

BOVINE MASTITIS

THE DIFFERENTIAL CELL CONTENT
OF MILK IN RELATION TO
SUB-CLINICAL MASTITIS

A Thesis submitted to the University of
Glasgow for the Degree of Doctor of
Philosophy in the Faculty of Science

by

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VOLUME II

PROTOCOLS OF THE EXAMINATION OF 13 HEIFERS

INTRODUCTION

Early diagnosis of bovine mastitis is essential to enable efficient curative measures to be carried out before there is permanent damage to the secreting tissue. Formerly, diagnosis was based for the most part on the detection of specific pathogens, the so-called mastitis organisms, in the milk. The total cell content of the milk was not widely used for diagnosing the disease because many workers were of the opinion that the presence of leucocytes and other cells in the milk, even in large numbers, was of little or no pathological significance, particularly in absence of pathogenic organisms from the milk. Further, it was pointed out that such cells were almost always present in milk and their numbers varied according to different factors particularly stage of lactation. However, Malcolm, King and Campbell (1942, 1944) found that the cell content of mid-lactation milk was a reliable criterion of mastitis. They also showed that such milk might contain large numbers of cells even although no mastitis organisms could be demonstrated, a condition referred to as "non specific" mastitis. McFarlane, Blackburn, Malcolm and Wilson (1949) found that the presence /

presence of a high cell content in the fore-milk was almost invariably associated with inflammatory changes in the mammary gland as indicated by histological examination of the udder tissue post-mortem. They also demonstrated that the cell content of milk correlated to a much higher degree with the histological findings post-mortem than did the results of the culture tests of the milk. This was due to the fact that in many instances no mastitis organisms were present in the milk, even although its cell content was high and the udder tissues showed pathological changes post-mortem. Further, in many of these cases no pathogens were found in the udder tissues post-mortem. Thus these workers confirmed the earlier findings of Malcolm et al. with regard to the occurrence of non-specific forms of mastitis. Chu (1949) also came to the conclusion that a high cell count was an indication of mastitis, and McEwan and Cooper (1947) employed this test for the diagnosis of mastitis.

In the above investigations attention was focussed chiefly on the total numbers of cells present in the milk rather than on the types, but it was felt desirable that information be obtained as to the types of cells in the milk and their significance in inflammatory conditions /

conditions of the udder. The present investigation was therefore undertaken in which not only a total cell count of the fore-milk was made, but also a differential cell count, of the polymorphs, lymphocytes and other cells present. The udder tissues were also examined post-mortem by histological and bacteriological methods. The bacteriological examination of the milk and of the udder tissue was carried out by the Bacteriology Department of the West of Scotland Agricultural College. Two difficulties were encountered in obtaining heifers for examination: first, comparatively few of these animals showed any abnormality in the milk during the first lactation, and secondly farmers would not readily part with such animals if they showed no clinical abnormality. Thirteen heifers however, were obtained for examination of the udder post-mortem. Over 5,000 milk samples from heifers and from older animals were examined. To avoid as far as possible the complicating factor of tuberculous mastitis, samples were only taken from tuberculin tested herds.

METHODS

Total and differential cell-counts

Prescott and Breed (1910) showed that centrifuging of milk samples to obtain the cell count gave unreliable results as a large proportion of the cells was retained in the cream and underlying skim milk. They therefore evolved the direct smear method.

At the commencement of the present investigation Prescott and Breed's experiments were repeated, although in the preparation of smears the cream was not transferred directly to the microscope slide, but diluted with cell-free skim or separated milk. The results showed that not only was a considerable proportion of the cells retained in the cream and the underlying skim milk, but the proportion of the cells which were polymorphs varied in the cream and at different levels in the skim milk. It was therefore decided, in preparing smears for both total and differential cell counts, not to centrifuge the milk but to use instead Prescott and Breed's direct smear method. However, instead of measuring the milk, 0.01ml., by means of a capillary pipette, a closed platinum loop of standard size was used. This method of measurement is much more rapid and convenient than /

than the other and according to the results of an experiment by Malcolm and Smillie (1942, unpublished) see Appendix, the experimental error is negligible. Further, instead of Newman's stain the differential staining method of Sheehan and Storey (1947) was adopted using Sudan Black. This dye stains the cytoplasmic granules of polymorphs and thus enables these cells to be rapidly yet accurately identified. The following procedure was used. The milk, after being examined by culture methods, was immediately formalised, one drop of 40 per cent. formaldehyde being added for each 10 ml. of milk. ^φ This treatment not only preserved the milk and fixed the cells but also helped to prevent the smears leaving the slide during staining. To prepare the smears 0.01 ml. of milk was transferred by means of a standard platinum loop to a microscope slide and smeared over an area of one square centimetre. Four separate smears, one from each quarter of the udder, were made on the same slide. These smears were dried on a level hot-plate and defatted by immersion for two minutes in tetrachloroethane, then drained and dried. The dried smears were/

^φ Hewlett, Villar and Revis (1910) also formalised the milk in this way on the assumption that this treatment increased the number of cells in the centrifuge deposit.

were immersed in Sudan Black B. solution^x for 20 minutes and afterwards treated with 0.1 per cent. acid alcohol for 30 seconds to remove the stain from any fat globules that had remained in the smear. The preparation was washed in water for two minutes, drained and dried, and counterstained by Leishman's method.

The cell count was carried out using a microscope giving an oil immersion field with a radius of 0.09 mm. The area of the field was therefore $\pi \times 0.09^2$ sq.mm. As the smear measured 100 sq.mm. there would be

$\frac{100}{\pi \times 0.09^2}$ fields in the whole smear, i.e. approximately

4,000. The amount of milk used in making the smear was /

x 1. Stock solution of Sudan Black.

Sudan Black B. 0.3 gram.
Absolute alcohol 100 ml.

Leave the solution for a few days to allow the dye to dissolve.

2. Stock buffer solution.

Phenol 16 gram.

Absolute alcohol 30 ml.

Sodium hydrogen phosphate (Na_2HPO_4) 0.3 gram.

Distilled water 100 ml.

Make separate solutions of the phenol in the absolute alcohol and of the sodium hydrogen phosphate in the distilled water and then mix the two solutions. For staining purposes 40 ml. of the buffer solution is mixed with 60 ml. of the stock solution of Sudan Black. The stain can be used at once.

was 0.01 ml. and therefore 4,000 fields would be equivalent to this amount of milk or 400,000 fields to 1 ml. of milk. In estimating the total number of all types of cells present, the cells in 40 fields were counted, and the result multiplied by 10,000

$$\left(\frac{\text{number of fields per ml. milk} - 40,000}{\text{number of fields counted} - 40} = 10,000 \right)$$

In making the differential cell counts three tally counters were used, the first for granular cells i.e. polymorphs, the second for lymphocytes and the third for all other cells (mostly epithelial cells). The count was continued until at least 100 cells had been recorded, and the percentage of the three types of cells obtained.

The specimens of milk were also examined for total cell content by the Bacteriology Department of the West of Scotland Agricultural College, but in this case the samples were tested prior to treatment with formalin, and the smears were stained by Newman's reagent instead of Sudan Black B. The cells were counted at the College by means of a microscope giving an oil immersion field with a radius of 0.1 mm.; thirty fields were counted and the result multiplied by a factor of 10,000 to give the total cell /

cell content per ml.

To enable a comparison to be made between the cell counts obtained by the two laboratories 313 duplicate specimens of milk were tested, the one specimen of the pair being examined by the College laboratory and the other by the author's laboratory. The results are given in Table 1. It will be seen from the table that the College laboratory found that 176 of the specimens had cell counts of less than 100,000 per ml. and the author obtained similar results for 165 of these specimens, i.e. 94 per cent. The College laboratory also found that 52 specimens had counts between 100,000 and 500,000 per ml., whereas the author obtained similar results for 34, or 65 per cent., of these specimens. Finally, of the 85 specimens which were shown by the College to contain more than 500,000 cells per ml., 74, i.e. 87 per cent., were found by the author to give similar results. Accordingly, there was close agreement between the results obtained by the two laboratories, the difference being no greater than could be ascribed to ordinary random error. This is confirmed by the fact that if the results of the independent tests of 313 samples are shown separately for each laboratory, as in /

TABLE 1

The cell counts of 313 duplicate specimens of milk, one of each pair being examined by the Bacteriology Department of the West of Scotland Agricultural College, and the other by veterinary research workers attached to the Pathology Department of Glasgow University.

| College laboratory | Number of Specimens | Veterinary laboratory | | |
|---------------------------------|---------------------|-----------------------------|---------------------------------|---------------------------------|
| | | Up to 100,000 cells per ml. | 100,000 - 500,000 cells per ml. | More than 500,000 cells per ml. |
| Up to 100,000 cells per ml. | 176 | <u>165</u> | 11 | - |
| 100,000 - 500,000 cells per ml. | 52 | 9 | <u>34</u> | 9 |
| More than 500,000 cells per ml. | 85 | 1 | 10 | <u>74</u> |

in Table 2, there is practically no difference between the number of specimens falling into the various groups. This is in agreement with the results obtained by Malcolm and Smillie (See Appendix 2), who in a similar experiment found there was no significant difference in the counts obtained by two laboratories.

Culture tests

These were carried out by the Bacteriology Department of the West of Scotland Agricultural College according to the following procedure. In the case of specimens of milk approximately 0.01 ml. was spread over half the surface of a 4 inch blood agar plate. The various colonies developing were examined and typed, and subcultures were made. Streptococci were classified according to Lancefield and Minett's groupings and were also typed according to heat resistance and action on aesculin, arginine, sodium hippurate, inulin, salicin, mannitol, litmus milk, etc. Those which did not belong to Lancefield's Group B or C, as determined by precipitin tests, or having cultural or biochemical characters of *Str. agalactiae*, *Str. dysgalactiae*, *Str. uberis* or *Str. bovis* were referred to as "atypical streptococci." Staphylococci were typed according to production of pigment, coagulase, /

TABLE 2

The independent cell count groupings of 313 duplicate specimens of milk, one of each pair being examined by the Bacteriology Department of the West of Scotland Agricultural College, and the other by veterinary research workers attached to the Pathology Department of Glasgow University.

| | Number of specimens | | |
|-----------------------|-----------------------------|---------------------------------|---------------------------------|
| | Up to 100,000 cells per ml. | 100,000 - 500,000 cells per ml. | More than 500,000 cells per ml. |
| College laboratory | 176 | 52 | 85 |
| Veterinary laboratory | 175 | 55 | 83 |

coagulase, haemolysis, and in some cases fermentation of mannitol.

In addition to the above procedure where weekly tests of milk from first lactation heifers were being carried out, plates of Edwards crystal violet blood agar medium (Edwards, 1933) were poured, using 0.1 ml. of the specimens as inoculum. Streptococci colonies which developed in this medium were typed in the same way as those on the direct blood plates.

In examining the udder tissue, cultures of the organisms were obtained by the following procedure. Approximately 3 grams. of the tissue was emulsified in broth and 0.01 ml. of the broth stroked within a few hours on blood agar. The remainder of the bouillon was incubated at 37°C overnight and then stroked on plates of blood agar and Pot. tellurite blood agar. The various colonies developing were examined and typed in the same way as for the milk cultures.

Estimation of electrical conductivity

Many milk samples, in addition to the other tests, were examined for electrical conductivity, the test being carried out by means of an I. S. I. Rapid Abnormality /

Abnormality Meter.^x As the electrical conductivity varies according to the number of factors, e.g. individual cow, stage of lactation, etc. more importance was attached to the differences between the results of the milk from individual quarters than to the absolute readings.

Post-mortem examination of the udder

This was carried out by the procedure evolved by McFarlane et al. (1949). The gland was divided into right and left halves and frozen. Each half was then subjected to multiple horizontal slicing, and as a rule four or five blocks of tissue were taken from slices at each of three different levels in every quarter for histological examination. At the same time material for bacteriological examination was obtained by means of a sterile uterine curette from the seared surface of the slice immediately above that from which the blocks of tissue were removed. The searing was carried out by repeated applications of paint scrapers brought to bright red heat in the flame of a blow-lamp. Later this procedure was modified/

x Industrial and Scientific Instruments Ltd.,
133/5 Euston Road, London, N.W. 1.

modified and the material for bacteriological examination was obtained by searing the lateral surface of the frozen unsliced gland and taking samples from it by means of $\frac{1}{8}$ " twist drill held in a hand brace. Specimens were taken as a rule in this way from three levels in each quarter, the drill being inserted in three different directions at each level. This method had the advantage over the curetting method in that it lessened the risk of contamination. It did not, however, give material from such a wide surface as the other method. The material was examined for bacteria as already described under culture tests (See page 9).

Blocks of tissue were then cut from the slices from three different levels of each quarter. The slice taken from the lowest part of the quarter was termed level 1; that from the middle of the quarter level 2; and that from the top of the quarter level 3; (See figure 1). The particular region of the level from which the blocks of tissue were removed was designated by a letter; A for the central region of the quarter, B for the region of the junction of the fore and hind quarter, C for the angle of the quarter, D for the lateral border and E for the medial border. /

border. The shape of the block was varied according to the region of the level from which it was taken. Thus a square block was cut from region A; a triangular block from region C; a truncated right-angled triangular block from region D; a truncated isosceles triangular block from region E and a rectangular block from region B. (See figure 2). Blocks of tissue were also removed from the wall of the cistern of the gland and from the supra-mammary lymph node, the block in the latter case being referred to as S.M.L.G. Owing to the difficulty of defining the junction of the fore and hind quarters, blocks of tissue were rarely taken from the B region and therefore the same shape of block, i.e. a rectangular one, was occasionally used in taking specimens of lesions found in other areas. In quarters of small dimensions only a limited number of blocks was taken from each slice and with very small quarters slices from only one or two levels were examined. As the blocks of tissues were still frozen when immersed in fixative the different shapes were retained.

