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From the Institute of Animal Breeding, Royal Agricultural College, Uppsala and Veterinary Division of the Agricultural Society, Uppsala, Sweden.

FACTORS INFLUENCING THE TYPE AND INCIDENCE OF MASTITIS IN SWEDISH DAIRY CATTLE

By

Jan Rendel and *Thorsten Sundberg*

Mastitis may cause a considerable reduction in the milk yield of the affected cows. In order to decrease the frequency of udder diseases in Sweden, a nation wide program for the control of mastitis was started in 1954. Data from the control program in Uppsala county furnished material for the present study. The majority of the mastitis infections were found to be due to strains of *staphylococci,* which often proved to be highly resistant to antibiotics. The effect of the control program and the influence of herd environment, age of the cows, milk production and heredity on the frequency of mastitis will be discussed. The extensive literature dealing with mastitis was recently reviewed by *Oliver* (1955) and *Plastridge* (1958). Only papers having direct bearing on our own findings will therefore be referred to in the present communication.

MATERIAL AND METHODS

Forty-seven dairy herds of varying size furnished material for the present study. All these herds took part in the mastitis control as well as in the official milk recording program. Twice a year each herd was visited by an experienced veterinarian. The mastitis diagnosis was based on all available information including anamnestic data; inspection and palpation of the udder; strip-cup tests for milk clots; bromthymol blue test for altered pH and cell counts and bacteriological tests of milk samples. The last mentioned two tests were carried out at the Veterinary

bacteriological laboratory Västerås according to methods described by *Thörne & Wallmark* (1960). Five ml. milk was collected seperately for each udder quarter in sterile vials containing 0.5 ml. of a 0.065 % sodium azide and 0.2 % bromcresol purple solution and subsequently sent to the laboratory in Västerås. During the years 1954—57 samples were taken from all cows regardless of the clinical results. However, the clinical examinations were found sufficient to trace the probable occurrence of mastitis and after 1957 milk samples were therefore taken from clinically suspect udders only. Quarters giving milk with more than 500,000 leucocytes per milliliter were considered to have developed mastitis.

During a given lactation period a cow was classified as having mastitis if she developed the disease at any time of the period and as healthy if she stayed free from symptoms for at least 7 months. The lactation in which the cow was disposed of form a special problem. However, is was decided to disregard such lactations if no test had been carried out after that 7 or more months had elapsed from the calving, provided that mastitis had not been detected at previous tests in that particular lactation.

Data obtained from these clinical and bacteriological tests during the period 1954—59 were statistically analysed. The majority of the herds in the control program participated during at least 5 years. In all 1433 cows were controlled for mastitis already during their first lactation. The majority of analyses will be restricted to these cows. In some analyses data from cows which were controlled only in the 2nd or later lactations will also be included. All cows belonged to the Swedish Red and White breed (SRB). Three fourth of the herds were served from an A.I. center, while the others used natural service.

The results from the clinical and bacteriological tests were recorded for each separate quarter of the udder during the five first lactation periods. The information was transformed to IBM cards together with data about parentage, year of birth, times of calving, production of butter fat during the first lactation (305 days) and the udder health of the dam. The statistical analyses were carried out according to standard methods. Significance at the 5 % level will be denoted by one asterisk, while two and three asterisks indicate significance at the 1 % and 0.1 % level respectively.

Table 1.
Influence of age and herd environment on the frequency of mastitis in 47 dairy herds.

Age in lactations	No. of cows	Proportion of cows with mastitis %	Proportion of healthy cows during all lactations %	Herds having 10 or more cows per age group					
				Total		A. I. herds		Heterogeneity between herds χ^2	
				No.	Range of mastitis frequency	No.	Range of mastitis frequency	Total	A. I. herds
1st	1433	14.9	85.1	41	0—41	30	0—41	79.1***	56.2**
2nd	965	23.8	67.6	35	0—48	24	0—48	63.3***	47.1**
3rd	563	29.3	54.0	21	0—44	13	0—44	20.4	11.9
4th	289	37.7	35.7	9	31—71	3	50—57	6.4	0.1
5th	110	31.8	30.0	2	0—43	—		5.3*	—

