes. When both rear legs are affected, they remain on the ground and are extended backward during an attack; hence, the term stretches. The condition becomes progressively more severe over a period of months or years until the muscles over the back, and eventually much of the body, are involved. Because physical activity is necessary to induce an attack, animals affected severely usually remain recumbent. Animals in the advanced stages have reduced value.

Roberts (4) observed or assembled reports of 65 cases, 33 bulls and 32 cows. Affected cattle included two full brothers, two half-brothers, three sons of the

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same bull, and a three-generation group of females. Five breeds were involved. Previously, Wirth and Diernhofer (6) stated that the syndrome might be determined by genetic factors.

Frauchiger and Hofmann (3) were unable to demonstrate histological changes in the central nervous system of mature cattle affected with *krampfgeit*. Roberts (4) postulated that the condition resulted from a derangement of the postural reflex mechanism.

The objectives of this investigation were to establish the frequency of the condition in a population of bulls used in natural and artificial service, and to evaluate a possible genetic influence upon the occurrence.

EXPERIMENTAL PROCEDURE

A study of useful tenure and reasons for disposal of bulls from natural and artificial service has been under way for some years (1, 2). Records were accumulated mainly by direct correspondence with owners, managers, and herdsmen. Reasons for disposal were available for 12,387 dairy and 448 beef bulls, as well as the ages at death or last effective natural service or semen collection.

Five-generation pedigrees were compiled on affected members of the five dairy breeds, and familial relationships established. Standard statistical techniques (5) were applied where appropriate.

Animals were considered *crampy* if the reason for disposal was listed as *crampy* or one of its previously mentioned synonyms. Other conditions which might have been *crampy*, but which were excluded: unable to mount, unable to stand up on hind legs, and refused to serve. Paralysis alone was not considered *crampy*, since it could follow a stroke caused by an embolism in the brain; similarly, injury of a peripheral nerve that interfered suddenly with control of a part of the body was not considered. Some diagnoses of rheumatism and gradual loss of use of the hind quarters were accepted. Estimates of frequency of *crampy* would, thus, doubtless be somewhat conservative.

RESULTS

Frequency of occurrence. Some 323 dairy and ten beef bulls died or were removed because of *crampy* (Table 1). These bulls were removed from service at a mean age of 10.02 ± 2.49 yr., with a range of 3 to 16 yr. Affected bulls comprised 2.6% of the total population. Among the five dairy breeds, frequency ranged from 1.9 to 3.9%. Chi-square analysis showed that frequency of occurrence differed highly significantly ($P < 0.01$) among breeds in the records.

Pedigree study. Familial relationships were determined from the pedigrees of affected bulls. Many of the related individuals were in widely separated parts of the country, in natural or artificial service, and under what was assumed to be good or excellent management. From one to eight sons of certain bulls were affected; a number of dams had two sons affected, some in different herds.

TABLE 1
Age at death or disposal of crampy dairy bulls

Years	Ayrshire	Brown Swiss	Guernsey	Holstein-Friesian	Jersey
	1,232	Total removed *			3,041
		803	3,166	4,145	
		Number removed for crampy			
3	....	....	....	1	....
4	....	1	1	4	1
5	2	....	....	5	1
6	2	1	2	11	4
7	5	1	6	17	3
8	4	....	8	16	1
9	5	3	9	27	11
10	10	3	10	22	10
11	9	2	10	17	9
12	4	4	8	15	8
13	3	1	3	5	2
14	1	....	2	2	2
15	1	....	1	2	....
16	2	....	....	3	....
Total	48	16	60	147	52
Percentage	3.9	2.0	1.9	3.5	1.7

* Total number of dairy bulls over 3½ yr. at disposal was 12,387, with 323 removed or died when crampy.