To avoid confusion, blocks from different quarters were stained different colours by adding a few drops of dye to the fixative. Thus light green stain /

stain was used for the left fore quarter; orange G for the right fore quarter and acid fuchsin for the right hind quarter. The left hind quarter was left unstained.

The tissue was fixed in 4 per cent. formaldehyde for two days, and then in a solution of saturated corrosive sublimate from four to six days. It was then dehydrated in 80 per cent. spirit for four hours, followed by 8 per cent. phenol methylated spirit over-night and two changes of absolute alcohol the next day. It was now cleared by leaving over-night in a mixture of equal parts of absolute alcohol and benzol. Next morning it was treated for four hours with benzol, the benzol being renewed after two hours. Embedding in paraffin wax took place in three stages lasting for four hours, overnight, and one hour, respectively. The tissue was then blocked in fresh paraffin wax. Sections of 7 to 8 μ were cut on a Cambridge rocker microtome and stained with haematoxylin and eosin. Representative sections from each quarter were stained respectively by the following methods:- picro-Mallory; Weigert's elastica stain; Gordon and Sweet's method for reticulum; carbol chromotrope and methylene blue for eosinophils; Unna Pappenheim /

Pappenheim for plasma cells; and Gram's stain and carbol thionin for organisms.

The macroscopic examination of the tissue was not carried out until the slices had been allowed to thaw.

THE CELLS IN MILK

Total cell content

In the early part of the present century, the cell count was used by many public health workers as an indication of the hygienic quality of milk. There was doubt, however, as to the exact significance of the various types of cells present, particularly whether they constituted pus or not. Thus Pennington and Roberts (1908) assumed that all cells found in milk were leucocytes or pus cells, and therefore concluded that 75 per cent. of cows towards the end of lactation showed pus in the milk. On the other hand, Revis (1908) thought that even normal milk could contain many leucocytes and that thus they were of no pathological significance. Hewlett, Villar and Revis (1909) were of the opinion that the majority of cells in milk differed considerably from leucocytes, and that although there were many multinucleate cells present, they were not polymorphs, and phagocytosis of bacteria was practically absent. In the following year the same workers (1910) examined 100 smears from the milk of six cows and observed no cells resembling polymorphs and concluded that the main cells in milk were epithelial. They found high cell counts to be due mainly to the presence of large numbers /

numbers of multinuclear cells. It is worthy of note that these workers added six drops of formaldehyde to each 60 ml. of milk on the assumption that this increased the number of cells in the centrifuge deposit. This practice would tend to pre-fix any polymorphs present and thus cause them to appear much smaller than in blood films. Savage (1910) found leucocytes in milk at all stages of lactation. He recognised polymorphs, lymphocytes and large leucocytes, and noted up to 70 per cent. of the last named in the milk of cows at the end of lactation. Scannell (1912) stated that leucocytes present in small numbers in milk did not constitute pus, but only if they were abundant or associated with streptococci. Breed (1914) thought that the cells in milk were leucocytes and epithelial cells. Varrier-Jones (1924) was not of the opinion that the presence of active polymorphs in milk constituted pus, but only dead polymorphs. Bourgeois (1927) stated that in normal milk the ratio of multinuclear cells to mononuclear was approximately 1:1. In an investigation of bovine mastitis Cherrington, Hansen and Halversen (1933) discussed the value of the relationship of the leucocyte content of milk to the bacterial count and concluded that normal milk contained /

contained less than 50,000 cells per ml., but that milk from cows having clinical mastitis invariably showed more than 100,000 cells per ml. Holm (1934) stated that normal milk contained only large and small lymphocytes, and that polymorphs and monocytes were present only in milk from cows suffering from mastitis.

From the results of the present investigation, it is possible to assess the value of the findings of these earlier workers. For instance, Pennington and Roberts (1908) were in error in stating that 75 per cent. of cows show pus in the milk at the end of lactation, for although at this stage, large numbers of cells are as a rule present, these are mainly non-vacuolated or vacuolated epithelial cells, and not pus cells. The findings of Revis (1908) that polymorphs and epithelial cells occur in normal milk is in agreement with the results of the present investigation. The failure of Hewlett et al. (1909) to find polymorphs in milk appears to be due to the fact that they treated the milk with formaldehyde and did not realise that this caused an apparent reduction in the size of these cells. The cells which according to Savage (1910) are large leucocytes and constitute 70 per cent. of the cells in milk from cows at the end of lactation are not leucocytes /

leucocytes but vacuolated and non-vacuolated epithelial cells. Scannell's observation (1912) that a few leucocytes in milk do not constitute pus is in agreement with the present work. This also applies to the findings of Breed (1914) that the milk contains leucocytes and epithelial cells. The statement of Varrier-Jones (1924) that polymorphs must be dead before pus is constituted is open to question. Bourgeois's (1927) statement that multinuclear and mononuclear cells are present in the ratio of approximately 1:1 in normal milk may be true, but this ratio also occurs in certain stages of mastitis.

The results of the work carried out by Malcolm et al. (1942, 1944) and also by McFarlane et al. (1949) confirm the conclusions of Cherrington et al. (1933) that the total cell count of milk is a valuable criterion of mastitis. They claim that a persistently high incidence of cells, particularly polymorphs in the case of mid-lactation, is a definite indication of an inflammatory condition, even although no organisms can be found in the milk. McFarlane et al. (1949) have shown that in 54 quarters examined for mastitis by means of ante-mortem cell count of the milk and post-mortem histological examination of the udder tissue the findings /

findings agreed in 92 per cent. of cases, and that with cows in mid-lactation, high cell counts (over 100,000 per ml.) persisting for several weeks were invariably associated with pathological changes in the quarter. They also found that histologically negative quarters had consistently low cell counts throughout both the current and previous lactations. Further, of 31 quarters which were pathologically positive, 94 per cent. gave high cell counts, but only 48 per cent. gave positive culture tests of the milk, providing evidence of the fact that in high proportion of cases of mastitis, amounting in that investigation to 51 per cent., no organisms may be found in the milk. They, however, suggested that a cell count of 100,000 per ml. by itself should not be taken as pathognomonic of mastitis. They recognised that there may be a considerable rise in cell count due to factors other than mastitis, e.g. unduly long retention of milk in the udder, or some affection of the general health, but in such cases all the quarters are likely to be affected similarly. Therefore, in interpreting the results of the cell count test as much importance was attached by them to marked differences between the cell count of the four quarters as to the absolute figures, particularly /

particularly where the counts are less than 500,000 per ml. and also where the samples are from old cows. Further, in routine advisory work a cell count of 100,000 per ml. may not leave sufficient margin for safety and a count of 200,000 or 250,000 per ml. would be preferable. In Malcolm's and in McFarlane's investigations (Malcolm et al. 1942, 44 McFarlane et al. 1949), no attempt was made to determine the numbers of the different cells present, the diagnosis being based simply on the total cell count. Thus while it was shown that the total cell count was a most reliable criterion for the diagnosis of mastitis, it was felt that in the present investigation, a differential cell count should be carried out to determine whether additional information could be obtained for diagnostic purposes.

Differential cell content

VARRIER-JONES gave a detailed description of the cells found in bovine milk (VARRIER-JONES 1924). To concentrate the cells, he centrifuged the milk in two stages. 10 ml. of the milk was first centrifuged in a graduated tube at 3,000 revolutions per minute for 10 minutes, and the cream and underlying skim milk removed leaving /

leaving only 0.5 ml. of liquid above the deposit in the tube. The deposit was then resuspended in the residual fluid and drawn up into a capillary pipette. The end of the pipette was now sealed and further spinning carried out to bring the cells to the bottom. Films of the deposit were made, allowed to dry and then stained at once by Jenner's method.

Varrier-Jones described nine types of cells.

1. The finely granular eosinophil cell

This cell was polymorphonuclear, round oval or even irregular in outline with clear cytoplasm filled with pink-stained granules. It was from 10 - 12 u in diameter and was observed to be distinctly phagocytic. This cell was constantly found in milk, although in very small numbers in normal milk. However large numbers were present in milk from inflamed quarters.

2. The coarsely granular eosinophil cell

This was 10 - 13 u in diameter, was oval or round in shape, and the cytoplasm was closely studded with deep pink granules, each measuring as much as 0.5 u. The nucleus was kidney-shaped or lobed.

3. The large mononuclear leucocyte

This was one of the largest cells found by Varrier-Jones /

Varrier-Jones in cows' milk but he did not give its size. It would appear, however, from Figure 3 in his article that this cell was larger than a polymorph and about two-thirds the size of a fat-laden epithelial cell, i.e. it was about 15 u in diameter. It was round or oval, and invariably stained dark blue, the stain, however, being unevenly distributed and giving the appearance of a tangled thread throughout the substance of the cell. According to Varrier-Jones this thread represented the nucleus and it almost completely filled the cell, there being only a trace of pale blue cytoplasm either to one side of it or all round it. These cells were invariably observed in cows' milk sometimes being a prominent feature in the stained film.

4. The lymphocyte

This was a small blue cell which as a rule stained deeply, the cytoplasm forming a thin ring of light blue colour around the deeply stained nucleus. It varied in size from 2 - 4 u but was as a rule about 3 u. It was fairly numerous in normal milk, although the numbers observed varied with different breeds of cattle.

5. The basophil cell

This cell was 8 - 10 u in diameter, was almost circular but occasionally oval. The large round or oval /

oval nucleus occupied two-thirds of the cell, and was always mononuclear. The cytoplasm was clear and transparent with irregular dark blue granules scattered unevenly throughout. It was rarely found in milk, being absent from normal milk, but occurring in small numbers under certain abnormal conditions.

6. The large neutrophil cell.

This cell was 5 - 9 u in diameter and was extremely rare. It was oval in shape and on rare occasions round. The cytoplasm was stained a faint blue throughout, but was filled with very fine mauve granules, except in the region of the nucleus.

7. Red blood corpuscles

These were invariably present in cows' milk, though in extremely small numbers under normal conditions.

8. Large epithelial cells

These cells were almost always present. They were round or oval and varied greatly in size some measuring as much as 20 u in diameter. The cytoplasm was somewhat granular, having a ground - glass appearance. It stained more or less deep blue. The nucleus was round or oval and occupied a quarter of the cell. It usually had a mottled appearance as though composed of a chromatin net-work. In the cytoplasm there were usually one, /

one, two or more clear spaces. According to Varrier-Jones, these were fat globules surrounded by an envelope which prevented the fat from staining by the ordinary fat-staining methods.

9. Mononuclear eosinophil cell.

This cell, according to Varrier-Jones, resembled the finely granular eosinophil cell, his type number 1. The cytoplasm stained a light pink, the substance being more or less vacuolated. These cells were abundant in late lactation milk. In some cases they were unvacuolated, measured 9 - 10 u in diameter, and were regarded by Varrier-Jones as epithelial cells.

It is evident from Varrier-Jones' description of the cells in milk that his first type of cell, i.e. the finely granular eosinophil cell, is the typical bovine polymorph, the cytoplasmic granules of which have eosinophilic properties even when observed in paraffin sections. His second type of cell, the coarsely granular eosinophil cell, is the bovine eosinophil, which has largereosinophilic granules than the bovine polymorph. His fifth type of cell, the basophil cell, would appear to be the basophil cell of bovine blood. But his sixth cell, the large neutrophil cell, has not been observed by the author and /

and it is possible that it is a degenerated granular cell. This view is supported to some extent by the fact that it is from 5 - 9 u in diameter.

In the present work the above four types of cells could not be distinguished as the Sudan black staining method was used, which stains all the granules in the cytoplasm a dark brown colour. Further, in the relatively thick smears by the Prescott and Breed method, these cells do not flatten to any extent on the slide, so that the morphology of their nuclei tends to be obscured by the granules and at the same time the cells appear to be relatively small. The tendency for the cell to flatten in the smear is even further reduced owing to their pre-fixation by the formaldehyde added to the milk in the present investigation. On the other hand, in a thin blood smear, the cells flatten out considerably and the granules of the eosinophils therefore appear relatively large and show a clear central zone. Thus it is possible in thin blood smears to distinguish polymorphs from eosinophils, even although the Sudan black staining method is used.

In the Prescott and Breed smears the granular cells may be round, oval or elongated in shape. Those which are round are from 5 to 6 u in diameter, those which are oval /

oval are from 5 by 3 u to 9 by 7 u, and the elongated forms are from 9 by 4 u to 13 by 3 u. (See Figure 3.) If milk smears are stained by Leishman's method alone or by means of carbol chromotrope, eosinophils may be demonstrated. No attempt, however, was made by such methods to determine the frequency of occurrence of these cells in milk. Nevertheless the fact that they have been observed by the author (in one case, C 42, in large numbers) in the acini of stained sections of udder tissue, shows that they may occur in milk.

Varrier-Jones does not indicate the frequency of occurrence of eosinophils in milk, but states that the basophil cell is "rare" and the large neutrophil cell "extremely rare". He also states with regard to the finely granular eosinophil cell - "This polymorpho-nuclear cell is constantly found in milk. In a normal sample the number is very small, almost negligible, but in milk from an inflamed quarter the number may be very considerable."

The author found that granular cells were seldom absent from the milk samples, approximately 5,000, examined by him. Even in cases where only a few cells were found in the smear, one at least of these cells was almost invariably a granular cell.

The other cells described by Varrier-Jones, using Jenner's stain, resemble closely in morphology and in staining properties the non-granular cells stained by the Sudan black-Leishman method. One of these cells, the fourth on his list, is the lymphocyte. This cell stains blue, the cytoplasm being paler in colour than the nucleus and appearing to one side of the latter or as a narrow ring around it. In the majority of specimens examined in the present investigation only 0 to 6 per cent. of the cells present were lymphocytes. In a few cases, however, the proportion amounted to 20 per cent. The lymphocytes were, as a rule, about 8 u in diameter, but varied from 5 to 9 u. (See Figure 3.) It should be noted that Varrier-Jones found them to be from 2 to 4 u in diameter.

