# The Nutritive Value of Colostrum for the Calf*

## 10. The Relationship between the Period of Time that a Calfhouse has been Occupied and the Incidence of Scouring and Mortality in Young Calves

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Examination of results obtained during the period 1949–54 has shown that newborn calves grow well when they are brought into our calfhouse after it has been left vacant for some time. When, however, they are brought in after the house has been occupied by a succession of experimental calves, their growth rate is less.

It is well known that scouring can reduce the live-weight gain of calves, and we have now shown that the incidence of scouring and hence the live-weight gain of a particular calf is related to the time interval between the first use of our calfhouse after a period of vacancy and the day that the calf is introduced. 'Occupation time', as used in this paper, is defined as the number of days that the calfhouse has been occupied following a period of vacancy.

### METHODS

Several experiments are carried out in our calfhouse each year, and the results of many of these have already been published. The calfhouse, consisting of thirteen individual pens (for details see Aschaffenburg, Bartlett, Kon, Terry, Thompson, Walker, Briggs, Cotchin & Lovell, 1949), is always disinfected and left empty during the summer months, and is then filled up at the end of August with calves collected within 8h of birth from about thirty farms in the Reading area. The pens are kept filled throughout the winter and spring months with a succession of calves, each calf being kept for a 3-week period. This practice was followed during the winters 1949–50, 1950–1 and 1953–4, but during 1951–2 and 1952–3 the calfhouse was left empty for a short period in the middle of the winter. Thus at the end of December 1951 there was a break of 15 days, from the middle of January 1953 one of 20 days and from the middle of February of the same year one of 17 days; these occasions allowed additional disinfection of the building. As the last two breaks were separated by a period of only 10 days during which the calf pens were occupied by eight calves mostly for a few days only, they will be considered as one break of 47 days beginning

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in the middle of January 1953. Besides the disinfection of the calfhouse during these periods of vacancy, routine disinfection of gutters and of space in front of the pens was carried out daily, and of individual pens after use by each calf. The straw bedding for each calf was allowed to accumulate until removal at the end of the 3-week period.

The results to be discussed have been extracted from experiments of randomized block design, in which, except during the winters 1952–3 and 1953–4, one calf deprived of colostrum was included in each block. However, only results for calves that had received colostrum were used for statistical analyses. After the colostrum-feeding period the calves were reared for 3 weeks on a 'synthetic milk' (Aschaffenburg *et al.* 1949), except after the 47-day break in 1953 when separated milk with 2% of non-vitaminized margarine was used, and in 1953–4 when the diet was whole milk from the Institute herd. The maximum daily allowance of milk was 1 lb./10 lb. live weight, and downward adjustments to the ration were made when scouring occurred (cf. Aschaffenburg, Bartlett, Kon, Roy, Walker, Briggs & Lovell, 1951). The consistency of the faeces of each calf was recorded daily during the experimental period.

Regression analyses were made of data from most of the experiments done during the 5 years, except where the small number of surviving calves made it impracticable. The number of days on which calves scoured appeared to form a Poisson distribution, and was therefore transformed, the transformation $\sqrt{(x+\frac{1}{2})}$ being used in the analysis. Live-weight gain/day was obtained from a linear regression of daily weights of each calf over the 3-week period. The curvatures of the regressions of the live-weight gain/day and of the number of days on which a calf scoured on 'occupation time' were rectified by using log 'occupation time'. In two experiments in which treatment significantly affected the incidence of scouring, and also in those experiments in which treatment may have had a slight effect on scouring, the regression coefficients and their standard errors were calculated from the residual error after that portion due to treatment differences had been removed.

## RESULTS

### *Effect of 'occupation time' on live-weight gain/day and on the incidence of scouring*

A negative relationship between live-weight gain/day and 'occupation time' occurred in seven experiments lasting 49–106 days immediately after a period of vacancy of the calfhouse, but not in any of the experiments that were started subsequently. Furthermore, in five of these seven experiments, there existed a positive relationship between the incidence of scouring and 'occupation time'. Details of the experiments, and the regression coefficients of incidence of scouring and of live-weight gain/day on 'occupation time' are given in Table 1. The data used in the calculation of the regression of scouring on 'occupation time' for these seven experiments involving a total of 202 calves are given in Fig. 1 *a–g*. It is apparent from these figures that, in general, with increasing 'occupation time', the variation in the incidence of scouring between individual calves introduced at about the same time tended to get larger.