One Ayrshire bull had seven crampy sons from a total of 29. The affected animals were 7 to nearly 16 yr. old at disposal or death. The remaining 22 sons were not reported as crampy at disposal, nor was the bull himself. Of the seven crampy sons, one was inbred, and another was out of the sire's paternal sister. Six of the seven sons traced through their dams to a common sire in the first, second, or third generation. Other affected descendants of this ancestor included four grandsons, a great-grandson, a double-great-grandson, a triple-great-grandson, and five great-great-grandsons. In another line, an Ayrshire bull had a crampy son, a crampy grandson, and the latter in turn had a crampy son. The last had a maternal brother affected likewise.

The 16 Brown Swiss bulls reported as crampy had the following pedigree relationships: (a) two were paternal brothers; (b) two were sired by full brothers; (c) a bull and his son were affected; (d) a bull and his grandson were affected, and (e) a bull and three-great-grandsons were afflicted.

A Guernsey bull left service at 10.6 yr. because of an injury to a stifle; his sire was removed at 9.1 yr. for stiff hind legs. Three sons of the first bull were discarded at 11.0 to 14.9 yr. for acute rheumatism, a twisted stifle and crampy, respectively. A grandson lost use of his hind legs at 12.4 yr.; another was slaughtered at 10.9 yr. for a back injury, and a third at 11.3 yr. for crampy. Two great-grandsons, themselves three-quarter brothers, were disposed of for crampy at 7.2 and 11.6 yr. Nine other more distantly related descendants tracing one to four times to the original bull were slaughtered at 7.7 to 11.1 yr. for crampy. In this line there were four successive generations of crampy bulls.

Among other Guernsey lines, there were two instances in which a bull, his grandsire, and two great-grandsons were crampy as well as a double-great-grand-

sire. These animals were removed at 6.3 to 13.5 yr. In another case, a bull, his sire, double-grandsire, and double-great-grandsire all were crampy.

Eight sons and nine grandsons of a popular Holstein bull were crampy. Another Holstein bull had eight sons and 14 grandsons that were crampy. Two of these affected sons were full brothers. Yet, other sons and grandsons left service for several different reasons other than crampy at 5 to 16 yr. Another outstanding bull lost the use of his left hind leg at 10.3 yr. His crampy descendants included a son, two grandsons, and four great-grandsons, of which two were full brothers and two others were three-quarter brothers. The dam of the two crampy full brothers was herself crampy. Another bull was himself removed for rheumatism in the hind legs at 8.6 yr.; one grandsire went out for paralysis in the rear quarters and the other for rheumatism. These were owners' statements.

In a different Holstein line, one bull was apparently normal, having left the herd because of old age at 14.7 yr. His sire had been removed at 14.0 yr. for an injury to a hind leg. The son, in turn, sired one affected bull, as well as having two affected grandsons and three great-grandsons. Two of the latter were fifteen-sixteenths brothers. One bull, his sire, and both grandsires went out of use because of the spastic condition, failure of the hind quarters, or paralysis, according to the statements of the respective owners. Two of these were full brothers. A bull, his son, and several of the daughters of each were crampy in an institutional dairy herd. A group of crampy Holsteins included a cow, her two sons, and a grandson. Her mates were closely related bulls; one died of unknown cause at 3 yr. and the other was reported to have an injured leg at 11.8 yr.

The following family relationships existed among afflicted Jersey bulls. An affected male had the following affected descendants: three sons, two grandsons, and six great-grandsons. One of the latter was a double-great-grandson. Another living great-grandson has been crampy since he was 4 yr. old. Three of the great-grandsons died in widely separated parts of the country, and the living crampy great-grandson; all were three-quarter brothers. In another line, a bull and son were affected; in another, a bull, grandson, and a great-grandson were crampy. Still another Jersey, which left a well-managed herd for a "mineral deficiency," had a grandson and two great-grandsons which were crampy at disposal when 6 to 12 yr. old.