Varrier-Jones's seventh cell, the red blood corpuscle, was found by him to occur only in very small numbers, one or two, in the deposit from 10 ml. of normal milk. It is therefore unlikely that they would be observed in the smear from 0.01 ml. of normal milk. This is in agreement with the experience of the author who found them only in blood stained samples of milk.

The eighth group of cells described by
Varrier-Jones, /

Varrier-Jones, the large epithelial cells, up to 20 u in diameter and containing fat globules in their cytoplasm, are probably the cells of "suppressed lactation", in other words, the vacuolated cells observed in the acini if a ductule is obstructed or if milking of the animal is suddenly suspended. (See Figure 5.) In some cases, however, these cells may be the vacuolated epithelial cells found in sub-acute catarrhal inflammation of the ducts. Varrier-Jones states that these large epithelial cells are present in almost all samples of milk. However, in the present work the author found that they were frequently absent from samples, although if present, generally occurred in large numbers.

The term, Mononuclear Eosinophil, is used by Varrier-Jones for two types of cells, one with vacuolated cytoplasm, the other with unvacuolated cytoplasm. Occasionally vacuolated cells with eosinophilic cytoplasm have been observed in the present investigation in association with vacuolated cells referred to in the preceding paragraph. In his description of the unvacuolated mononuclear eosinophil, Varrier-Jones refers to a figure in which he shows one unvacuolated cell of about 9 to 10 u with eosinophilic cytoplasm. /

cytoplasm. This resembles a plasma cell. In the present work such cells have not been observed in milk samples.

VARRIER-JONES'S third cell, the large mononuclear leucocyte is not a leucocyte but the epithelial cell cast off from the acini and is found in practically all milk smears. It becomes more abundant in advanced lactation, being the cell cast off in the process of involution. In sections of udder tissue large numbers are seen in the acini and ducts during advanced lactation, and also during the rapid process of post-inflammatory involution. (See Figure 4.)

In the early part of this investigation before formaldehyde was used to preserve the milk, a few multinucleate degenerating epithelial cells were observed, but after treatment of the milk with formaldehyde was adopted as a regular procedure, no multinucleate cells without the characteristic dark brown granules were observed. Thus it would appear that the large numbers of multinucleate "pseudopolymorphs" found by Zlotnik (1947) and stated by him to be degenerating epithelial cells, were in fact true polymorphonuclear leucocytes. This view is confirmed by examination of his tables and photographs.

In /

In the present work, accordingly, the cells found in milk smears stained by Sudan black, Leishman method, may be classified by the following method.

1. Granular cells, containing in the cytoplasm

granules stained dark brown in colour. This group includes the polymorph the eosinophil, and probably the basophil. These cells may be rounded, from 5 to 6 u in diameter, oval 5 x 3 u to 9 x 7 u or elongated 9 x 4 u to 13 x 3 u. The elongated type are found only in smears prepared from milk which has been formalised soon after it is drawn from the cow. (See Figure 3.)

2. Non-granular cells, containing no dark brown

granules in the cytoplasm. This group included lymphocytes 5 to 9 u in diameter (see Figure 3); non-vacuolated epithelial cells with large nuclei measuring 7 to 15 u. (see Figure 4); vacuolated epithelial cells measuring 9 to 24 u. (see Figure 5); and other cells such as monocytes, macrophages and plasma cells.

Camera lucida drawings of polymorphs in blood films and in thin films of unformalised milk and in Prescott and Breed smears of unformalised milk are shown in Figure 6. The upper part of Figure 3 shows the outlines of granular leucocytes, i.e. cells with granular cytoplasm but not differentiated as polymorphs, eosinophils or basophils, seen in Prescott and Breed smears prepared from formalised milk.

Results of examination of the milk for cells

From over 5,000 samples of milk which were examined for total cell count, for differential cell count and by culture methods for mastitis organisms, 1,710 were selected in which the state of lactation of the cows was known. Of these samples, 1,271 were of milk from cows in mid-lactation, i.e. giving more than one gallon daily and not more than seven months in lactation. Of these specimens, 377 contained specific mastitis organisms; 127 having mastitis streptococci and 250 pathogenic staphylococci. The remaining 894 specimens were either sterile or contained no mastitis organisms, but only various saprophytic bacteria, e.g. commensal corynebacteria and micrococci from the udder. The results are given in Table 3.

TABLE 3

The average proportion of polymorphs in relation to cell count and absence or presence of mastitis organisms, in 1,271 specimens of mid-lactation milk.

Average proportion of the cells which were polymorphs, expressed as a percentage.

| Total cell count. | Mastitis organisms absent. | Mastitis organisms present |
|---------------------------------|----------------------------|----------------------------|
| Up to 100,000 cells per ml. | 44 | 44 |
| 100,000-500,000 cells per ml. | 51 | 52 |
| More than 500,000 cells per ml. | 55 | 60 |

Four hundred and thirty nine samples were from cows in advanced lactation, i.e. cows giving less than one gallon of milk daily and more than seven months in lactation. Of these specimens, 101 contained mastitis organisms; 45 having mastitis streptococci and 56 pathogenic staphylococci. The remainder, 388 specimens, were either sterile or contained no mastitis organisms but only commensal corynebacteria and micrococci. The results are given in Table 4.

It will be seen from Table 3 that in the case of milk from cows in mid-lactation, with increase in the total cell content there was an increase in the average proportion of the cells which were polymorphs. This applied whether mastitis organisms were present or not. Further, the average proportion of polymorphs was appreciably lower with counts of less than 100,000 cells per ml. than with higher cell counts, the average proportion in the former being 44 per cent. and in the latter 51 to 60 per cent. This is consistent with the findings of Malcolm et al. (1942: 1944) and McFarlane et al. (1949) that in the case of mid-lactation milk, cell counts of more than a 100,000 per ml. indicate inflammatory changes in the udder, and that under such pathological conditions a rise in the proportion /

TABLE 4

The average proportion of polymorphs in relation to cell count and absence or presence of mastitis organisms, in 439 specimens of advanced lactation milk.

Average proportion of the cells which were polymorphs, expressed as a percentage.

| Total cell count | Mastitis organisms absent | Mastitis organisms present |
|---------------------------------|---------------------------|----------------------------|
| Up to 100,000 cells per ml. | 33 | 49 |
| 100,000 - 500,000 cells per ml. | 40 | 55 |
| More than 500,000 cells per ml. | 45 | 47 |

proportion of polymorphs is to be expected. The table also shows that there was on the whole no well marked difference in the average proportion of polymorphs in milk of the same total cell content, no matter whether mastitis pathogens were present or not. It must be noted, however, that in specimens containing more than 500,000 cells per ml., the proportion of polymorphs was rather higher where mastitis organisms were present. This appeared to be due to the fact that a number of these specimens were derived from clinical cases of mastitis, and such specimens as a rule have extremely high polymorph proportions.

In the case of cows in advanced lactation, (see Table 4), the average proportion of polymorphs in the specimens containing no mastitis organisms increased as the cell count rose, but there was no similar consistent upward trend where mastitis organisms were present. The average proportion of polymorphs was however, invariably lower in the absence of mastitis organisms than in their presence and this was more marked where the cell count was less than 500,000 per ml. In this connection it must be kept in mind that in advanced lactation, milk even from mastitis-free cows has as a rule a high total cell count (more than 100,000 /

100,000 per ml.) owing to the presence of epithelial cells, shed from the mammary tissue in the process of involution. Thus such advanced lactation specimens as showed no mastitis organisms, could be for the most part from mastitis-free cows, particularly where the cell count was not excessively high, i.e. not more than 500,000 per ml. One would expect in such mastitis-free specimens that owing to the presence of large numbers of epithelial cells the average proportion of polymorphs would be low. On the other hand, the advanced lactation specimens which contained mastitis organisms, would in many cases have been derived from cows suffering from mastitis, and as a result of inflammatory conditions would show higher polymorph proportions.

As a whole, the specimens from cows in advanced lactation and free from mastitis organisms had appreciably lower polymorph proportions than those of similar specimens from cows in mid-lactation. This, as previously mentioned, would be due to the larger content of epithelial cells in advanced lactation milk. In milk containing mastitis organisms and presumably in many cases drawn from cows suffering from mastitis, the polymorph proportion of advanced lactation /

lactation specimens, where the cell count was more than 500,000 per ml., was also appreciably lower than that of mid-lactation specimens. This was no doubt due to the increased numbers of epithelial cells in the advanced lactation milk. There was, however, no marked difference between the polymorph proportions of advanced lactation and mid-lactation milk in the case of specimens which contained mastitis organisms and had lower cell counts than 500,000 per ml. With such advanced lactation specimens the fact that the cell count is less than 500,000 per ml. shows that involution is not proceeding rapidly and that there is not therefore excessive shedding of epithelial cells. For this reason the effect of mastitis lesions in raising the polymorph proportion of the milk is more evident in these specimens than in those of higher cell count. It would appear from the above figures that the differential cell count possesses no advantage over the total cell count as a diagnostic method, except that the proportion of granular leucocytes tended to be lower in the milk from cows in late lactation than in the milk from cows in mid-lactation. This amounts to the fact that if a single sample of milk from an animal is examined the total and differential cell count combined may be no more informative than the total cell count alone.

THE POST-MORTEM EXAMINATION

OF THE BOVINE UDDER

Structure of the Udder

The bovine udder is divided into right and left halves by a double fibro-elastic membrane. Each half is composed of two separate glands, the fore and hind quarters of the udder, although the division between them is not as a rule discernible to the naked eye or microscopically. Thus the normal udder has four quarters, each with a single teat. At the tip of the teat is a shallow depression leading into the teat-canal. This canal, sometimes termed the streak-canal, acts as the sphincter to the gland, being surrounded by plain muscle fibres. It is about 10 mm. long and opens into the teat-cistern, the collecting space within the teat. At the point where the teat canal joins the cistern, the stratified squamous epithelium lining the former is thrown up to form a rosette, Fürstenberg's rosette. The structure of the teat cistern of the Ayrshire cow varies with different animals and to some extent with different teats of the same animal. The wall may be smooth except for two or three vertical rugae which extend the length of the cistern /

cistern, and under which blood vessels are present. These rugae may or may not be prominent. Rows of transverse rugae may also occur, so that a network of vertical and transverse rugae is formed in the wall of the teat cistern with pockets in the intervening spaces. In some teats all the pockets are shallow; in others they are all up to 0.5cm. in depth. However, in certain teats the pockets are deep in the upper part of the cistern and quite shallow or entirely absent in the lower part. The teat cistern as a rule forms a continuous space with the gland cistern, the collecting space within the gland. The gland cistern is usually globe-shaped and from it radiate the main collecting ducts of the quarter. The vertical rugae of the teat cistern continue up the wall of the gland cistern and branch to form other vertical rugae. Transverse rugae may also occur in the wall of the gland cistern so that as in the case of the teat cistern a network is formed in the wall. The mouths of the main ducts are found in the interspaces of the network of rugae in the upper part of the gland cistern, but blind pockets may occur in the interspaces of the lower part of the gland cistern. These pockets may be up to 2 cms. in depth; they /

they are as a rule deeper than the pockets in the wall of the teat cistern. It would appear that these blind pockets in the wall of the teat cistern and gland cistern are abortive attempts to form main ducts. The main ducts divide into two or more branches close to the point where they radiate from the cistern and therefore it is difficult to estimate their number. The author has found by making celluloid casts of the duct system that the branches of the main ducts radiate in straight lines and give off side branches of varying length and diameter; these branch repeatedly and become smaller and smaller, the smallest ducts being sometimes termed ductules. In the lactating udder, each terminal duct or ductule finally opens into an acinus, i.e. a space surrounded by secretory epithelium. The acini do not occur singly but as aggregates, each of which is referred to as a lobule. Aggregates of lobules are sometimes called lobes, but this term should not be used because, owing to the irregularity of the branching of the duct system, it is difficult to determine what constitutes a lobe. A lobe could be regarded merely as the tissue drained by each main duct but this appears to be unnecessary, and for the sake of simplicity it is better to regard the /

udder as being an aggregation of lobules.

The ducts are named according to their position and the extent of the area they drain. Thus, the ducts within the individual lobules and which drain the acini, are termed intralobular ducts, and the duct which issues from each lobule and which drains it, is termed the lobular duct. The ducts which are formed by the union of lobular ducts and which lie between the lobules, are termed interlobular ducts. These interlobular ducts become larger and larger as more and more of them unite until finally they become one of the branches of a main duct. The size of the interlobular duct at its union with the branch main duct, will depend upon the number of lobular ducts from which it has sprung; these lobular ducts may be few or many depending on the position of the interlobular duct in the udder. If a group of lobules is adjacent to a branch duct, the interlobular duct from the group may open directly into the branch duct. In the same way where a single lobule lies adjacent to a large duct, its lobular duct may open directly into the latter. Such lobules are referred to in this work as periductal lobules; they can be seen in the walls of the main ducts and the gland cistern and occasionally /

occasionally in the wall of the teat cistern. Reconstruction by the author of serial sections of udder tissue shows that periductal lobules occur along the whole length of the ducts to the point where the latter branch into the smaller ducts, which drain the numerous terminal lobules. Thus the arrangement of all the lobules and the ducts is similar to that of leaves on the trunk, branches and twigs of a tree.

THE MACROSCOPIC APPEARANCE OF THE NORMAL
UDDER OF A COW WHICH HAS BEEN BLED AT
THE TIME OF SLAUGHTER ^x

The epithelial lining of the gland cistern and teat cistern and of the ducts is smooth, shining and translucent with pericisternal and periductal lobules showing through. The appearance of the cut surface of the gland varies in different stages of lactation. In full lactation the surface is composed of large pale pink opaque lobules, 3.0mm. and over, which protrude from the surface and on pressure exude milk.