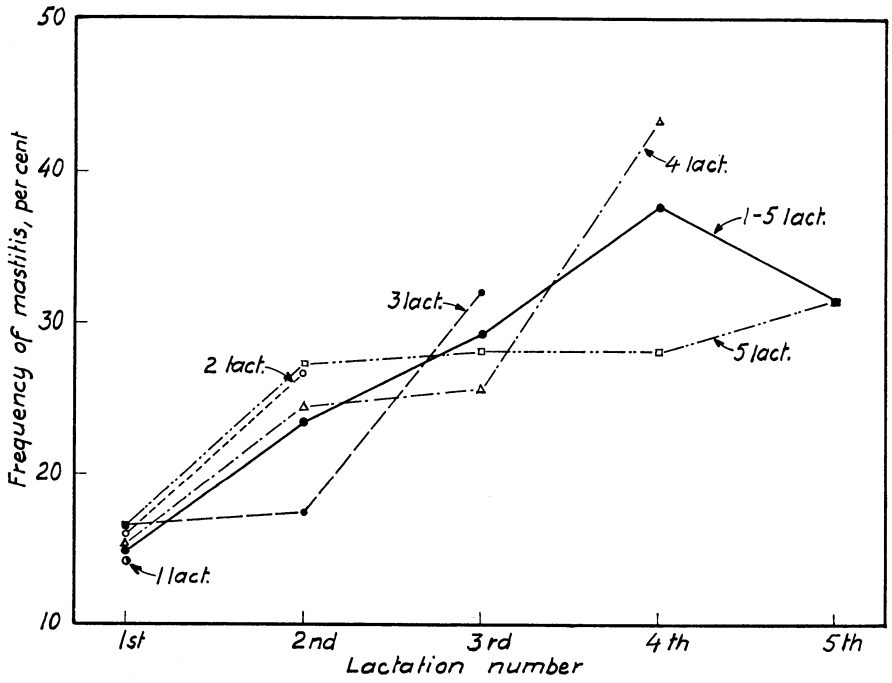

Fig. 1. The effect of age on the incidence of mastitis. The results are given separately for cows having 1, 2, 3, 4 and 5 lactations each and for the pooled data from all lactations.

RESULTS

Influence of age

The age of the cows had a very marked effect on the incidence of udder disease (Table 1 and Fig. 1). The frequency of animals with mastitis increased from 14.9 % among first calf heifers to

about 35 % among cows in their 4th—5th lactation period. The difference between the age groups was highly significant. The age effect in cows having 2, 3, 4 and 5 lactations periods respectively is depicted separately in Fig. 1.

Less than one third of the animals having 5 controlled lactation periods remained free from mastitis in all these periods. The increased susceptibility to mastitis by age obtained in the present material agrees with the results obtained in several earlier studies (see *Oliver* 1955 and *Plastridge* 1958). However, little is known about the causes for this age effect. Based on the findings of *Dodd* and *Neave* (1951) that slow milking cows were more resistant to mastitis and also culled at an earlier age, *Oliver* (1955) suggested that at least a part of the effect of age on the resistance was due to bias introduced by selection.

In the present material the possible effect of such selection on the incidence of mastitis could be studied in cows having 2—4 lactation periods. The first lactation had to be omitted, because only those first lactations were entered into our records which were subjected to at least one mastitis control. The animals calving the 2nd,3rd and 4th time respectively were divided into two groups (A) those being proved to have had mastitis and (B) the remaining cows. An animal was assumed to be culled if no new calf was produced within 2 years after the preceding calving. The study was therefore limited to lactations starting before Jan. 1st 1958. Group B comprised all cows which were classified as healthy (cf. page 14) and those being culled within 7 months from the last calving without recorded mastitis. Some of the latter animals were culled before any mastitis test was performed, while others were healthy at the first examination but culled before the second test. At least some of these cows did probably develop mastitis before culling. The culling percentage in group A will therefore give an under-estimate of the true culling level among mastitis cows, while the frequency in group B will yield an over-estimate of the culling level among cows free from mastitis.

As seen from Table 2 the culling levels were on the average almost exactly the same in the two groups. However, within the 4th lactation period there was a significantly higher culling level among cows with mastitis than in group B, while more culling took place in group B in the 2nd and 3rd lactation periods. The latter difference was not significant. The present data lend there-

Table 2.

The percentage of cows culled in the 2nd to 4th lactation among cows with proved mastitis (group A) and among the remaining cows (group B). See text.

Age in lactations	Group A		Group B				Heterogeneity between groups χ^2
	No. of cows calving	Percentage culled	No. of cows calving			Percentage culled	
			Total	Classified as healthy	Unclassified		
2nd	150	18.7	513	449	64	20.7	0.3
3rd	71	18.3	243	202	41	29.6	3.6
4th	37	48.7	65	58	7	23.1	7.0*
Total	258	22.9	821	709	112	23.5	0.5

fore no support to the suggestion by *Oliver* (1955) that the influence of age on mastitis resistance might be due to a higher culling rate among the resistant cows. On the contrary mastitis seems to be a frequent cause of culling in older cows. This selection will tend to decrease the rise in the mastitis incidence with increased age.