Other breeds. Of 251 Milking Shorthorn bulls, crampy individuals included one each at 6, 8, and 9 yr. old. One crampy Angus bull out of 91 animals went out at 10 yr. old. A 6-yr. and an 11-yr.-old Beef Shorthorn were eliminated among the 32 of this breed. Two Herefords were crampy at 3 yr., and one each at 8 and 9 yr., among 74 animals. This was 2.2% of the 448 beef and dual-purpose animals.

Frequency in sire groups and lines. Pedigree study enabled the grouping of normal and affected bulls into sire groups (paternal half-sibs to full sibs). Where closely related bulls occurred, they were grouped into lines. Where members of a line were crossed with unrelated females, the sons were designated

TABLE 2

Frequency and distribution of crampy sons among sire-groups and among lines and line-crosses

Breed	Total No. of sons ^a	Number of crampy sons	Degrees of freedom	Chi-square
Among sire-groups				
Holstein	183	26	20	26.9
Guernsey	183	10	25	36.0
Combined	366	36	45	62.8 ^b
Among lines and line-crosses				
Holstein	235	35	18	33.1
Guernseys	257	17	22	33.8
Combined	492	52	40	66.9 ^c

^a In groups of four or more.^b $P < 0.04$.^c $P < 0.01$.

as a line-cross. The requirement was added that a sire group, or a line or line-cross, must have consisted of at least four individuals. Only Guernsey and Holstein bulls past 5 yr. old were included in the chi-square analysis.

As shown in Table 2, 366 males representing 47 sire groups and 492 males of 42 lines and line-crosses were utilized. It was assumed that if crampy were due to nongenetic factors it would occur in these categories in a random fashion. Chi-square analysis showed that this hypothesis was rejected at the 4 and 1% levels, respectively. Besides the frequencies of affected animals mentioned previously, additional groups were relatively free of the condition. Among sire groups the following extremes were noted: zero of 18 sons and zero of 19 sons; among line-crosses: zero of 19 and one of 61 sons.

DISCUSSION

Evidence of genetic influence on crampy appears almost conclusive. Frequencies of the condition in the five dairy breeds differed significantly; crampy occurred in cattle within closely bred family lines and did not occur in other closely bred but unrelated lines. The character developed in animals where both sire and dam were affected. Familial relationships, although not convincing individually, seem too numerous to be discounted.

Perhaps the exact mode of inheritance may never be learned. It is entirely possible that multiple gene inheritance may be involved, with the condition inherited in the manner of many quantitative characteristics. However, the condition may be inherited as a qualitative characteristic. There were numerous instances from pedigree analysis that followed the pattern of that of recessive red hair-color. The manifestation of crampy may be attributable to incomplete penetrance.

The condition is neither sex-limited nor sex-linked. It occurred in bulls and cows, as well as in first-generation progeny of affected animals of either sex. It is not dominant in character, since it frequently skipped generations in expressing itself. If it were assumed that crampy was inherited as a simple recessive, then its gene frequency would be about 16.2%, with 2.6% of the geno-

type homozygous recessive (crampy), 27.1% heterozygous (or carriers), and 70.3% homozygous dominant, or free from the gene. Incomplete penetrance would necessarily make this estimate of gene frequency low, since many animals doubtless left the herds before the condition was recognized, and thus were assumed free. These suppositions do not preclude the possibility that polygenic inheritance may be involved.

The average age at disposal (10.02 yr.) was higher than the over-all age of disposal of the desirable bulls from artificial service (1, 2). Affected animals were discarded as young as 3 yr., however, and some bulls transmitting high milk production would have been kept longer, had it been possible.

In the past, some crampy bulls have been used in the advanced stages, being treated with pain-relieving drugs and collected sometimes with electro-ejaculators when unable to mount. This indicated esteem of these individuals because of desirable characteristics. The popularity of their respective progeny indicated regard for their ability to transmit milk and butterfat production. The crampy condition is distributed widely enough and is of sufficient importance in shortening the useful lives of some dairy animals that some consideration should be given when breeding to known affected bulls. Breeders may wish to consider crampy when selecting future herd sires, should their ancestry be known as carriers.

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