Examination /

x The macroscopic and microscopic appearance of the udder derived from a cow which has been bled at the time of slaughter differs considerably from that of an unbled cow due to the presence of blood in the latter.

Examination of the lobules with a hand lens shows that the opacity is due to the presence of milk in the acini. A slice of tissue is soft to the touch, and if stretched is found to be very elastic although tearing readily. In addition to the more or less circular main ducts, smaller slit-like interlobular ducts 2.0 to 3.0 mm. long can be observed amongst the lobules. There is a minimum of supporting tissue around the lobules and ducts.

Later in lactation the lobules when they commence to undergo involution decrease in size and do not protrude to the same extent from the cut surface. The perilobular connective tissue is relatively more abundant, so that a slice of the tissue is not so soft to the touch, is less elastic and not readily ruptured. Thus the extent to which involution has proceeded can be determined by the size and opacity of the lobules and by degree of their protrusion from the cut surface.

In fully involuted tissue the lobules are small, 0.5 mm. in diameter and, owing to the absence of milk, ~~tan~~ brown-coloured and translucent. They do not protrude from the cut surface. The perilobular connective tissue is readily observed and, as a rule contains large /

large amounts of fat. A slice of the tissue is no longer elastic and is not readily ruptured. The interlobular ducts are still slit-like and have a minimum of connective tissue around them. Involuted lobules and those which are in the process of involution are in some cases chrome-coloured.

THE MACROSCOPIC APPEARANCE OF THE MASTITIC
UDDER OF A COW WHICH HAS BEEN BLED AT
THE TIME OF SLAUGHTER

Acute inflammation of lactating lobules is not readily detected macroscopically. But lobules in this condition may be slightly darker in colour than normal lobules, and as they tend to involute rapidly, they are usually smaller in size and protrude less from the cut surface. After involution has occurred the affected lobule cannot be distinguished from the normal one. The amount of involuted tissue in affected quarters is frequently greater than in non-affected quarters of the same udder. Early inflammatory changes occurring in ducts are more readily observed than in the lobules. The earliest change in the duct consists of a slight granularity of the mucous membrane. This granularity may become marked and may be associated with thickening of the duct wall. Later, there may be severe periductal fibrosis with or without pus /

pus in the lumen. The macroscopic appearance of the udder in advanced mastitis is mainly the result of a progression of those duct changes. Thus there may be extensive periductal fibrosis with obliteration of ducts. The above observations do not refer to the appearance of the lactating udder affected with acute necrotising mastitis. In this condition the ducts are filled with pus and necrotic debris and the cut surface of the gland shows large areas of coagulative necrosis which are smooth and firm to the touch.

THE MICROSCOPIC APPEARANCE OF THE NORMAL
UDDER OF A COW WHICH HAS BEEN BLED AT
THE TIME OF SLAUGHTER

If a section of an udder in full lactation is examined microscopically, it will be observed that there is a minimum amount of interlobular connective tissue. The lobules consist almost entirely of milk secreting acini filled with milk. The acini are lined with a single layer of flattened epithelial cells and an interacinar capillary. The so-called myoepithelial cells occur in association with the acini. These cells have a flattened nucleus with a long fibril at each end, the fibrils having similar staining reactions to plain muscle. In thin sections of udder tissue they often /

often appear to be in association with the interacinar capillaries, but Richardson (1949) has shown by means of thick sections (100 μ) that in the goat they are separate from the capillaries and form a contractile network around the acini and ductules. The intra-lobular ducts may be recognised by the fact that their epithelial lining is two-layered like the lining of the rest of the duct system of the udder, apart from the stratified squamous epithelium of the streak-canal. In addition the wall of the intra-lobular ducts have fine elastic fibrils, which are not present in the walls of the acini.

As lactation progresses the lobules become smaller due to a decrease in the number and size of the acini. It would appear that the epithelial cells in the acini become exhausted as lactation advances and are cast off so that the acini shrink. The view is supported by the fact that as the lobules decrease in size, there is an increase in the proportion of interacinar and interlobular tissue present.

The normal process of involution goes on gradually until complete involution is reached. At this stage all the acini have disappeared and only the intralobular ducts, surrounded by relatively acellular intralobular /

intralobular connective tissue, are present in the lobules. The interlobular tissue as a rule contains much fat and large lymph spaces. The presence of large amounts of interlobular fat in fully involuted udder tissue causes it to resemble closely the udder of the newly-born calf, except that in the latter there are no lobules but only ducts in the connective tissue supporting the fat. Under modern conditions the period between lactations (the so-called "dry" period) is frequently of short duration and therefore it is rare to find the whole udder in a state of complete involution. In cows in late lactation complete involution may occur only in certain parts of the udder, particularly in periductal lobules around the main collecting ducts, i.e. the ducts in the cranio-lateral part of the fore-quarters (C and D areas) and in the caudal part of the hind-quarters (C area). Those parts of the udder which are completely involuted in this way are firmer to the touch than the lactating parts and may give a false appearance of induration on clinical examination. The finding of normally involuted tissue in a normal lactating quarter is mentioned by McFarlane and Rennie (1950).

Accordingly, lobules may be described as in

'full /

'full lactation', 'lactating'; 'partially involuted'; or 'involuted'. (See Figures 7 to 10.) The lactating lobule may be distinguished from the lobule in full lactation by the fact that its overall size is reduced and also its acini are slightly smaller. Partially involuted lobules show lactating acini in one part and only ductules in another. When the process of involution is complete, i.e. in the case of the involuted lobule, no acini are apparent in any part of the lobule.

Corpora amylacea, i.e. the laminated basophilic bodies described by McFadyean (1930), are frequently found in the acini, being particularly abundant in older cows. As the present work has been mainly concerned with the udders of young animals, it has been possible to observe the stages in the formation of these bodies. The first evidence of their formation is the appearance in the acini of eosinophilic circular bodies, the smallest of which measure about 2 u. in diameter. These bodies appear to coalesce to form much larger eosinophilic bodies, 50 u. or more in diameter, which are frequently irregular in outline and may be surrounded by a number of polymorphs. Ultimately these bodies become smooth and round. In older /

older cows the corpora amylacea are as a rule laminated and basophilic, and occasionally become encapsulated by fibrous tissue.

The term normal has been used in describing the microscopic appearances of the ducts and the lobules, where there was no evidence of inflammatory changes.

THE MICROSCOPIC APPEARANCES OF THE LESIONS OF EARLY MASTITIS

The earliest lesion consists of an acute cellular exudate into the acini of a lobule. The cells of the exudate are mainly polymorphs although in one case (C'42), eosinophils were chiefly found. The lesions are usually focal, occurring in a few contiguous acini in a lobule. The foci, however, are frequently widely disseminated, affected lobules being found in various parts of the quarter. The lesion is termed mild, moderate, or severe according to the amount of exudate present. (See Figures 12 to 14.) A mild cellular exudate may also be observed around corpora amylacea. The acute cellular exudate of the early lesion appears to be followed by rapid involution of the affected lobules, the involuted lobules containing a large number of macrophages, lymphocytes and eosinophils, in the intralobular connective tissue. Such /

Such lobules are referred to as having undergone post-inflammatory involution. (See Figures 15 and 16.) The high cellular content of a lobule which has undergone this rapid type of involution enables it to be distinguished from a lobule which has undergone the slower involution of exhaustion, as in the latter case the intralobular connective tissue is relatively acellular.

Where the involution is rapid due to mastitis there is frequently no evidence of true fibrosis but the periductular connective tissue may occasionally show evidence of sub-acute inflammation, there being signs of early or commencing fibroblastic activity, accompanied as a rule by a cellular exudate into the ductules.

In some instances the acute lesion in the acini is associated with vacuolation of the acinar epithelium. Spencer and McNutt (1950) mention this phenomenon, and they are of the opinion that it is caused by the blockage of a small collecting duct by a fibrinous clot. Vacuolation of the acinar epithelium may, however, occur in the absence of an acute lesion, and is brought about by the sudden suspension of milking. McFarlane (1946, personal communication) termed this suppressed /

suppressed lactation. (See Figure 11). The lobules throughout the quarter are affected. It is probable that whilst the fluid retained in the acini is re-absorbed milk fat accumulates in the acinar epithelium causing the vacuolated appearance. Isolated lobules may, however, show this condition in a quarter being milked normally. These isolated lobules as a rule contain corpora amylacea, and although the latter usually occur in the acini, it is possible that one of these bodies might block a ductule.

The lesions found in the ducts are probably of more importance than those in the lobules, owing to the fact that the damage is of a more permanent nature, a point to which Duffy (1947) previously drew attention and which is fully confirmed in the present work.

"Since cessation of lactation is the common sequel of infection, the affected lobules may undergo atrophy and in consequence the affected tissue disappears, leaving the way clear for the production at a later date of normal epithelial structures preparatory to another lactation, whereas the duct system being permanent suffers irreparable damage." Accordingly, if a duct becomes occluded by fibrosis, its whole drainage /

drainage area becomes useless for milk production, and the larger the duct the larger the area affected.

The acute stage of inflammation of a duct is probably of a transient nature, being rapidly followed by a sub-epithelial production of granulation tissue, (see Figure 17.), i.e. a sub-acute lesion, which frequently becomes catarrhal. In the catarrhal state the epithelial cells become hyperplastic and often vacuolated, (see Figure 18.) Such a lesion is termed mild, moderate or severe, according to the amount of granulation tissue present in the duct wall. If only one or two areas of the duct wall are affected, the lesion is referred to as focal. If sub-acute lesions are severe, the resulting fibrosis may partially or completely occlude the duct.

CLASSIFICATION OF MASTITIS IN HEIFERS

The lesions found in the udders of the 13 heifers have been arbitrarily divided into those occurring in the ducts and those in the lobules. This division is convenient but not absolute, because the ductules within the lobules are continuations of the ducts and are of similar structure, and may therefore be affected with similar lesions. The following is the classification that has been evolved for use in the present work. /

work.

1. Lesions in the ducts.
 - (a) acute exudative.
 - (b) sub-acute or formative lesions.
 - (c) periductal fibrosis.
2. Lesions in the lobules.
 - (a) acute exudative.
 - i. in lactating lobules.
 - ii. in normally involuted lobules or in lobules that have never lactated, as in the virgin udder.
 - (b) post-inflammatory involution.
 - i. without acute exudate in the ductules.
 - ii. with acute exudate in the ductules.
 - iii. with sub-acute or formative lesions around the ductules.
 - iv. with periductular fibrosis.

Not all the lesions mentioned in this classification were observed in the udders of the 13 heifers examined, but all have been seen in the tissues of older /

older cows. Acute exudative lesions in the ducts were found only in association with sub-acute lesions. Sub-acute lesions around ductules occurring in lobules which showed post-inflammatory involution were not recognised although they may have been present to a mild degree, nor was periductular fibrosis observed.

This classification is not sufficiently comprehensive to embrace all types of mastitis. For instance, it does not include acute necrotising mastitis and acute suppurative mastitis in both of which there is rapid destruction of tissue.

McFarlane and Rennie (1950) classify lobular mastitis under four headings:- exudative, productive, active non-progressive (dormant); post-inflammatory fibrosis (extinct). Exudative and productive mastitis may occur in both lactating and involuted tissue, dormant mastitis usually in involuted tissue, extinct mastitis commonly in involuted areas but lactating areas may show a mild degree of the change. The classifications may be compared as follows:-

McFarlane /

McFarlane and Rennie.

Present classification.

Exudative in lactating
tissue.

Acute exudative in
lactating lobules.

Exudative in involuted
tissue.

Post-inflammatory involution
with acute exudate in the
ductules.

Productive in lactating
tissue.

Not observed.

Productive in involuted
tissue.

Post-inflammatory involution
with sub-acute lesions
around the ductules.

Dormant in lactating
tissue.

Not observed.

Dormant in involuted
tissue.

Post-inflammatory involution
without acute exudate.

Extinct in lactating
tissue.

Not observed.

Extinct in involuted
tissue.

Post-inflammatory involution
with periductular fibrosis.

EXAMINATION /

EXAMINATION OF THE UDDERS OF 13 HEIFERS

Of the 52 quarters from the 13 heifers, full details of which are given in Volume II, 25 were normal on microscopic examination and 27 were abnormal. The microscopic findings in the abnormal quarters may be divided into six groups.

1. Severe unifocal acute lobular mastitis

In three quarters, C 31 LF, C 42 LF, and C 42 RH, severe acute inflammatory exudate was found in two or three acini of a single lobule, and in one quarter, C 36 RH, a similar exudate was found in the intralobular tissue of an otherwise normally involuted lobule. No other lesions were found in the portions examined. The cell counts of the milk from these quarters were seldom over 10,000 per ml. Occasionally they had risen as high as 70,000, but had returned to normal at the time of slaughter. A single count of 270,000 cells per ml. was found in a sample from quarter C 42 RH twelve weeks before slaughter, but it is unlikely that this had any association with the acute focus found so long afterwards. All these quarters were lactating although normally involuted lobules occurred in the main drainage area. The involuted lobules varied in extent from 6 to 25 per cent. //

cent. of the quarter.

In quarter C 31 LF, non-haemolytic staphylococci occurred in the milk on three occasions prior to slaughter but their numbers were small and they were not found in the tissue after slaughter, even on enrichment. It is therefore unlikely that they were associated with the development of the lesions. Streptococcus bovis was isolated from the tissue, but only on enrichment, and as it was not found in the milk prior to slaughter, it also was probably of no significance. Two non-haemolytic colonies of Staphylococcus aureus occurred on the plate from a sample of milk taken from C 42 LF six days before slaughter, and similar organisms were isolated, but only on enrichment from the tissue taken after slaughter from close to the region where the acute focus was found. Fourteen non-haemolytic colonies of Staphylococcus aureus grew on the plates from the milk derived from C 42 RH six days before slaughter, and similar organisms were isolated, but only on enrichment, from the tissue close to the region where the acute focus was found. It may be of some significance that this organism was found only in the tissue taken from close to the lesion in both these quarters. No organisms /

organisms of any type were found in the milk or in the tissue of quarter C 36 RH.