From Table 1, it is evident that the increase in the incidence of scouring with 'occupation time' was considerably less for calves reared on whole milk (1953–4)

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Table 1. *Relationship between the incidence of scouring and the period of time that the calfhouse had been occupied*

| Date of first use of calfhouse | Period of previous vacancy (days) | Period covered by analysis (days) | No. of calves used in analysis | Mean interval between arrival of successive calves (days) | Colostrum given to calves (ml.) | Basic diet | Presence in experiment of calves deprived of colostrum | General means: No. of days on which scouring occurred† ($y_1$) | General means: Live-weight gain/day (lb.) ($y_2$) | General means: Period of time between first use of calfhouse and arrival of calf† (days) ($x$) | Regression coefficients with their standard errors: $b_{\sqrt{(y_1+\frac{1}{2})}\log x}$ | Regression coefficients with their standard errors: $b_{y_2 \log x}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26. viii. 49 | 109 | 56 | 24 | 1·7 | 3410‡ | 'Synthetic milk' | Yes | 2·0 | 0·592 | 28 | 0·727 ± 0·282* | −0·411 ± 0·167* |
| 17. viii. 50 | 79 | 63 | 32 | 1·1 | 400 | 'Synthetic milk' | Yes | 3·5 | 0·475 | 31 | 0·746 ± 0·228** | −0·396 ± 0·124** |
| 7. ix. 51 | 102 | 76 | 26 | 1·7 | 400 or 3410‡ or colostrum for 10 days | 'Synthetic milk' | Yes | 2·8 | 0·623 | 36 | 0·539 ± 0·325 N.S.§ | −0·362 ± 0·137*§ |
| 2. i. 52 | 15 | 58 | 18 | 1·4 | 400 | 'Synthetic milk' or diluted colostrum for 21 days | Yes | 5·3 | 0·213 | 25 | 0·412 ± 0·176*§ | −0·361 ± 0·113**§ |
| 7. ix. 52 | 133 | 59 | 30 | 1·7 | 3410‡ | 'Synthetic milk' | No | 3·9 | 0·324 | 30 | 0·724 ± 0·213**§ | −0·446 ± 0·109***§ |
| 9. iii. 53 | 47 | 49 | 24 | 2·0 | 400 | Fresh separated milk with 2 % margarine fat added, or diluted colostrum for 21 days | No | 1·5 | 0·160 | 20 | 0·623 ± 0·220**§ | −0·223 ± 0·088*§ |
| 10. ix. 53 | 104 | 106 | 48 | 2·0 | 3410‡ | Whole-herd milk | No (except from 68th day onwards) | 1·1 | 0·429 | 50 | 0·239 ± 0·175 N.S.§ | −0·150 ± 0·052**§ |

* Significant at $P < 0·05$. ** Significant at $P < 0·01$. *** Significant at $P < 0·001$. N.S. Not significant.

† Actual mean values are given and not values corresponding to mean of transformed values.

‡ 6 pt.

§ Calculated from sums of squares, after that portion due to treatment differences had been removed.