The occurrence of new cases of mastitis in previously healthy cows was studied in the various lactation periods (Table 3 and Fig. 2). With the exception of the 40 cows which remained healthy for 4 lactations and had a 5th lactation period, there was a tendency to higher incidence of first mastitis cases with increased lactation age.

Influence of herd environment

In some herds all animals of a given lactation age were free from mastitis, while in other herds about half of the cows were affected. The heterogeneity between herds was statistically significant within the 1st, 2nd and 5th lactation periods but not in the remaining periods, probably because of the small number of animals (Table 1). The A.I. herds may be assumed to share approximately the same genes. The large differences in the average incidence of mastitis which occurred also between these herds (Table 1) strongly suggest that the herd differences are mainly of environmental origin.

Table 3.

The frequency of mastitis in different age groups among cows being healthy in all previous lactations.

No. of lactations per animal	Lactation period								Heterogeneity between groups χ^2
	2nd		3rd		4th		5th		
	Total No.	Mastitis %	Total No.	Mastitis %	Total No.	Mastitis %	Total No.	Mastitis %	
5	92	23.9	70	24.3	53	24.5	40	17.5	0.8
4	151	19.9	121	19.0	98	35.7			10.5**
3	229	12.7	200	23.5					8.6**
2	338	22.7							
Total	810	19.5	391	22.3	151	31.8	40	17.5	11.9**

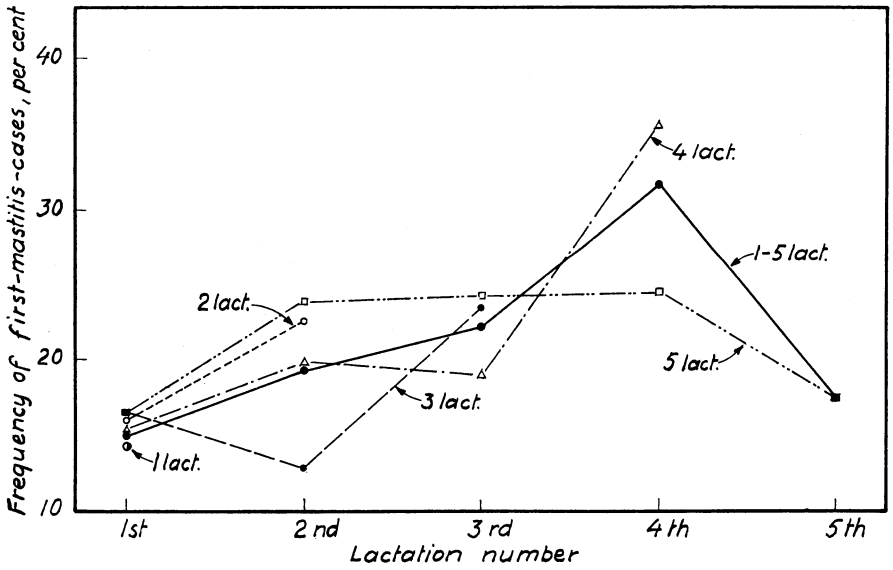

Fig. 2. The effect of age on the frequency of new cases of mastitis in previously healthy cows. The results are given separately for cows having 1, 2, 3, 4 and 5 lactations each and for the pooled data from all lactations.

Types of infection

As seen from Table 4 about 65 per cent of the cases of mastitis were proved to be caused by staphylococci alone. However, these bacteria also took part in the great majority of mastitis infections caused by 2 or more organisms. The last column of Table 4 refers to cases of clinical mastitis occurring between the ordinary control visits. The infection type is therefore unknown. However, there are reason to believe that a great part of these infections

Table 4.
The frequency of the different infection types among all infected udder quarters.

Lactation number	No. of infected animals	No. of infected quarters per animal	Type and frequency of infection								
			Str. agalactiae	Other Streptococci	Staphylococci	Corynebacterium pyogenes	Coli	Cocci	Others	2 or more types	Unknown
1st	214	1.38	1.69	14.53	65.88	1.35	0.34	—	2.36	4.73	9.12
2nd	230	1.38	1.89	9.78	66.56	0.32	0.63	0.63	0.32	8.20	11.67
3rd	165	1.33	1.83	10.05	66.21	—	0.91	1.37	3.65	9.59	6.39
4th	109	1.44	0.64	10.19	61.78	—	0.64	2.55	4.46	7.00	12.74
5th	35	1.49	—	23.08	57.69	—	—	—	1.92	11.54	5.77
Total	753	1.38	1.54	11.91	65.13	0.48	0.58	0.86	2.31	7.49	9.70

were also caused by staphylococci. In the present material about four fifth of all cases of mastitis were thus associated with infections with various strains of staphylococci. *Streptococcus agalactiae* occurred in a few animals only and did not cause any serious problem. However, other streptococci were found in about 12 % of the udder quarters with mastitis. *Neave* et al. (1952) who investigated the incidence of clinical mastitis in 6 large English herds freed from *Str. agalactiae* found also a very high proportion of the cases (64 %) to be caused by various staphylococci.