The four quarters in this group show that a single focus of acute lobular mastitis may occur in a quarter without causing a marked rise in the cell count of the milk, probably because the lesion is very small and of very recent onset, possibly even since the previous milking. One of these quarters,

C 36 RH, differed from the other three in that the acute focus did not occur in the acini of a lactating lobule but in the intralobular tissue of an involuted lobule. It would be unlikely for any cells from this lesion to find their way into the milk. Such a lesion may have arisen in one of two ways. (1) An acute focus in a lactating lobule may have caused the lobule to involute. In this case the lobule would have shown signs of post-inflammatory involution, but there was no evidence of this, (2) An acute focus may have occurred primarily in the interstitial tissue of an involuted lobule. If such a lesion were caused by micro-organisms it would indicate a path of infection other than by way of the teat canal.

2. Mild multifocal acute lobular mastitis

In five quarters there was a mild acute inflammatory /

inflammatory exudate in the acini of two or more lobules without other lesions in the portions examined. The final cell count of the milk from these quarters was low, 20,000 cells per ml. or less. However, in three of these quarters, all derived from the same animal, C 19, cell counts of up to 130,000 had been obtained within two weeks of slaughter. The remaining two quarters in this group were also derived from one heifer. One of these, C 37 LF, showed cell counts of 100,000 cells per ml. three weeks before slaughter, and 52 per cent. of the cells were granular leucocytes. The last two counts were less than 10,000 per ml. and 10,000 per ml. respectively. The other quarter, C 37 RF, showed counts of 540,000 cells per ml. (68 per cent. being granular leucocytes) three weeks before slaughter; and 160,000 cells per ml. (58 per cent. being granular leucocytes) two weeks before slaughter, and 100,000 cells per ml. one week before slaughter. The final count, however, was less than 10,000 cells per ml. All five quarters in this group were in full lactation with practically no lobules fully involuted.

In two of the quarters, C 19 LF and RF, no organisms were found in the milk but in C 19 RF, non-haemolytic /

non-haemolytic staphylococci were obtained from the tissue from two levels on enrichment. In quarter C 19 LH, large numbers of non-haemolytic staphylococci were present in the milk on one occasion but this was a sample taken four weeks before slaughter and they were not found in later samples. They were obtained from the tissue after slaughter but only on enrichment. As, however, the lesions were few and very small it is not surprising that any organism concerned would be found only on enrichment. With regard to the remaining two quarters, C 37 LF and C 37 RF, only a few diphtheroids occurred in the milk and they were not obtained from the tissues even on enrichment. Streptococcus bovis was found on enrichment from the tissue of quarter C 37 LF, but it did not occur in the milk samples.

It is evident from these results that a severe disturbance, indicated by an increase in the cell count and a high proportion of granular leucocytes, may occur in a quarter and yet if the cell count has returned to a low figure before slaughter, the tissue may show only mild acute lesions in two or three areas. In other words, almost complete resolution of an acutely inflamed lobule may occur, without post-inflammatory involution /

involution intervening. If it were not for the fact that the final count from C 37 RF was less than 10,000 cells per ml., the pattern of the cell counts and the proportion of granular leucocytes would resemble closely those of the three quarters discussed in the next group - severe multifocal acute lobular mastitis.

3. Severe multifocal acute lobular mastitis

In three quarters, C 33 RF, C 42 LH and C 42 RF, there was severe multifocal acute lobular mastitis with, in addition, lobules showing post-inflammatory involution. In no case did severe acute lesions, affecting many lobules, occur without some other abnormality elsewhere; involution due to a previous acute lesion was always present indicating that the process had been in existence for some time. The cell counts from these three quarters were in all cases low, as a rule less than 10,000 per ml., until a few weeks before slaughter.

C 33 RF. In this quarter the count of the milk rose to 70,000 cells per ml. three weeks before slaughter and up to 610,000 the following week. The counts made at eight days, five days and two days before slaughter and on the day of slaughter were approximately 200,000 cells per ml. Differential cells /

cells counts made on the last five samples showed that the proportion of granular leucocytes was 66, 78, 71, 73 and 62 per cent., respectively. Thus the total counts of granular leucocytes in these samples were roughly 400,000, 160,000, 180,000, 170,000 and 140,000 per ml. It was found that about 4 per cent. of this quarter had severe acute lesions and 4 per cent. post-inflammatory involution, and there were no normally involuted lobules present. Macroscopic examination had not revealed these lesions, the quarter appearing to the naked eye to be a normal lactating quarter with no involuted lobules. Six haemolytic colonies of Staphylococcus aureus were found on the direct blood plates prepared from the milk of this quarter 28 weeks before slaughter but not in later samples. Non-haemolytic Staphylococcus aureus was found in the milk at 26, 25, and 7 weeks before slaughter. No organisms were recovered from the tissue taken from this quarter, but from the tissue taken from Level 1 of its neighbour, C 33 RH, a normal quarter, non haemolytic staphylococci were isolated, both by direct culture and on enrichment. The twist-drill used for taking this tissue penetrated the abnormal quarter, and it is therefore possible that /

that the organisms were from the latter, and may have been associated with the lesions.

C 42 LH. In this quarter the cell count rose to 310,000 cells per ml. seven and a half weeks before slaughter, and to 860,000 cells per ml. at seven weeks. At five and a half weeks it dropped to 290,000 only to rise to 1,130,000 cells per ml. at four and a half weeks. Counts of about 700,000 cells per ml. were obtained at three weeks, two weeks and one week before slaughter. The differential cell counts of the samples taken at seven, five and a half, four and a half, three two and one week prior to slaughter were 64, 60, 43, 68, 50 and 59 per cent. granular leucocytes respectively. Thus the total counts of granular leucocytes in these samples were 550,000, 170,000, 520,000, 520,000, 370,000 and 440,000 per ml. It was found that 17 per cent. of this quarter showed severe acute lesions, and about 8 per cent. post-inflammatory involution. A further 8 per cent. of the lobules were normally involuted. A large proportion of the cells in the acute inflammatory exudate were eosinophils, and many of these cells were scattered through the supramammary lymphatic node. On macroscopic examination this appeared /

appeared to be a normal lactating quarter with involuted lobules in the main drainage areas. Only diphtheroids were found in the samples from this quarter, but haemolytic coagulase-positive staphylococci were found in the tissue taken from Level 1 on enrichment, and non-haemolytic staphylococci were found by direct culture and on enrichment in tissue from the left supramammary lymphatic node. It is possible that the haemolytic staphylococci were associated with the development of the lesions, but the significance of the non-haemolytic staphylococci which were found only in the supramammary lymphatic node is uncertain.

C 42 RF. This quarter was from the same heifer as the previous quarter. It showed a rise in cell count to 50,000 cells per ml. seven and a half weeks before slaughter and then to 360,000 cells per ml. at seven weeks. The count was 240,000 at five and a half weeks, 100,000 at four and a half weeks, 230,000 at three weeks, 330,000 at two weeks and 410,000 at one week. The samples examined at seven, five and a half, four and a half, three and two weeks and at one week before slaughter showed 70, 59, 63, 51, 32 and 33 per cent. granular leucocytes, giving total counts of /

of these cells per ml. of 250,000, 140,000, 60,000, 120,000, 100,000 and 130,000 respectively. It was found that 4 per cent. of this quarter showed severe acute lesions and about 4 per cent. post-inflammatory involution. A further 29 per cent. of the lobules were normally involuted. In this quarter also a large proportion of the cells in the acute inflammatory exudate were eosinophils, and there were many of these cells scattered through the supramammary lymphatic node on this the right side of the udder. The macroscopic examination, however, gave a false appearance of a normal lactating quarter with involuted lobules in the main drainage area. A few non-haemolytic staphylococci were found in one sample taken 19 weeks before slaughter but only diphtheroids were isolated from subsequent samples. Haemolytic coagulase-positive staphylococci were isolated from the tissue of one level and non-haemolytic staphylococci were obtained from the right supramammary lymphatic node. In both these cases the organisms were obtained from the tissue only on enrichment so that their numbers were probably small. It is possible, however, that the haemolytic staphylococci were associated with the lesions in the quarter, but the /

the significance of the non-haemolytic type, which was found only in the supramammary lymph node is uncertain.

The three quarters in this group show that when many lobules are affected by severe acute lesions there is a rise in cell count of the milk, a high proportion of the cells being at first granular leucocytes. Table 5 gives the number of granular and non-granular cells per ml. and the total cell counts of the milk from these quarters. The extent of the acute lesions in the quarters, 4 per cent., 17 per cent., and 4 per cent. respectively, bears a direct relationship to the numbers of granular leucocytes in the final counts, i.e. 140,000, 440,000 and 130,000, respectively. It may therefore be inferred that in a quarter in a similar state of lactation to these quarters and like them with no lesions in the ducts, the findings of about 150,000 granular leucocytes per ml. indicates that about 4 per cent. of the quarter is affected with severe acute lobular mastitis. This relationship between the number of granular leucocytes in the milk and the extent to which the quarter is affected may be approached from another angle. For instance in the milk from C 33 RF there were 400,000 granular leucocytes per ml. two weeks before slaughter, but in all the subsequent /

TABLE 5

The number of granular and non-granular cells in specimens of milk drawn at intervals from quarters C 33 RF, C 42 LH and C 42 RF. The cell counts are expressed in thousands per ml.

| | Time before slaughter | | | | | | | | | |
|---------------------------------------|-----------------------|-----------|------------|------------|-----------|-----------|----------|-----------|-----------|-----------|
| | 7½ wks. | 7 wks. | 5½ wks. | 4½ wks. | 3 wks. | 2 wks. | 1 wk. | 5 days | 2 days | 0 days |
| <u>C 33 RF.</u> | | | | | | | | | | |
| Granular cells | - | - | - | - | - | 400 | 160 | 180 | 170 | 140 |
| Non-granular cells | - | - | - | - | - | 210 | 50 | 60 | 60 | 80 |
| Total granular and non-granular cells | 10 | 10 | 20 | 10 | 70 | 610 | 210 | 240 | 230 | 220 |
| <u>C 42 LH.</u> | | | | | | | | | | |
| Granular cells | - | 550 | 170 | 520 | 520 | 370 | 440 | - | - | - |
| Non-granular cells | - | 310 | 120 | 610 | 160 | 380 | 350 | - | - | - |
| Total granular and non-granular cells | 310 | 860 | 290 | 1130 | 680 | 750 | 790 | - | - | - |
| <u>C 42 RF.</u> | | | | | | | | | | |
| Granular cells | - | 250 | 140 | 60 | 120 | 100 | 130 | - | - | - |
| Non-granular cells | - | 110 | 100 | 40 | 110 | 230 | 280 | - | - | - |
| Total granular and non-granular cells | 50 | 360 | 240 | 100 | 230 | 330 | 410 | - | - | - |

subsequent counts only 160,000 per ml. It may be assumed that this fall of over 200,000 cells per ml. was due to the area originally affected becoming reduced owing to the occurrence of post-inflammatory involution, which in the case of this quarter was 4 per cent. Thus it may be inferred that the 4 per cent. of the quarter originally affected with severe acute lobular mastitis but now involuted, had been responsible for adding over 200,000 granular cells per ml. to the milk. Referring on the same basis to the figures for C 42 LH (see Table 5) it will be seen that the occurrence of post-inflammatory involution of 8 per cent. of the quarter had caused a fall in granular leucocytes from 550,000 per ml. at seven weeks to 170,000 at five and a half weeks, a fall of nearly 400,000 cells per ml., the same relationship between the area involuted and the fall in number of granular leucocytes as in the previous case. In this quarter the number of granular leucocytes per ml. again rose to about the previous level four and a half weeks before slaughter, and stayed about the same level in subsequent samples. This rise was probably due to new areas becoming affected. Further, referring to the figures for C 42 RF, it will be seen that post-inflammatory /

post-inflammatory involution of 4 per cent. of the quarter had caused a decrease in the numbers of granular leucocytes from 250,000 per ml. at seven weeks to 60,000 at four and a half weeks, a fall of about 200,000 cells per ml. This is similar to the figures for C 33 RF. In both these methods of calculating the number of granular leucocytes which may be found per ml. of milk if a certain area is affected with an acute inflammatory process, it is assumed that no ducts are blocked by coagulated milk or exudate, and in the second method there has been neither resolution of affected areas, nor an extension of the area affected. Though the finding of from 150,000 to 200,000 granular leucocytes per ml. of milk may mean that 4 per cent. of the lobules are affected with acute lobular mastitis, and from 300,000 to 400,000 that 8 per cent. are affected, it does not follow that when large areas of the quarter are affected the number of cells found in the milk will be in direct arithmetical ratio. Two opposing factors will operate:- the milk yield of the quarter will be reduced, thus causing an increase in the cells per ml., while the blocking of ducts by coagulated milk and exudate will prevent the cells from the areas drained by /

by these ducts from reaching the rest of the milk, and so cause a reduction in the cells per ml.

The acute cellular exudate in two of the quarters in this group, which were both from the same animal, C 42 LH and C 42 RF, contained large numbers of eosinophils, and many of these cells scattered through the supramammary lymphatic nodes. The other two quarters from this heifer were discussed under Group 1, severe unifocal acute lobular mastitis, and the lesions in these quarters also contained a high proportion of eosinophils. In one of these quarters a number of white blood cells had sedimented to the side of a large blood vessel in one section and the majority of these cells were eosinophils. It is therefore probable that this animal had a generalised eosinophilia, and the fact that its hide was badly "warbled" may have had some bearing on this.