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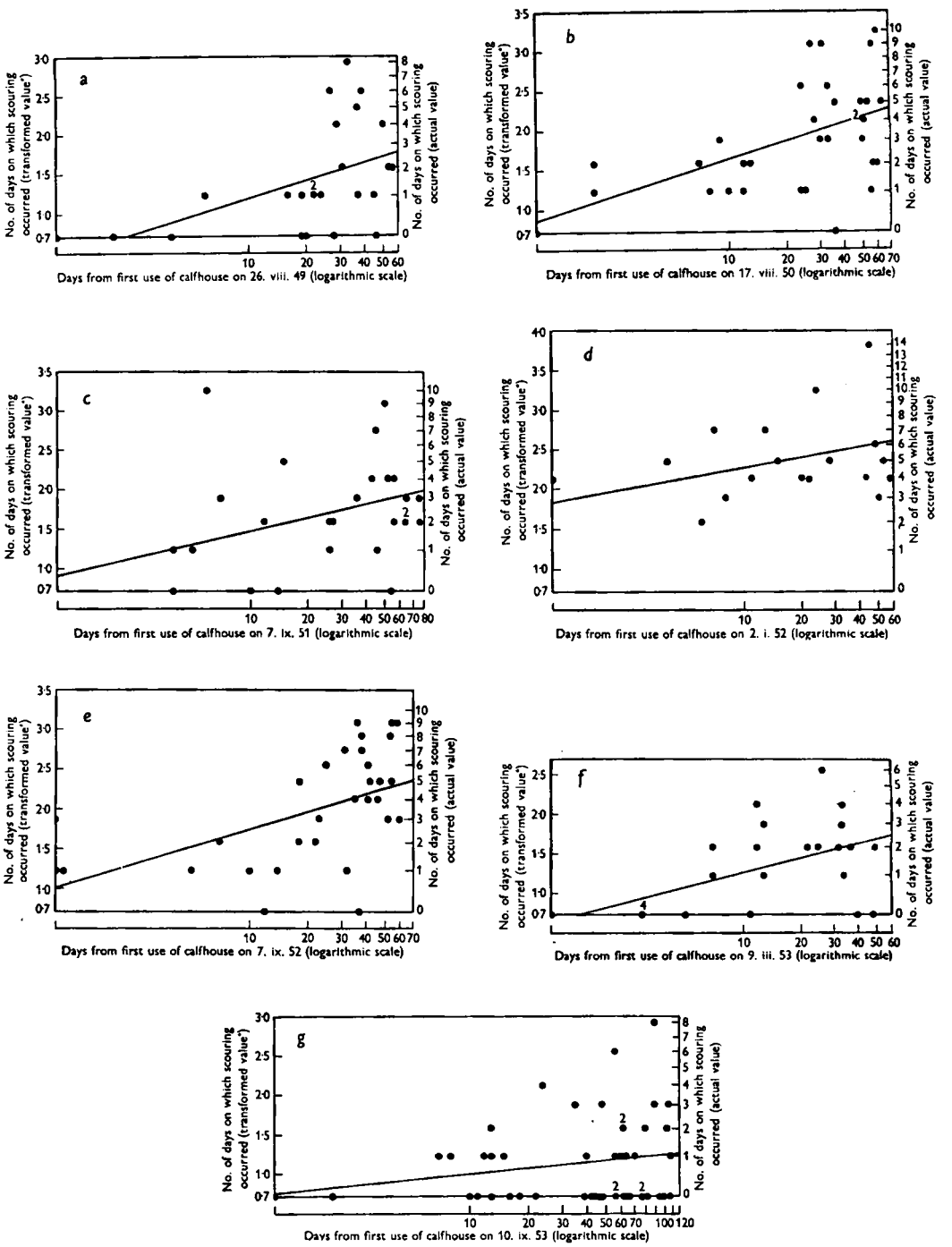


Fig. 1. Relationship between the incidence of scouring and the period of time that the calfhouse had been occupied. The figure 2 in some of the graphs indicates the coincidence of two values.

* $\sqrt{(x+\frac{1}{2})}$ (see p. 12).

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than for those receiving 'synthetic milk' or fresh separated milk containing 2% margarine fat. Whereas in five out of six experiments with these last two diets an increase in scouring could be detected during the first 50–80 days after a period of vacancy, no significant increase was obtained with calves on a whole-milk diet, even though the experiment lasted 106 days after a period of vacancy. Nevertheless, calves reared on whole milk showed a depression in growth rate with increasing 'occupation time'.

The quantity of colostrum fed to the calves in the various experiments is given in Table 1 and it will be seen that the depression in growth rate and increase in scouring with 'occupation time' occurred irrespective of the quantity fed in a particular experiment. Moreover, scouring still increased in the winter of 1952–3 when calves deprived of colostrum were excluded from the experiments.

In the experiment begun after a period of vacancy of 15 days in January 1952, the incidence of scouring was much higher than in the previous experiment. From Fig. 1*c* and *d* it can be seen that the regression line continued at the same slope over the two experiments, beginning at the same level of scouring in the second experiment as was reached at the end of the first. In contrast, the incidence of scouring in the experiment after the 47-day break beginning in January 1953 was lower than in the previous experiment.

*The effect of 'occupation time' on mortality*

Although the data were not subjected to statistical analysis it would appear that 'occupation time' had a slight effect on the period of survival of calves that had been deprived of colostrum. Calves arriving immediately after a break in the use of the calfhouse tended to survive the 3-week period, or to live longer than their successors.

In comparison, 'occupation time' had a marked effect on the mortality rate of calves that had received colostrum. Deaths from *Bacterium coli* infection occurred at the end of two of the experiments conducted after a long period of vacancy; in two of the other experiments there were no deaths, although the mortality rate was high in subsequent experiments; in contrast, after the 15-day break in 1951, deaths occurred near the beginning of the experiment. The 'occupation time' before the first death in the experiments is given in Table 2, together with the percentage of calves that died subsequently.