The age of the cows had no apparent influence on the ratio between the organisms causing mastitis. The older animals were thus less resistant against both staphylococci and streptococci. These findings are contrary to the results of *Murphy* (1945) and *Hughes* (1954), who did not find an increased rate of staphylococcal infections with age. However, our results are in accord with those of *Oliver* et al. (1956a and b). *Murphy* de-

termined the incidence of infections rather than the frequency of mastitis. Among 451 complete lactation periods of 205 individuals he found that the incidence of streptococcal infections increased from 14.3 % in the first lactation to 58.3 % in the fifth period. The incidence of staphylococcal infections was very high; although fluctuating slightly it stayed within a narrow range of 77 % through all five lactation periods. However, *Murphy* did not distinguish between pathogenic and non-pathogenic staphylococci; a fact which probably explains the difference between his results and those of the present study.

There was a slight but statistically non-significant increase in the number of udder quarters with mastitis per animal as the age increased. This latter finding is in accordance with results obtained by *Klein & Learmonth* (1935).

Changes in the frequency and type of mastitis during the control program.

As already pointed out the detailed studies of the udder health will be limited to cows which were controlled already during their first lactation period. However, to get an idea of the effect of the control program, data from cows which were in their 2nd to 5th lactation when the control program started, will also be used.

The frequency of mastitis in the first lactation period showed a gradual decrease from 17.3 % in animals calving in the last control year to 7.9 % for those calving in the 6th year (Table 5). For the remaining four lactation periods there was a similar decrease in the mastitis frequency. The heterogeneity between control years was statistically significant in the 5th lactation period only. However, in the 1st, 2nd and 5th lactation periods the incidence of mastitis was significantly higher in the 1st control year than in the 5th and 6th years. The very marked difference between the control years of the same lactation period falling just above and below the zig-zag line in Table 5 is interesting. The results above the line refer to animals having one or more lactation periods when the control program started, while the values below the zig-zag line refers to animals with all their lactations controlled. It seems likely that the environment to which the animals are subjected during their first lactation period is of importance for the future udder health even though

Table 5.[1])

The change in the frequency of mastitis in different lactation periods.

Calving during year of control	Lactation period									
	1st		2nd		3rd		4th		5th	
	No. of cows	Per cent with mastitis	No. of cows	Per cent with mastitis	No. of cows	Per cent with mastitis	No. of cows	Per cent with mastitis	No. of cows	Per cent with mastitis
1st	300	17.3	194	33.5	147	40.1	110	46.4	68	47.1
2nd	269	17.8	226	23.9	150	38.7	106	53.8	81	59.3
3rd	280	16.1	224	24.6	157	30.6	115	40.0	72	47.2
4th	282	13.1	238	24.0	162	24.7	111	37.8	72	36.1
5th	226	11.5	196	22.5	164	31.1	107	36.5	66	28.8
6th	76	7.9	81	24.7	80	31.3	71	38.0	44	36.4
Hetero-geneity between years, χ^2	9.2		8.3		7.0		9.6		17.3**	

[1]) The animals falling below the zig-zag line had all their lactation periods controlled.

the direct influence on the first lactation period may be relatively small. Propaganda for more careful milking and better general hygiene make parts of the control program. The results in Table 5 indicate that the general treatment of the animals was poor prior to the participation in the mastitis control and that the poor milking technique and bad hygiene had an adverse effect also in subsequent lactations falling within the control program.

No significant change was found during the control period in the frequency of the various bacterial types causing the infections.

The distribution of mastitis on udder quarters.