4. Post-inflammatory involution with residual lesions.

Eleven quarters showed post-inflammatory involution, the tissue affected varying in extent from 6 per cent. to 66 per cent. of the quarter. In addition, with one exception, there were mild to severe focal acute lesions in lactating lobules.

C 33 LH. On macroscopic examination this quarter appeared /

appeared to be a normal lactating quarter with no involuted lobules. However, on microscopic examination, it was found that 6 per cent. of the quarter showed post-inflammatory involution and 6 per cent. normal involution. No acute lesions were found in lactating lobules. Two of the areas of post-inflammatory involution were, however, still active in that there were polymorphs in the ductules. One week after calving, i.e. 29 weeks before slaughter, the cell count was 70,000 cells per ml. of which 34 per cent. were granular leucocytes. The subsequent counts until three weeks before slaughter were low, in most instances less than 10,000 cells per ml., but in two cases 30,000 per ml. Three and two weeks before slaughter the cell count was 40,000 per ml., 50 per cent. of the cells in the latter case being granular leucocytes. At eight, five and two days before slaughter cell counts of less than 10,000 per ml. were obtained but on the day of slaughter the count was 60,000 per ml. Only 15 per cent. of the cells in the last count were granular leucocytes. Non-haemolytic staphylococci frequently found in the milk, but were not obtained from the tissue after slaughter.

C 32 RF. On microscopic examination 8 per cent. of the /

the lobules in this quarter showed post-inflammatory involution, 17 per cent. normal involution and 2 per cent. mild to severe acute lesions in lactating lobules. From four weeks after calving, or 28 weeks before slaughter, until 17 weeks before slaughter, the cell count varied between less than 10,000 cells per ml. and 60,000 cells per ml. At 16 weeks it rose to 260,000 per ml. but a week later fell to 50,000, 56 per cent. of the cells in the latter case being granular leucocytes. A week later the count rose to 180,000 cells per ml., 62 per cent. of the cells being granular leucocytes. From 13 weeks to 2 weeks before slaughter counts varying between 10,000 and 180,000 were obtained. One week before slaughter the count rose to 190,000 cells per ml., 23 per cent. of the cells being granular leucocytes, and on the day of slaughter there was a further rise to 370,000 per ml., only 23 per cent. of the cells being granular leucocytes. Non-haemolytic staphylococci were found in the milk at 27, 15, 3 weeks and at 1 week before slaughter, but they could be obtained from the tissue only on enrichment from one level. Diphtheroids in small numbers were found in the milk on several occasions. On macroscopic examination this quarter appeared /

appeared quite different from its neighbour in that the lactating lobules, though of the same diameter, protruded less from the cut surface. The lobules in the C. and D. areas of Levels 1 and 2 were involuted. C 4 RH. On microscopic examination 15 per cent. of the lobules in this quarter showed post-inflammatory involution, 18 per cent. normal involution and 1 per cent. mild acute inflammation in lactating lobules. The cell count fell from 190,000 per ml. at 19 weeks before slaughter to 30,000 at 18 weeks, then rose to 260,000 at 14 weeks. No further samples were received until 6 weeks before slaughter when a count of less than 10,000 cells per ml. was obtained. The subsequent counts varied between 10,000 and 50,000 cells per ml. The only samples received in this laboratory were those taken at nine days and four days before slaughter, and these had counts of 30,000 and less than 10,000 cells per ml., with 10 and 15 per cent. granular cells, respectively. Haemolytic and non-haemolytic staphylococci were found occasionally in the milk from this quarter but only in very small numbers and they were not found in the tissues. On macroscopic examination this quarter appeared to be a normal lactating quarter with the lobules involuted in the C areas of all /

all levels and in the D area of levels 1 and 2.

C 32 LF. Fifteen per cent. of the lobules in this quarter showed post-inflammatory involution, 10 per cent. normal involution and two per cent. mild to moderate acute inflammation in lactating lobules. In addition 15 per cent. of the duct system was affected with moderate sub-acute inflammation. For 28 weeks the cell count of the milk varied between 10,000 and 300,000 cells per ml. and the percentage of granular leucocytes between 40 and 56. The final count was 300,000 cells per ml. of which 49 per cent. were granular leucocytes. Diphtheroids, haemolytic and non-haemolytic staphylococci occurred in the milk occasionally prior to slaughter but only in small numbers. Only non-haemolytic staphylococci were isolated from the tissue and these were found only on enrichment. On macroscopic examination this appeared to be a normal lactating quarter, with lobules involuted in the C area and part of the B area of Levels 1 and 2.

C 36 RF. Sixteen per cent. of the lobules in this quarter showed post-inflammatory involution and 6 per cent. mild acute inflammation in lactating lobules. Sixteen per cent. of the lobules were normally involuted. /

involuted. From 10 weeks to 5 weeks before slaughter the cell count did not exceed 20,000 cells per ml. At four weeks the count was 60,000 and a week later 130,000 cells per ml. The counts made at two weeks, one week, and before the animal left the farm were 90,000, 100,000, and 320,000 with 48, 51, and 59 per cent. granular leucocytes, respectively. Apart from the finding of diphtheroids in the milk on two occasions no organisms were found in the milk or tissues. On macroscopic examination this quarter appeared to be a normal lactating quarter with the lobules involuted in the C and D areas of Levels 1 and 2. The quarter was overstocked because the animal was not slaughtered until the day after its arrival at the abattoir and the evening milking had been omitted.

C 4 LH. Thirty-three per cent. of the lobules in this quarter showed post-inflammatory involution, 17 per cent. normal involution and 5 per cent. mild acute inflammation in lactating lobules. The cell count rose from 10,000 cells per ml. at 19 weeks before slaughter to 210,000 at 16 weeks and 520,000 at 14 weeks. No further samples were received until six weeks before slaughter when the count was 5,000,000 cells per ml. It fell to 1,000,000 per ml. a week later /

later and the subsequent counts at four weeks, three weeks, nine days, four days and on the day before slaughter were all about 500,000 cells per ml. Only the samples taken at nine days and at four days were received in this laboratory, the percentages of granular leucocytes being 50 and 31, respectively. Haemolytic and non-haemolytic staphylococci were found on only one occasion in the milk, respectively. Only small numbers were present and they were not obtained from the tissue after slaughter. Macroscopic examination showed that involution was more advanced in this quarter than in the other three from the same udder. The following areas were involuted:- level 1, C and D; level 2, C, D and B, and level 3, C, E and B. The upper end of the streak canal was slightly narrowed by a fibrous band; no difficulty in milking the quarter had, however, been noticed.

C 14 LH. Fifty per cent. of the lobules in this quarter showed post-inflammatory involution, 33 per cent. normal involution and 1 per cent. mild acute inflammation in lactating lobules. In the sample of colostrum taken four days after calving, there were 1,640,000 cells per ml. of which 65 per cent. were granular leucocytes. A week later (i.e. eleven weeks before /

before slaughter) the count had fallen to 100,000, with 34 per cent. granular leucocytes. It rose to 320,000 at ten weeks, and then fell to 60,000 with only 15 per cent. granular leucocytes at nine weeks. A cell count of 20,000 cells per ml. eight weeks before slaughter, was followed by a gradual rise until at three weeks before slaughter there were 800,000 per ml. of which 57 per cent. were granular leucocytes. The counts at two weeks and one week and before slaughter were 1,390,000 and 2,200,000 cells per ml., with 52 and 35 per cent. granular leucocytes, respectively. A few non-haemolytic staphylococci were found in the milk on several occasions prior to slaughter. They were also found in the tissue after slaughter but only on enrichment. On macroscopic examination this appeared to be a normal involuting quarter with areas of lactating lobules scattered throughout.

The remaining four quarters in this group were all from one heifer, C 13. When the milk was first examined, 24 weeks before slaughter, the animal had already been in lactation for 22 weeks. The cell counts of the samples from the four quarters were all in the region of 1,000,000 cells per ml. and 48 to /

to 58 per cent. of the cells were granular leucocytes. The subsequent counts in all four quarters remained high, but the percentage of granular leucocytes fell until, at nine weeks before slaughter it was below 30 in all quarters. The total counts then started to rise until finally they amounted to from 2,700,000 to 7,000,000 cells per ml. in the milk from the four quarters.

C 13 LH. Thirty-three per cent. of the lobules in this quarter showed post-inflammatory involution, 17 per cent. normal involution and 6 per cent. mild acute inflammation in lactating lobules. There was an acute inflammatory exudate in the ductules of a few of the lobules showing post-inflammatory involution. Haemolytic staphylococci were found in the milk in very small numbers on only two occasions, i.e. 21 weeks and 15 weeks before slaughter. Non-haemolytic staphylococci were found in samples of milk taken at 17 weeks and 16 weeks before slaughter. The latter were also obtained on enrichment from the tissue. Diphtheroids were frequently found in the milk but were not found in udder tissue. Macroscopic examination showed a quarter in late lactation, composed of small chrome-coloured lactating lobules except /

except in the C area of levels 1 and 2 where the lobules were involuted.

C 13 RH. Thirty-three per cent. of the lobules in this quarter showed post-inflammatory involution, 17 per cent. normal involution and 33 per cent. mild to severe acute inflammation in lactating or partially involuted lobules. In addition, 1 per cent. of the duct system was affected with moderate sub-acute lesions. There was an acute inflammatory exudate in the ductules of many of the lobules affected with post-inflammatory involution. Non-haemolytic staphylococci and diphtheroids were frequently found in the milk but non-haemolytic staphylococci alone in the tissue and these only on enrichment. A few haemolytic staphylococci were found in the milk on one occasion but this was 17 weeks before slaughter. Macroscopic examination showed a quarter in late lactation, composed of small chrome-coloured lactating lobules, except in the C area of level 1, where the lobules were involuted.

C 13 LF. Fifty per cent. of the lobules in this quarter showed post-inflammatory 16 per cent. normal involution and 8 per cent. mild to moderate acute inflammation in lactating lobules. In addition, 10 per /

per cent. of the duct system was affected with mild sub-acute lesions. There was an acute inflammatory exudate in the ductules of many of the lobules affected with post-inflammatory involution. Non-haemolytic staphylococci were frequently found in the milk of this quarter and they were also obtained from the tissue on enrichment. Macroscopic examination showed a quarter in late lactation, composed of small chrome-coloured lactating lobules, except in the C area of levels 1 and 2, where the lobules were involuted.

C 13 RF. Sixty-six per cent. of the lobules in this quarter showed post-inflammatory involution 27 per cent. normal involution and 7 per cent. mild acute inflammation in lactating lobules. In addition, 75 per cent. of the duct system was affected with mild to moderate sub-acute lesions. There was an acute inflammatory exudate in the ductules of many of the lobules affected with post-inflammatory involution. Non-haemolytic staphylococci were found in the milk on several occasions and they were also isolated from the tissue on enrichment. Diphtheroids occurred in many of the milk samples and a few haemolytic staphylococci in the milk on two occasions, i.e. 21 weeks and 17 weeks /

weeks before slaughter, but these organisms were not obtained from the udder tissue even on enrichment. Macroscopic examination showed a quarter which had undergone involution except for an area of lactating lobules around the gland cistern.

The extent of the lesions in the eleven quarters in this group are given in Table 6. The period during which the cell count was abnormally high and the maximum count recorded are also stated. It will be seen that the extent of post-inflammatory involution in a quarter is related to the maximum cell count obtained. On this basis the quarters fall into two sections, one section of five quarters in which the cell count was always less than 500,000 cells per ml., and a second section of six quarters in which the cell count had risen to over 2,000,000 cells per ml. The first section showed from 6 to 16 per cent. post-inflammatory involution and the second section from 33 per cent. to 66 per cent. post-inflammatory involution.

The extent of acute residual lesions in lactating lobules in these eleven quarters bears no relation to the extent of post-inflammatory involution, to the period during which the cell count was /

TABLE 6

The relationship between extent of lesions, the duration of high cell counts and the maximum cell count of the milk of 11 quarters.

| Quarter | Extent of different types of lesions | | | Duration of high cell counts | Maximum cell count (cells per ml.) |
|-------------------|--------------------------------------|-------|-------|------------------------------|------------------------------------|
| | P.l.l. | Acute | Ducts | | |
| <u>Section 1.</u> | | | | | |
| C 33 LH | 6% | - | - | 2 weeks | 70,000 |
| C 32 RF | 8% | 2% | - | 16 weeks | 370,000 |
| C 4 RH | 15% | 1% | - | 5 weeks | 260,000 |
| C 32 LF | 15% | 2% | 15% | 28 weeks | 300,000 |
| C 36 RF | 16% | 6% | - | 4 weeks | 320,000 |
| <u>Section 2.</u> | | | | | |
| C 4 LH | 33% | 5% | - | 19 weeks | 5,000,000 |
| C 13 LH | 33% | 6% | - | 24 weeks | 3,000,000 |
| C 13 RH | 33% | 33% | 1% | 24 weeks | 3,700,000 |
| C 14 LH | 50% | 1% | - | 12½ weeks | 2,200,000 |
| C 13 LF | 50% | 8% | 10% | 24 weeks | 6,900,000 |
| C 13 RF | 66% | 7% | 75% | 24 weeks | 7,000,000 |

P.l.l. = Post-inflammatory involution.

Acute = Residual mild acute lesions in lactating lobules.

Ducts = Mild to moderate, sub-acute lesions in the walls of the duct system.

was raised or the maximum count obtained. It depends to some extent on the amount of lactating tissue remaining in the quarter. Four quarters which had sub-acute lesions in the duct system had high cell counts over long periods, at least 24 weeks, and so it may be inferred that these lesions were secondary to a prolonged affection of the lobules. This supports the theory that the primary lesions in sub-clinical mastitis occur in the lobules. The eleven quarters in this group in which post-inflammatory involution was the predominant lesion show the importance of this lesion as an indication that there has been an acute inflammatory process in a lobule.