Furthermore, once the increase in scouring had occurred, three serological types of *Bact. coli*, strains R.V.C. 95A, 118A and 330 (Wood, 1955), were isolated from the majority of calves that died although they had received colostrum, and their antigenic structure is as follows:

| | Antigenic structure | | |
|---|---|---|---|
| Strain | 'O' | 'K' | 'H' |
| R.V.C. 95A | 26 | B6 | — |
| R.V.C. 118A | 9 | A | — |
| R.V.C. 330 | 78 | B | — |

In 1950–1, of sixteen calves that died having received colostrum, R.V.C. 118A was isolated from nine, and R.V.C. 95A from three. In 1951–2, of twenty-one colostrum-

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fed calves that died, R.V.C. 118A was isolated from fourteen and R.V.C. 330 from six. Two of these strains, R.V.C. 95A and 118A, were isolated from colostrum-deprived calves on rare occasions only. An examination of strains isolated from rectal swabs of calves during the 1951–2 season revealed that even surviving calves that were clinically ill frequently carried strains R.V.C. 95A and 118A in their intestinal tract. From this it appears that the presence of pathogenic strains within the intestinal tract does not necessarily lead to death.

Table 2. *Relationship between mortality and period of time that the calfhouse had been occupied*

| Date of first use of calfhouse | Period of previous vacancy (days) | Colostrum given to calves (ml.) | Total no. of calves on experiment (*a*) | 'Occupation time' before death of first calf (days) | No. of calves on experiment before first death (*b*) | No. of calves that died (*c*) | Percentage of calves that died $\left(\frac{c}{a-b} \times 100\right)$ |
|---|---|---|---|---|---|---|---|
| 26. viii. 49 | 109 | 3410* | 24 | No deaths | 24 | 0 | 0 |
| 17. viii. 50 | 79 | 400 | 32 | No deaths | 32 | 0 | 0 |
| 7. ix. 51 | 102 | 400 or 3410* or colostrum for 10 days | 30 | 54 | 19 | 4 | 36 |
| 2. i. 52 | 15 | 400 | 24 | 8 | 5 | 5 | 26 |
| 7. ix. 52 | 133 | 3410* | 32 | 54 | 29 | 2 | 67 |
| 9. iii. 53 | 47 | 400 | 24 | No deaths | 24 | 0 | 0 |
| 10. ix. 53 | 104 | 3410* | 48 | No deaths | 48 | 0 | 0 |

* 6 pt.

## DISCUSSION

These findings show that under our conditions the incidence of scouring of calves reared on 'synthetic milk' increased for about 60 days after the first use of the calfhouse, whereas when the diet was whole milk, the increase was at a very much lower rate. The depression in growth rate with 'occupation time' was largely a reflexion of the increase in the incidence of scouring, but even in the absence of scouring growth rate appeared to be decreasing. This was especially noticeable with calves reared on whole milk. From our evidence it seems possible that this increase was due to a build-up of *Bact. coli* 'infection' in the calfhouse, especially as calves that received colostrum did not die until the incidence of scouring was high.

During such build-up, indicated by the increase of scouring and the death of colostrum-fed calves, there were isolated from dead calves a few serological types of *Bact. coli* which, from this work and from that undertaken in other countries, appear to be particularly pathogenic to the young calf. Cultures antigenically the same as strain R.V.C. 95A have been recovered from dead calves in Denmark and in Pakistan (Ørskov, 1951; Bokhari & Ørskov, 1952) and strains R.V.C. 118A and 330 from calves dying in Sweden (Bokhari & Ørskov, 1952). The last-mentioned strain had previously been recovered only from dead calves, and, apart from the detection of three carriers, none was recovered in our experiments where examination has been made of 108 rectal swabs from calves which were in contact with this organism over a considerable period.