As already pointed out, milking technique is of great importance to udder health. *Oliver* (1955) who reviewed the literature on this subject concluded that prolonged attachment of the milking machine is detrimental especially if the vacuum level is high. In most cattle breeds the front half of the udder contains less milk than the hind quarters. *Johansson* (1957) found that in the Swedish Red and White breed approximately 43 % of the milk is produced by the front half of the udder. The

milking time is also shorter for the half even though the difference is not quite as large as for the amount of milk. It might therefore be assumed that the injury caused by prolonged milking would be largest in the front quarters. However, in the present material no significant difference with regard to frequency of mastitis was observed between the front and rear halves of the udder nor was there any difference between the right and left halves. As a matter of fact a slight excess of mastitis occurred in the hind quarters. Of the 1041 quarters with mastitis 535 (51.4 %) belonged to the rear half. *Neave* et al. (1952) found also a higher frequency of mastitis (62 %) in the hind quarters and similar results were obtained by *Arthur* (1957). The excess of mastitis in the rear half is believed to be due to the fact that this part is usually dirtiest and more often injured by tramps than the front half. The protected position of the front teats seems thus to outweight the probable disadvantage of the disproportion of the udder, when machine milking is used. The udder proportions are highly heritable (*Johansson,* 1957) and can easily be changed through breeding. The influence of the udder proportions on udder health seems therefore to warrant further research.

The repeatability of udder health between successive lactation periods.

Cases of mastitis treated with penicillin or other antibiotics often show clinical recovery within a few weeks after treatment. However, it is a common experience among veterinarians that cows which developed mastitis in one lactation period will frequently develop mastitis again in subsequent lactations even though recovery was noticed after the first infection. In the present material the repeatability of udder health between consecutive lactations has been investigated with the animal as well as the udder quarter as observational unit. The animals were only inspected twice a year (cf. page 14) and it was therefore not possible to distinguish between reinfections of healthy animals and chronic mastitis lasting over two or more lactation periods.

The regression of the udder health in one lactation on that in a previous lactation period will be used as a measure of the repeatability. To take an example; of the 965 cows having two complete records 810 were classified as healthy, while 155 were

Table 6.
The repeatability of udder health between succeeding lactation periods.

Lactations										Av. repeatability at a given No. of calvings between the lactations			
1st to				2nd to			3rd to		4th to				
2nd	3rd	4th	5th	3rd	4th	5th	4th	5th	5th	1	2	3	4
6.9***	20.1***	12.0	1.8	24.3***	9.2	11.3	19.4**	23.1*	27.6**	25.7***	17.3***	11.8*	1.8

found to have mastitis in the first lactation period. The difference between these two groups can be said to make one unit. In the succeeding lactation period 158 of the previously healthy cows, or 19.5 %, had mastitis, while the corresponding figures for the other group were 72 and 46.4 %. The difference of one unit in the first lactation period between the two groups had diminished to $72/155 - 158/810 = 0.269$ units. The regression coefficient (repeatability) of the result in the 2nd lactation on that in the first period is therefore 0.269. The statistical significance of this regression coefficient is measured by the degree of heterogeneity between the two groups with regard to udder health in the 2nd lactation period, giving $\chi^2 = 52.0^{***}$; 1 degree of freedom. The repeatability between the other lactation periods, based on the health of the individual animals, was estimated in a similar way (Table 6). As the number of calvings intervening the lactation periods under observation increased the repeatability decreased considerably. On the average the repeatability between two consecutive periods amounted to 0.26; that between lactations separated by two calvings was 0.17, while the repeatability between more distant lactations was still smaller.

It is of interest to know to what extent the mastitis in animals affected in two successive lactation periods hits the same or different udder quarters. Animal with mastitis in at least two consecutive periods were therefore selected and the regression of the health of the left front quarter in the 2nd period on that of the same quarter in the first lactation was estimated and similarly for the three other quarters. The average value of these estimates can be taken as an expression for the extent to which mastitis in the 1st and 2nd lactations were caused by infections in the same udder quarter.

The corresponding repeatability values were estimated for the 2nd—3rd; 3rd—4th and 4th—5th lactations. As seen from

Table 7.

The repeatability of mastitis in separate quarters in consecutive lactation periods of cows with mastitis (average for all quarters, taken separately).

	Lactations			
	1st to 2nd	2nd to 3rd	3rd to 4th	4th to 5th
Repeatability	33.6***	32.1***	41.0***	44.2***

Table 7 mastitis affects the same quarter significantly more often than would be expected by chance and the repeatability tends to increase with increased lactation age. The repeatability between the 1st and 2nd periods was thus 0.34 and that between the 4th and 5th 0.44. This rise most likely reflects an increase of chronic mastitis by lactation age. It is interesting to note that the frequency of culling among cows with mastitis also increases with age (cf. Table 2). These parallel changes in the culling level and the repeatability of the mastitis status per quarter very probably have the same cause; viz. an increase in the incidence of chronic mastitis, which leads to difficulties at milking, reduced milk yield and ultimately culling.