Table 7 shows in tabular form the micro-organisms found in the milk and tissue of the eleven quarters of this group. It will be seen from the table that haemolytic staphylococci were found in the milk of six of the quarters on one or two occasions, but in all instances their numbers were small and they were not obtained in the tissue after slaughter, even on enrichment. Thus they did not appear to be associated with the lesions. Non-haemolytic staphylococci were only found on one occasion in the milk of C 4 LH, but were /

TABLE 7

The different types of micro-organisms found
in the milk and tissue of 11 quarters

| Quarter | <u>Organisms found in the milk</u> | | | <u>Organisms found in the tissue</u> |
|------------------|------------------------------------|-----------------------|--------------|--------------------------------------|
| | Haemolytic staphs | Non-haemolytic staphs | Diphtheroids | Non-haemolytic staphs |
| <u>Section 1</u> | | | | |
| C 33 LH | | + | | |
| C 32 RF | | + | + | + and Str. bovis |
| C 4 RH | + ^x | + | + | |
| C 32 LF | + ^x | + | + | + |
| C 36 RF | | | + | |
| <u>Section 2</u> | | | | |
| C 4 LH | + ^x | + [■] | + | |
| C 13 LH | + ^x | + | + | + |
| C 13 RH | + ^x | + | + | + |
| C 14 LH | | + | | + |
| C 13 LF | | + | + | + |
| C 13 RF | + ^x | + | + | + |

x Never more than four colonies from 0.01ml. of milk, and only found on a few occasions.

■ Only found on one occasion.

were not found in the tissue taken after slaughter and were probably of no importance. However, such organisms were frequently found in the milk of nine other quarters. They were also obtained from the tissue of seven of these but only on enrichment, showing that they were present in the tissue only in small numbers. There is therefore some doubt as to whether these organisms were of importance in this form of mastitis or whether they were merely commensals in the udder.

5. Sub-acute lesions in the ducts associated with trauma

There were three quarters in this group, each with a history that the teat had been tramped on by another animal.

C 37 LH. In this quarter all the duct system showed moderate to severe sub-acute inflammation and 90 per cent. of the lobules post-inflammatory involution with polymorphs present in the interductular tissue in addition to other cells. The remaining 10 per cent. of the lobules, all in Level 3, were lactating and appeared normal except for one in which the acinar epithelium was vacuolated. There was a small nodule at the upper end of the streak canal and the epithelial lining of the teat-cistern was rough. The lining of the /

the gland-cistern and of the major ducts, however, appeared normal macroscopically. According to the history of the animal the teat had been tramped on at the time of calving, sixteen weeks before slaughter, and was not milking freely. A teat bougie was inserted and the quarter treated with "Udolac", a sulphone preparation. A sample of milk was taken from this quarter 6 weeks before slaughter. It contained over 11,000,000 cells per ml., of which 71 per cent. were granular leucocytes. A week later a sample from the same quarter was blood-stained and contained many small clots. The total cell count of this sample was 66,000,000 cells per ml. of which 88 per cent. were granular leucocytes. The count dropped to 25,000,000 per ml. in a sample drawn four weeks before slaughter and 20,000,000 per ml. at three weeks, the proportion of granular leucocytes in both these samples being 84 per cent. The cell counts of samples taken at two weeks and six days before slaughter, and on the day of slaughter were over 3,000,000, almost 4,000,000 and over 6,000,000 cells per ml. respectively, the percentage of granular leucocytes being 71, 47 and 53. The variation in the cell counts may be interpreted in the following manner.

Acute /

Acute lobular mastitis occurred after injury to the teat, and by the time the count had reached 66,000,000 cells per ml. the majority of the lobules in the quarter were affected. The milk yield would by this time be markedly reduced, both by the presence of the acute lesions and by the fact that the quarter had not been milking freely, thus concentrating the cells in the milk. It is also probable that the sub-acute lesions in the ducts had appeared by this time, eleven weeks after the injury, and the cells from these lesions would be added to the milk. As more lobules involuted, reducing the area of acute lesions, the cell count fell. The cells found in the milk on the day of slaughter, over 6,000,000 per ml. of which 53 per cent. were granular leucocytes, must have been derived from the sub-acute lesions in the ducts and from the involuted lobules, as there were no acute lesions in the areas of lactation remaining. The involuted lobules still showed evidence of acute inflammatory exudate. Diphtheroids and atypical streptococci, i.e. streptococci other than Streptococcus agalactiae, Streptococcus dysgalactiae and Streptococcus uberis, were found in the milk samples from this quarter but only on rare occasions and /

and they were not found in the tissue after slaughter so they were probably not associated with the lesions. Non-haemolytic staphylococci, although not present in any of the milk samples, were obtained by direct culture from the tissue, so they may have had some association with the lesions.

C 30 LH. In this quarter 50 per cent. of the duct system showed mild to severe sub-acute inflammation, the remainder being normal. Three per cent. of the lobules showed post-inflammatory involution with an acute exudate in the ducts and 45 per cent. post-inflammatory involution without exudate. Slightly more than 1 per cent. of the lobules showed severe acute inflammation in lactating tissue. The state of lactation of the quarter was 50 per cent. lactating lobules, 50 per cent. involuted, only about two per cent. of the latter being normally involuted. The above figures do not take into account an area of bruising found in the C area between Levels 2 and 3 in which the ducts showed severe sub-acute inflammation and periductal fibrosis and in addition a severe macrophage reaction in involuted lobules. Blood pigment was abundant in this area. The other lesions in the quarter were chiefly in the milk drainage area of the bruise. /

bruise. Level 3 was mainly composed of lactating lobules, which were normal except for a focus of acute inflammation in the D area. Macroscopic examination of the quarter showed evidence of surgical interference to the streak canal. A 1.5mm. nodule was present in the upper part of this canal. The teat-cistern was somewhat shrunken but the epithelial lining appeared normal, as did that of the gland cistern and major ducts. Level 1 was composed of chrome-coloured translucent lobules and Levels 2 and 3 of orange-coloured opaque lobules which protruded very little from the cut surface. An area of chrome-coloured involuted lobules in the B and E areas was histologically normal. The area of bruising between Levels 2 and 3 was observed macroscopically. The history of the quarter was that the teat had been tramped on 12 weeks before slaughter. The streak canal was surgically enlarged by means of McLean's knife 10 weeks before slaughter and about four weeks later the quarter was treated with 14 tubes of penicillin each tube containing 100,000 units of the drug. The cell-count rose to 660,000 cells per ml. a week after the tramping, i.e. just prior to the streak canal being enlarged. Six and a half weeks before /

slaughter, before treatment, a count of nearly 6,000,000 cells per ml. was obtained but, at six weeks, probably during treatment, it had dropped to 1,640,000, of which 82 per cent. were granular leucocytes. From five and a half weeks to two weeks before slaughter cell counts of from 760,000 to 3,500,000 cells per ml. were obtained, the percentage of granular leucocytes remaining around 70. At 12 days the count was 540,000 per ml. 54 per cent. being granular leucocytes, and at ten days 400,000 per ml. 72 per cent. being granular leucocytes. At nine days the cell count rose to 1,300,000 cells per ml., 60 per cent. being granular leucocytes, and at four days the count was 2,200,000 per ml. 76 per cent. being granular leucocytes. The count at two days was similar, but on the day of slaughter it had risen to 6,000,000 of which 60 per cent. were granular leucocytes.

Although this quarter was reported as having a tramped teat, the lesions appear to have followed the bruising of the caudal aspect of the quarter. There was periductal fibrosis in this area, indicating that it was probably the oldest lesion in the quarter. In addition the other lesions found were mainly in its drainage /

drainage area. It is probable that the majority of the 660,000 cells per ml. found a week after the supposed tramping of the teat came from the bruised area, whereas when the cell count had reached 6,000,000 cells per ml., acute lobular mastitis had occurred in the majority of the lobules which were found to be involuted when the quarter was examined after slaughter, and many of the cells found in the milk would be from this area. The fall of the cell count in the subsequent samples would indicate the occurrence of post-inflammatory involution in these lobules. This fall coincided with the treatment with penicillin. The sudden jump in the cell count from 400,000 cells per ml. at ten days before slaughter to 1,300,000 at nine days seems to indicate that the fresh areas had become affected. This may have been when the sub-acute lesions in the duct system became active, because the cell count rose until it reached 6,000,000 on the day of slaughter and the majority of the cells in the latter count must have been derived from the lesions in the ducts. Only about one per cent. of the lobules showed severe acute mastitis in lactating tissue and only three per cent. post-inflammatory involution with acute exudate. There was /

was no acute exudate in association with the remaining 45 per cent. of the lobules which showed post-inflammatory involution. It may be inferred, therefore, that the majority of the 6,000,000 cells per ml., 60 per cent. of these being granular cells, found in the final count were derived from sub-acute lesions in the ducts. From one to three colonies of non-haemolytic staphylococci were found in the plates prepared from the milk on three occasions and one colony of haemolytic Staphylococcus albus was obtained on the plate prepared from the sample taken four days before slaughter. Haemolytic coagulase-positive Staphylococcus aureus was found in the tissue removed from Level 1 on enrichment, and Streptococcus bovis from Level 3 on enrichment. The former organism was probably associated with the lesions.

C 31 RH. The following clinical details refer to this quarter. "There is an indurated core on the posterior aspect of this quarter close to the septum. The teat-orifice is patent and dripping milk. The teat was tramped on and was operated on with McLean's knife and consequently the teat orifice is left more patent than usual." The date on which the teat was tramped is unknown. The cell counts of the milk samples /

samples were below 20,000 cells per ml. from 17 weeks until nine weeks before slaughter, except for a count at 12 weeks of 100,000 cells per ml. At seven weeks before slaughter, however, the cell count was 2,000,000 per ml., and about the same a week later, 87 per cent. of the cells being leucocytes. At five-and-a-half weeks the count was 1,170,000 and at four-and-a-half weeks 1,550,000 of which 67 per cent. were granular leucocytes. At four weeks the count had risen to over 2,500,000, 92 per cent. granular leucocytes, but at three-and-a-half and at two weeks it had dropped to 360,000 and 160,000 cells per ml., 77 and 70 per cent. respectively being granular leucocytes. At two weeks and at one-and-a-half weeks the count rose to 6,000,000 per ml. with 80 per cent. granular leucocytes. The counts at four days and two days were over 3,000,000, 78 and 85 per cent. granular leucocytes and on the day of slaughter 9,000,000, 87 per cent. granular cells.

Macroscopic examination of the quarter showed marked roughening of the epithelial lining of the teat cistern, and in the streak canal evidence of surgical interference. The epithelial lining of the gland cistern and of the major ducts appeared normal.

The /

The lobules were smaller than those in the other three quarters of the udder and did not protrude so much from the cut surface. They measured from 1.0 to 2.0mm. in diameter, except in the C area of Level 1, where they measured 1.0mm. and were fawn and translucent in contrast to the pink opaque lobules elsewhere. There was a small patch, about 3.0cm. in diameter, in the C area above Level 3 where the interlobular ducts contained dry greenish pus. This was in the region where the "indurated core" was felt clinically. Microscopic examination showed sub-acute lesions in the whole of the duct system, mild in most areas, but very severe in the region where the green pus was seen. The lesions were also severe in the C area of Level 3, immediately below this region. Part of the wall of the gland cistern also showed severe sub-acute lesions. Only 8 per cent. of the lobules showed post-inflammatory involution, and these were confined to Level 1 and to the wall of the gland cistern. Severe acute mastitis was found in 25 per cent. of the lobules, scattered more or less evenly throughout the quarter. The state of lactation was about 92 per cent. lactating and 8 per cent. involuted.

The most striking feature of this quarter is the relatively /

relatively small proportion, i.e. 8 per cent. of the lobules showing post-inflammatory involution although very high cell counts had been obtained for seven weeks. It is possible, however, that the high cell count occurred in two stages. The first increase in cell count may have been caused principally by the damage to the teat cistern and the lesion in the upper part of the gland, but the secondary rise in cell count two weeks before slaughter would be due to the development of the more generalised acute lobular mastitis and to the sub-acute lesions in the ducts. It is therefore probable that high cell counts, 2,000,000 or more cells per ml., with a very high percentage of granular cells, 87 per cent. may be caused by relatively small, but very severe lesions.

Atypical streptococci were found frequently in the milk samples from this quarter and haemolytic staphylococci in the last two samples. Haemolytic staphylococci and Streptococcus bovis were obtained from the tissue from all three levels after slaughter, and in one level on direct culture. Thus they may have been associated with the lesions, the haemolytic staphylococci particularly with the terminal lesions.

6. "Blind" quarter.

O 35 RF. /

C 35 RF. The first sample of the milk was received from this quarter 10 weeks before slaughter, i.e. about 7 weeks after calving. It contained less than 10,000 cells per ml. The next sample taken seven weeks before slaughter contained 40,000,000 cells per ml., 90 per cent. being granular leucocytes. No further samples were obtained from this quarter. Macroscopic examination showed a fully involuted quarter mainly composed of dilated ducts filled with straw coloured fluid. The involuted lobules measured less than 0.5mm. in diameter. Only about 3.0cms. of the upper part of the teat cistern was patent, the lower part was obliterated by a core of post-inflammatory fibrosis. The epithelial lining of that part of the teat cistern still patent was rough. Microscopic examination revealed no abnormality of the ducts or lobules.

A severe inflammatory lesion confined to the lower part of the teat cistern, had evidently been responsible for this quarter becoming "blind". The majority of the cells found in the sample taken seven weeks before slaughter were probably derived from this lesion. It is interesting to note that normal involution of the lobules resulted from the suppression of lactation./

lactation. The milk in the quarter had been reabsorbed leaving clear straw-coloured fluid. No organisms were isolated from either sample of milk. Non-haemolytic staphylococci were found in the tissue removed after slaughter, but were probably not associated with such a severe lesion.