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The origin of these strains is obscure, but it is highly probable that they were introduced with the large numbers of calves used in these experiments, and also that they gradually became established in the calf-pens. During the 1951–2 season, strain R.V.C. 118A was isolated from the faeces of a calf some weeks before the first calf died of this infection, and also with increasing frequency during this period from the rectal swabs of other calves. There is thus some evidence to support the contention that the numbers of the infective organisms as well as their antigenic structure are important in the study of these infections. No experiments were undertaken to determine whether the virulence of strains increased as the season progressed, but from cultural and serological tests there did not appear to be any obvious differences. The break of about 3 months in the use of the calfhouse during each summer was sufficient to eliminate scouring at the beginning of the subsequent season. The relationship, mentioned earlier, between the results of the two experiments before and after the 15-day break may have been a chance effect. If it is considered that this break had little effect in checking the infection in the calfhouse, the total period over which scouring was increasing during the winter 1951–2 was 134 days. The very short time that elapsed after this break before the first colostrum-fed calf died suggests that this break did not materially reduce the level of infection in the calfhouse. In January 1953, by leaving the calfhouse vacant for 47 days, scouring was eliminated at the beginning of the next experiment. This suggests that this break was sufficient to reduce the infection in the calfhouse. However, it must be remembered that the basic diet of the calves in the experiment after the break was fresh separated milk with 2% margarine added, whereas previously the 'synthetic milk' had been used.

Although the increase in scouring was not significant when calves were reared on whole milk in 1953–4 it seems highly probable that such an increase was in fact occurring, although clearly at a slower rate than with calves reared on 'synthetic milk'. The depression in growth rate of the calves with 'occupation time' supports this contention. Moreover, further experiments with whole milk as the basic diet have been begun 60–70 days after the incidence of scouring had been increased to a high level with calves reared on 'synthetic milk'. In these experiments (to be published), calves reared on whole milk or separated milk containing 2% margarine had a slightly lower incidence of scouring than those given 'synthetic milk', but, even so, scouring was very severe.

In an earlier paper (Ingram, Lovell, Wood, Aschaffenburg, Bartlett, Kon, Roy & Sears, 1953), we suggested that the withholding of colostrum from one calf in each block of the experiments might be one of the factors responsible for the increase in scouring, but the experiments conducted in 1952–3 and 1953–4 when all calves received colostrum do not support this contention.

The relationship between scouring and 'occupation time' occurred, under our conditions, when a large number of susceptible newborn calves was brought into our calfhouse. From preliminary field investigations, it seems very likely that on some farms, especially where the calving season is concentrated in the autumn and winter months, a similar increase in scouring occurs, probably at a slower rate, resulting in high mortality and severe scouring in the late winter and early spring months. The



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effect of season on mortality of calves has been shown in surveys by Jordan (1933), Lovell & Hill (1940) and Withers (1952*a*), the losses in spring-born calves being greater than in those born in the autumn. Examination of the data given by Withers (1952*b*) shows that, for dairy heifer calves up to 1 month of age, there is a gradual increase in mortality rate throughout the main calving season. The mean percentage of dairy heifer calves born alive that died in each month during the years (1946–8) of Withers's survey, and the percentage of total births that occurred in each month during the same period are given in Fig. 2. Jordan suggested that the higher losses in the late spring

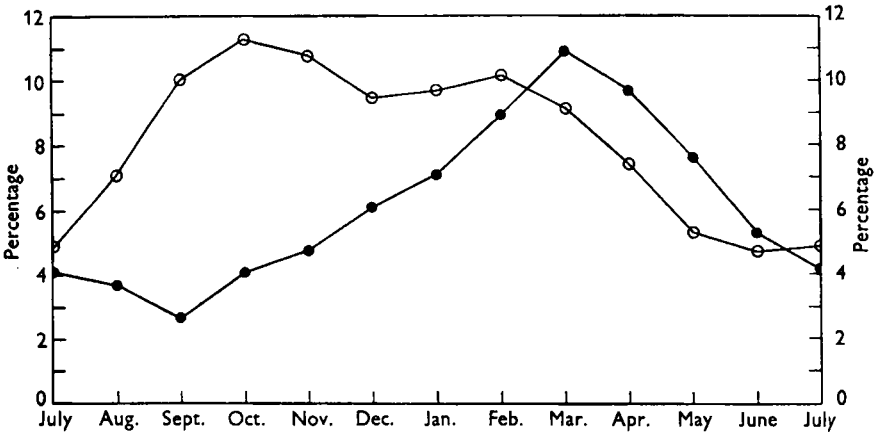


Fig. 2. Relationship between mortality rate and month of year (adapted from Withers, 1952*b*). ○, percentage of total births that occurred each month; ●, percentage of calves born alive that died each month. (Based on a moving average of 3 consecutive months to remove minor month-to-month fluctuations.)

were due to the low vitamin A level of the prepartum diet of the dams in the late winter and early spring. Walker (1948) found a seasonal effect on the growth rate of newborn calves, which he attributed to the absence of fresh grass in the prepartum diet of the dams. By feeding preserved grass, either dried or as silage, in the winter rations of cows, Payne (1949) found that the high mortality rate and incidence of nutritional scours of calves born in the early spring months could be reduced. On the other hand, it has been suggested (Anonymous, 1943) that a shortage of vitamin D is responsible for the greater difficulty of rearing spring-born calves, since the greater part of gestation occurs during the season of lowest solar radiation.