Variation of mastitis with butter fat production

The results of previous studies on the influence of milk yield on the incidence of mastitis are conflicting. *McLeod & Wilson* (1951) examined four herds bacteriologically for mastitis at 3 monthly intervals during 9—13 years. Cows which became infected with *Str. agalactiae* produced on the average 8.4 % more milk in the preceding lactation than cows in the same herd calving at the same time and not becoming infected. As already pointed out *Dodd & Neave* found fast milking cows to be more susceptible to mastitis than slower milkers. In the same material *Dodd & Foot* (1953) showed that the fast milking animals produced most milk. However, in extensive field surveys by *Ward* (1944) no evidence for any relationship between mastitis and milk yield was obtained, and data by *Murnane* 1940) showed that the frequency of mastitis was high among the low producers in an experimental herd.

In the present study the influence of butter fat production in the first lactation on the mastitis incidence in that and future lactations was investigated. In order to eliminate the influence

Table 8.[1])

The production of butter fat during the 1st lactation in cows which in subsequent lactations could be divided into groups with and without mastitis respectively. All heifers were free from mastitis during the 1st lactation.

Lactation period	Mastitis cows		Healthy cows	
	No.	Mean deviation from herd av. (kg.)	No.	Mean deviation from herd av. (kg.)
2nd	149	—17.5	621	—17.8
2nd—3rd	157	—15.7	295	—16.1
2nd—4th	137	—13.3	102	—12.6
2nd—5th	59	—15.9	32	— 8.6

[1]) The herd average is mainly determined by mature cows and the deviation between the heifers' production and the herd average is consequently negative.

of the herds and years on the fat yield, the individual production records were expressed as the deviation from the contemporary herd average. The production of heifers which developed mastitis in the first lactation period was slightly less than in heifers remaining healthy. However, the difference was not statistically significant.

The cows being healthy during their 1st lactation and having at least one additional lactation were divided into two groups, viz. those remaining healthy during the 2nd lactation and those which developed mastitis. Corresponding groups were formed also for the higher lactation ages (Table 8). In none of the age groups the difference in production between the cows with and without mastitis reached statistical significance. Therefore in the present material there does not seem to be any relationship whatsoever between butter fat production and incidence of mastitis.

Hereditary influence on mastitis

Previous studies by *Lush* (1950) and *Legates & Grinnells* (1952) strongly suggest that the individual variation in susceptibility to mastitis is partly inherited. *Lush* determined the intra-herd regression of the daughters' udder health on that of their dams in 494 dam-daughter pairs from 27 New Zealand dairy herds. Each cow was classified as susceptible if she had developed mastitis at any age or as resistand if she had not developed ma-

stitis reached at least 8 years of age. The regression coefficient amounted to 0.19 and the heritability was accordingly estimated at 0.38 with a standard error of 0.16. *Legates & Grinnells* based their study on dam-daughter comparisons and on the correlation between paternal half sibs in eleven herds in North Carolina. The average heritability was estimated at 0.27 ± 0.10.

The herds in the present material have taken part in the control program for maximum 5—6 years and the number of dam-daughter pairs with large number of controlled lactations is therefore inevitably small. Furthermore the cows are distributed on several herds and the number of sires used is large. The material is therefore not well suited for heritability studies. More data are being accumulated and the results to be presented here should therefore be considered as preliminary.

Table 9.
The regression of the mastitis status of daughters on that of their dams.

Lactations of Dam	Lactations of Daughter	No. of pairs	Regression	Statistical significance of regression
1	1—3[1])	164	0.021	$P > 0.7$
1	2—3	67	0.053	$P > 0.9$
2	1—3[1])	148	0.113	$P > 0.1$
2	2—3	64	0.198	$P > 0.1$
3	1—3[1])	124	0.094	$P > 0.1$
3	2—3	51	0.092	$P > 0.4$

[1]) Pooled data from daughters having just one lactation and those having two or three lactations.

In all 164 dam-daugther pairs in 36 herds were available. The regression of the daugthers on the mastitis resistance of their dams was calculated under varying requirements on the information about the animals (Table 9). In no case the number of pairs was sufficient to make possible the elimination of any influence caused by differences in herd environment. The regressions show a tendency to increase as the amount of information about the dams and/or their daughters increases. When based on the resistance in the dams' first lactation only, the regression was negligible. When 2—3 lactation periods of the dams were available the regression increased to 0.10 or more, and would thus points toward a heritability of about 0.20 provided that the regression was not to any large extent caused by the common

Table 10.

Frequency of resistant cows in progeny groups of more than 10 individuals from different A.I. bulls.

Lactation period	No. of sires	Size of progeny group		Percent daughters with mastitis		Heterogeneity between progeny averages after elimination of the time trend
		Av.	Range	Average	Range between progeny groups	
1st	21	33.3	11—82	12.9	0—40.0	$P > 0.3$
1st—2nd	17	27.2	12—57	28.6	17.6—46.2	$P > 0.5$
1st—3rd	12	18.8	10—34	42.7	25.0—58.8	$P > 0.3$

environment of the dam and daughter. In no case the regression coefficients reached statistical significance.

The offspring of A.I. sires in the material may be assumed to be distributed at random among the different A.I. herds. No less than 21 of these sires had more than 10 daughters with a complete record on the first lactation period. The incidence of mastitis in these progeny groups varied between 0 and 40 %, with an over all average of 12.9 %. These data and similar compilations for progeny groups with two and three lactations are summarized in Table 10. The frequency of mastitis decreased with an increasing number of years in the control program (cf. Table 5). To avoid bias from this time trend the sires were divided into groups according to the period in which they were used, and the heterogeneity between progeny averages was estimated within such groups. As seen from Table 10 the variation of the incidence of mastitis was large in the different sire families. However, the material was small and the heterogeneity did not reach statistical significance.

DISCUSSION

With the exception of the highest lactation age (5 years) the frequency of entirely new cases of mastitis in animals previously free from this disease showed a marked rise with lactation age (Table 3, Fig. 2). This is contrary to the findings on the first infection rate obtained by *Oliver* et al. (1956 b) in a small material. They concluded that the marked rise in the total incidence of udder infections with age "is a result of re-infections and persisting infections, and that first infections show no significant change by age". It should be stressed that *Oliver* et al. investigated

the infection rate, while in the present material the frequency of mastitis was studied. It seems very likely that subclinical infections in one lactation will increase the probability of clinical mastitis in subsequent lactations. The maximum rate of first-mastitis cases would therefore be expected to occur later than that of the new infections. The most susceptible animals probably become infected first while animals remaining healthy for several lactations are likely to have an inherently higher degree of resistance. The incidence of first-mastitis cases would therefore be expected to decrease in the highest age classes. Such a decrease was found in the group with 5 lactation periods (cf. Fig. 3).

The probability that an animal which has once developed mastitis will develop this disease in the succeeding lactation period is significantly larger than in previously healthy animals (cf. Table 6). The very marked rise in the total incidence of mastitis with increased age appears therefore to be due to a combination of the cumulative effect of previous mastitis infections and an increase in first-mastitis cases with age.

The treatment of cows with mastitis as well as the propaganda for better milking and general hygiene which take place in the control program was followed by a marked decline in the incidence of mastitis (cf. Table 5). However, in spite of all effort no less than 30 % of the cows in the 3rd—5th lactations developed mastitis when all their lactations fell within the control program. In some of the worst herds, the owners and/or the cowmen may have been disinclined to accept advise, but even in some apparantly well managed herds the frequency of mastitis was high. One should therefore not be too optimistic about the possibility to decrease the general frequency of mastitis in cows at their most productive age below 25 % by the aid of managemental or hygienic means alone.

The results in the present study suggest that heredity plays some role in the resistance to mastitis, and substantial evidence for a genetic influence on the mastitis resistance has been presented by *Lush* (1950) and *Legates & Grinnells* (1952). Genetic resistance to mastitis may be difficult to utilize. Progeny tests of sires based on their daughters' resistance during the first lactation period would be rather inefficient because of the low frequency of mastitis in young cows. A great number of daughters per sire would be needed. The results from several lactation periods will be required before animals with inherent resistance

can be identified. Any improvement of the genetic resistance to mastitis should therefore be based mainly on the selection of the young sires from high yielding dams with many lactations and good udder health. This is particularly important for sires which will be used in A.I. service. Information about the genetic resistance of a young bull may also be obtained from its paternal half sisters particularly if the sire was utilized for artificial breeding and the mastitis control was widely used (cf. *Lush* 1947).

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SUMMARY

The incidence and bacteriological type of mastitis was studied during the years 1954—59 in 47 herds of the Swedish Red and White breed, which took part in a nation-wide mastitis control program. Of the animals under study 1433 were tested already in the 1st lactation period and 110 of these were followed for 5 consecutive lactations. About 4/5 of the mastitis cases were associated with staphylococcal infections. The total incidence of mastitis as well as the frequency of entirely new cases showed a significant rise with increasing age.

The control program caused a considerable decrease in the frequency of mastitis. However, in spite of this about 30 % of the cows still developed mastitis in the 3rd—5th lactation after five years of control. The regression of the animals' udder health in one lactation on that in the previous lactation was about 0.26***. The extent to which the disease was caused by mastitis of the same udder quarter increased with age.