It is possible that variations in the nutritional and physiological state of the dam may be one of the factors causing the general increase in mortality shown in Fig. 2, but in our experiments this factor would seem to be of little significance, for the increase in scouring occurred consistently each year, and with calves reared on 'synthetic milk' was noticeable within 3–4 weeks after the introduction of the first calf into the calfhouse. Variations in the nutritional and physiological state of the dam certainly could not explain the reduction in the incidence of scouring after the calf-house had been left empty for 47 days during mid-winter 1952–3. For the same reasons, it would appear that the strain imposed on the calves during transit to the

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Institute by weather conditions at different times of the winter was of negligible importance.

In an earlier experiment, we were unable to demonstrate any beneficial effect of vitamin A on mortality or scouring during the first 3 weeks of life, even with calves born in the early spring months (Aschaffenburg, Bartlett, Kon, Roy, Sears, Thompson, Ingram, Lovell & Wood, 1953), and therefore we believe that the major factor responsible for the greater incidence of scouring and mortality in the spring, under our conditions, is the build up of 'infection' in the calfhouse. Under certain farm conditions, it is possible that the same phenomenon occurs, although additional factors, such as the prepartum nutrition of the dam, changes in environmental temperatures and in the composition of the milk of cows turned out to new leys in the spring (Shanks, 1950) may all play their part in lowering the resistance of the calf to infection.

SUMMARY

1. Regression analyses on data from 202 newborn Shorthorn calves brought into the calfhouse from a number of farms during the years 1949–54 have shown that the incidence of scouring during the first 3 weeks of life increases and the live-weight gain decreases with the period of time between the first use of the calfhouse after a period of vacancy and the day that a calf is introduced. The depression in live-weight gain was largely due to the increase in scouring. This increase in scouring occurred irrespective of the quantity of colostrum given to the calves, and of the presence or absence of colostrum-deprived calves. The rate of increase in the incidence of scouring of calves reared on whole milk was probably lower than for those on a 'synthetic milk' diet.

2. Calves deprived of colostrum tended to survive slightly longer immediately after a period of vacancy than their successors. Deaths of calves given colostrum occurred only after the incidence of scouring had increased to a high level.

3. The increase in scouring of calves reared on 'synthetic milk' could not be demonstrated in experiments beginning 60–70 days after the first use of the calfhouse. A break of 47 days was sufficient to eliminate scouring at the beginning of the subsequent experiment, whereas a break of 15 days appeared to be too short.

4. The build up of infection could be associated with serological types of *Bact. coli* which were pathogenic to the calf.

5. It is suggested that a similar phenomenon may be partly responsible for the known increase in scouring and mortality in late winter under normal farm conditions.

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# Energy Utilization in Overfed Thin Young Men*

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Some people keep in good health, appear to have a good appetite and yet remain very thin. This is a commonplace observation. Their friends may wonder what they do with the food they eat. Yet no physiological abnormality has been demonstrated in such people. Grafe (Grafe & Graham, 1911; Grafe, 1933) has indeed suggested that some people possess a mechanism that burns off any excess of food eaten. This *luxus Konsumption* mechanism might be set too high, and so might keep a person permanently thin. His experiments on both animals and patients are not generally accepted as reliable evidence for his thesis. In particular he failed to appreciate that starvation *per se* lowers the basal metabolic rate. Gulick (1922) in careful experiments on himself, a lean person, found that on a high caloric diet and a standard régime, he gained weight more rapidly when his initial weight was lower than usual than from a start well above his usual weight. These observations were consistent with a *luxus Konsumption* mechanism, but as he did not control accurately his energy expenditure, they provide no conclusive evidence. We know of no other scientific evidence to support the hypothesis. Newburgh (1950) has shown how tenuous is the support for a *luxus Konsumption* and himself produced evidence that there is no metabolic control by direct oxidation of a dietary excess of food.

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