There was no relationship between the butter fat yield of the animals during their 1st lactation, measured as the deviation from

the contemporary herd average, and the incidence of mastitis in later lactations.

The regression of the udder health of the daughters on that of their dams was determined in 164 pairs. When based on the results of 2—3 lactations in the dams and daughters the regressions amounted to 0.09—0.20. Although statistically non significant the regression suggests some genetic influence on the susceptibility to mastitis.

ZUSAMMENFASSUNG

Faktoren, die den Typ und das Vorkommen von Mastitis beim schwedischen Milchvieh beeinflussen.

Das Vorkommen von Mastitis und deren Typ in den Jahren 1954—59 wurde in 47 SRB-Beständen studiert, die an der vom Veterinärdirektorat und von den Landwirtschaftskammern organisierten Mastitiskontrolle teilnahmen. Von den untersuchten Tieren wurden 1433 während der ersten Laktationsperiode kontrolliert, und 110 von diesen liessen sich während fünf aufeinander folgenden Laktationen beobachten. Ungefähr vier Fünftel der Mastitiden waren mit Staphylokokkeninfektionen verbunden. Das totale Auftreten von Mastitis wie auch das Vorkommen ganz neuer Fälle der Krankheit zeigten eine signifikante Zunahme mit steigendem Alter.

Das Kontrollprogramm verursachte einen deutlichen Rückgang in der Mastitisfrequenz. Trotzdem waren ungefähr 30 % der Kühe in der 3.—5. Laktation mit Euterentzündung behaftet; die Kontrolle war damals seit 5 Jahren ausgeübt worden. Die Regression der Gesundheit des Euters der Tiere in einer Laktation zum Gesundheitszustand in der nächst vorhergehenden Laktation belief sich auf 0,26***. Bei Tieren, die zwei Jahre hintereinander krank gewesen waren, wurde die Mastitis in grossem Umfange durch Infektion im selben Euterviertel verursacht. Diese Wiederholung nahm mit steigendem Alter zu.

Zwischen dem Butterfettertrag während der 1. Laktation, als Abweichung vom gleichzeitigen Bestandesdurchschnitt gemessen, und dem Vorkommen von Mastitis in späteren Laktationsperioden lag keinerlei Zusammenhang vor.

Die Regression, der Eutergesundheit der Töchter zu derjenigen der Mütter wurde bei 164 Mutter-Tochter-Paaren bestimmt. Da sich dieselbe auf die Resultate von 2—3 Laktationen sowohl bei den Müttern als auch Töchtern stützte, betrug die Regression 0,09—0,20. Die Regression war nicht statistisch sicher, deutet aber trotzdem einen gewissen erblichen Einfluss auf die Resistenz gegen Mastitis an.

SAMMANFATTNING

Faktorer, som påvirkar typ och förekomst av mastit hos svensk mjölkboskap.

Förekomst och typ av mastit under åren 1954—59 studerades i 47 SRB-besättningar, vilka deltog i den av veterinärstyrelsen och hushållningssällskapen organiserade mastit-kontrollen. Av de undersökta

djuren kontrollerades 1433 under första laktationsperioden och 110 av dessa kunde följas under fem på varandra följande laktioner. Ungefär 4/5 av mastiterna var associerade med stafylococc-infektioner. Den totala förekomsten av mastit, såväl som förekomsten av helt nya fall av sjukdomen visade en signifikant ökning med stigande ålder.

Kontrollprogrammet förorsakade en påtaglig nedgång i mastitfrekvensen. Men trots detta hade ungefär 30 % av korna juverinflammation i 3:e—5:e laktationen, då kontrollen pågått i 5 år. Regressionen av djurens juverhälsa i en laktation på hälsotillståndet i närmast föregående laktation uppgick till 0,26***. Hos djur som var sjuka två år i följd förorsakades mastiten i stor utsträckning av infektion i samma juverfjärdedele. Denna upprepning ökade med stegrad ålder.

Det förelåg intet som helst samband mellan smörfettavkastningen under 1:a laktationen, mätt som avvikelsen från det samtidiga besättningsmedeltalet, och förekomsten av mastit i senare laktationsperioder.

Regressionen av döttrarnas juverhälsa på mödrarnas bestämdes i 164 moder-dotter par. Då den grundades på resultaten från 2—3 laktationer hos såväl mödrarna som döttrarna uppgick regressionen till 0,09—0,20. Regressionen var icke statistiskt säker men antyder trots detta ett visst ärftligt inflytande på resistensen mot mastit.

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