High cell counts in quarters normal histologically

Of the 25 quarters, which were found to be normal histologically, only four had cell counts of over 100,000 cells per ml. The quarters, C 14 LF, C 14 RF and C 14 RH, all from the same animal, had cell counts of 450,000, 1,950,000 and 620,000 cells per ml., respectively, in the first samples examined, but these samples were of colostrum taken four days after calving. The percentage of granular leucocytes present was about 36. The counts of the milk from these quarters had dropped to normal in the samples taken eight weeks before slaughter, but rose in subsequent samples, the final counts for the three normal quarters being 320,000, 440,000 and 450,000 cells per ml. with 20, 24 and 30 per cent. granular leucocytes respectively. The animal was a "poor milker" and although it had only been in lactation for about 12 weeks, the process of involution was well advanced. The inference may /

may be drawn that in the course of the shedding of epithelial cells during the process of involution granular leucocytes also escape into the milk. The fact that the animal was a "poor milker" suggests an endocrine upset and for this reason these quarters should not be taken to represent the normal, even though histologically they showed no evidence of inflammatory change.

The quarter C 19 RH, was normal histologically, but had a cell count of 140,000 cells per ml. two weeks before slaughter and 40,000, with 56 per cent. granular cells, one week before slaughter. The final cell count was less than 10,000 cells per ml. This quarter was from the same animal as three of the quarters discussed under Group II of abnormal quarters. The findings in the three abnormal quarters showed that resolution of acute lesions in a quarter could occur leaving only mild focal acute lesions. It is possible that in quarter C 19 RH either the mild acute lesions were present in parts of the quarter not examined, or that complete resolution had occurred.

CELL COUNTS MADE ON SAMPLES TAKEN AFTER
THE JOURNEY TO THE ABATTOIR

In eleven of the heifers it was possible to take
milk /

milk samples after the animal had been transported to the abattoir. The cell content of these samples showed great variation from that in the last samples taken at the farm. In 19 abnormal quarters the total count was raised from twice to 73 times by the journey, the percentage of granular leucocytes was however similar in most cases. In 4 abnormal quarters the count had dropped to one half or one third, and in one it was similar. In eleven normal quarters the count was increased from twice to forty times and in nine it was similar. This great variation may have been due to the taking of milk samples at a different time, i.e. not immediately prior to milking, and to increased sedimentation of cells during the journey. For these reasons the lesions found in the abnormal quarters have been related to the cell counts made on fore-milk taken on the farm immediately prior to normal milking time.

COMPARISON OF THE BACTERIOLOGICAL FINDINGS IN THE NORMAL AND ABNORMAL QUARTERS

Diphtheroid organisms were recovered from the milk of 18 normal and 20 abnormal quarters but never from the tissue. Streptococcus bovis, on the other hand, was never recovered from the milk of any quarter, /

quarter, but was found in the tissue of two normal and six abnormal quarters. Francis (1949) also found that Streptococcus bovis was commonly found on culturing udder tissue, but that it was rarely found in the milk. The explanation of this may be that this organism is present only in the tissue or the bloodstream and not in the milk. It is difficult to explain why diphtheroid organisms so commonly found in the milk were not recovered from the udder tissue, unless they are susceptible to freezing. The examination of the atypical streptococci, found in the milk of two abnormal quarters, was only carried to the point of establishing that they were not "typical mastitis streptococci."

It will be seen from Table 8, that non-haemolytic staphylococci were found in the milk but not in the tissues of seven normal and seven abnormal quarters; in the tissues but not in the milk of six normal and three abnormal quarters, and in both the milk and tissues of six normal and ten abnormal quarters. Haemolytic staphylococci were found in the milk but not in the tissues of six normal and six abnormal quarters; in the tissues but not in the milk of one normal and two abnormal quarters, and in both the milk and /

TABLE 8

The number of normal and abnormal quarters in which haemolytic and non-haemolytic staphylococci were found in the milk or the tissues

| Organisms | Condition of quarter | Number of quarters where organisms found in the milk but not in the tissues ^x | Number of quarters where organisms found in the tissues but not in the milk | Number of quarters where organisms found in both the milk and tissues ^x |
|------------------|----------------------|--|---|--|
| Haem. staphs | Normal | 6 | 1 | 2 |
| | Abnormal | 6 | 2 | 2 |
| Non-haem. staphs | Normal | 7 | 6 | 6 |
| | Abnormal | 7 | 3 | 10 |

^xQuarters are included even although the organisms were found on only one or two occasions in the milk and irrespective of the fact that samples taken later were negative. The Table, therefore, gives no indication of the incidence of the organisms in the milk.

and the tissue of two normal and two abnormal quarters. Except for Streptococcus bovis none of these organisms were found in a markedly greater number of abnormal than normal quarters, suggesting that, though in some instances they may have been associated with the lesions, some other factor is primarily responsible for the occurrence of sub-clinical mastitis.

Organisms were always very scanty, and were never histologically demonstrable.

Only aerobic cultures were made in the present work but in view of the findings of Stuart, Buntain and Langridge (1951) it would be advisable that in any future work anaerobic cultures be made. In addition to Corynebacterium pyogenes they isolated from the secretions of quarters affected with summer mastitis, an anaerobic coccus, a microaerophilic coccus and Streptococcus dysgalactiae. Infusion of a mixture of the four organisms into 38 dry quarters, caused summer mastitis in 33 of them and there was pus in the cisterns of the other five. Infusion of Corynebacterium pyogenes alone caused summer mastitis in only four out of 20 quarters. It would therefore be of value to find out whether either the anaerobic or the microaerophilic organisms occur in the udders of /

of lactating cows and if so whether they have any bearing on sub-clinical mastitis.

for some time. The total cell content of milk has been shown to be a reliable index for diagnosis of sub-clinical mastitis (Malcolm et al. 1946 and Williams et al. 1947). In the present work the differential cell content of milk has been examined to determine the types and proportions of white cells in normal and abnormal milk to correlate these findings with changes occurring in the udder, particularly in the case of early lesions of mastitis, and to assess the value of the differential cell count as a diagnostic method.

THE CELLS IN MILK

There has been considerable difference of opinion as to the significance of the various types of white cells in milk. It is generally agreed that the presence of a large number of white cells in milk is indicative of mastitis. However, the relative importance of the different types of cells has been a matter of controversy. Some workers have considered the total cell count as the most important factor, while others have emphasized the importance of the differential cell count. The present work is concerned with the differential cell count and its value as a diagnostic method.

GENERAL DISCUSSION AND CONCLUSIONS

Early diagnosis of mastitis is essential so that curative measures may be applied before permanent damage occurs in the udder. Before bacteria are recovered from the milk mastitis may have been present for some time. The total cell content of milk has been shown to be a reliable method for diagnosis of sub-clinical mastitis (Malcolm et al. 1944 and McFarlane et al. 1949). In the present work the differential cell content of milk has been examined to determine the types and proportions of different cells in normal and abnormal milk: to correlate these findings with changes occurring in the udder, particularly in the case of early lesions of mastitis, and to assess the value of the differential cell count as a diagnostic method.

THE CELLS IN MILK

There has been considerable difference of opinion as to the significance of the various types of cells in milk, and particularly as to whether they constitute pus or not. Some of the early workers assumed that all the cells in milk were leucocytes or pus cells, and therefore concluded that pus was present in the milk of

75 per cent. of cows in late lactation. Others were of the opinion that leucocytes could occur even in normal milk and thus were of no pathological significance. Even as late as 1947, Zlotnik attempted to account for the presence of the polymorphs found in normal milk by stating that they were degenerated epithelial cells. Varrier-Jones (1924) gave a detailed description of nine types of cells found in milk. One of these, "the large mononuclear leucocyte", was misnamed, as it is evident from his description that it is in reality the unvacuolated epithelial cell, which is present in both normal and abnormal milk. In the present investigation, using a differential method to stain the granular leucocytes, it has been shown that the cells in normal and abnormal milk fall mainly into three groups: granular leucocytes, lymphocytes and epithelial cells. In the majority of samples the proportion of lymphocytes was so low that no attempt was made to determine whether they were of any significance. However, the proportion of granular leucocytes to other cells in the milk has been investigated with heifers and cows in which the stage of lactation was known. In thirteen of these heifers, the udder tissues were later examined post-mortem.

Examination /

Examination of the results obtained shows that the differential cell count as a rule possesses no advantage over the total cell count as a diagnostic method. However, in mastitis-free cows the proportion of granular leucocytes tends to be lower in advanced lactation milk than in mid-lactation, so that where the stage of lactation is unknown and the cell content is high, the differential cell count would be of use in determining whether the high cell count was due to advanced lactation or to mastitis. As has been shown mastitis may exist when no mastitis organisms can be recovered from the milk. On the other hand, mastitis organisms may occasionally be recovered from the milk of normal quarters. Examination of the udders of 13 heifers has shown that if a single cell count of the milk is high and the proportion of granular leucocytes is over 50 per cent., there is an acute inflammatory process in the quarter concerned. If, however, the proportion of granular leucocytes is below 50 per cent., this does not mean that there is no inflammatory process in the quarter concerned. Quarter C 42 RF showed acute inflammation and yet in its later cell counts the percentage of granular leucocytes was low, because the process of post-inflammatory involution was /

was in excess of the production of acute inflammatory exudate. For the differential cell count to be of value for diagnostic purposes, milk samples should be examined at regular intervals for total cell content and proportion of granular cells. The data thus obtained should give a reasonably accurate picture of the changes occurring in the quarter, whether they are of an inflammatory nature or due to involution. In estimating the significance of a single differential cell count, especially one made on late-lactation milk, it is necessary to consider the absolute number of granular leucocytes present as well as their percentage, and also the volume of the milk secreted.

It must be noted that daily variations of milk yield in any particular quarter may influence the number of cells per ml. in the milk, and because of this the figures obtained can only approximate to the truth.

THE TOTAL CELL COUNT AS A DIAGNOSTIC METHOD

The present work confirms the findings of Malcolm and McFarlane that with heifers in mid-lactation persistent cell counts of over 100,000 per ml. are indicative of mastitis but in older cows a rather higher /

higher figure, 200,000 or 250,000 cells per ml., may be a fairer criterion of the presence of the disease in routine diagnostic work. As they suggest, it is advisable to compare the count obtained with the counts of the milk from the other three quarters of the udder. However, where all the quarters show high cell counts and mastitis organisms are absent, the question arises with cows which have been in lactation for six or seven months whether the high cell counts are due to advanced lactation or mastitis in all quarters. Thus when samples from heifer C13 were first examined five months after calving the cell counts were high in all quarters, and therefore the inference might have been drawn that the animal was approaching prematurely the stage of late lactation. Weekly sampling of the milk from this udder, however, showed that the proportion of granular leucocytes in three of the quarters was as a rule over 50 per cent., suggesting that these quarters at least were mastitic. Examination of the udder after slaughter showed mastitis in all four quarters. Heifer C14 also showed persistent high cell counts in the milk of all quarters and the milk yield was low. The animal had only been in lactation for twelve and a half weeks when slaughtered, and thus appeared /

appeared to be in mid-lactation. It might therefore have been concluded that all four quarters were mastitic and that this was responsible for the low yield. However the milk of only one quarter, the left hind, had an abnormally high proportion of granular leucocytes (over 50 per cent.) and this quarter alone showed evidence of mastitis on examination after slaughter. The remaining three quarters were found to be in late lactation.

If the stage of lactation is known, the total cell count of milk is an ideal routine method for the diagnosis of sub-clinical mastitis. The time taken to carry out differential cell counts, - about one hour to stain the smears and an average of three minutes to perform each count, - may limit its use to research programmes. For assessing the progress of lesions in experimental mastitis, and estimating the efficacy of treatment, the differential cell count should be invaluable.

PATHOLOGY

Regular examination of milk samples from 13 heifers has made it possible to study the development of the early lesions of mastitis. The primary lesion takes the form of an acute cellular exudate into the acini /

acini of a lobule. (This earliest lesion of mastitis has recently been described by Spencer and McNutt (1950) in the cow and by Pattison (1951) in the goat.) In quarters in which the cell counts had been raised for more than two weeks a further change was noted. Lobules in various parts of the quarter were found to be involuted, the lobules being larger than those which had undergone normal involution and the interductular tissue was very cellular. In some quarters these lobules showed an acute cellular exudate in the ductules. If these lobules had involuted as result of an acute inflammatory process it would explain the presence of the large numbers of epithelial cells found in the milk samples, because, though the proportion of granular cells found might be high (over 60 per cent.), there was the proportion of epithelial cells to be accounted for, often as many as 50 per cent. of the cells. By this concept of post-inflammatory involution of an inflamed lobule, it is possible to explain the varying proportion of granular leucocytes and epithelial cells in the milk. Theoretically if the milk was examined daily until there was a rise in cell count, the first high-count should have an extremely high proportion of granular cells. /

cells. The affected lobules, however, would commence to involute, and the acinar epithelium would be shed into the milk and the proportion of epithelial cells in the milk thereby increased. As fresh lobules became affected and in turn underwent post-inflammatory involution the total cell count and proportion of cells would fluctuate in consequence. In the three quarters showing severe acute lobular mastitis and post-inflammatory involution the cell counts followed this pattern, though the percentage of granular cells in the preliminary rise was not ascertained. It was possible to show in these quarters that 150,000 granular cells per ml. of the milk represented 4 per cent. of the quarter affected with severe acute lobular mastitis, and also to show that post-inflammatory involution of 4 per cent. of a quarter resulted in a reduction in the cell count by about 200,000 granular cells per ml. Though the figure of between 150,000 and 200,000 granular cells per ml. in the milk may mean that about 4 per cent. of a quarter is affected with severe acute lobular mastitis it does not follow that when large areas of a quarter are affected the number of cells found in the milk will be in direct arithmetical ratio. Two opposing factors will operate:-
the /

the milk yield of the quarter will be reduced thus concentrating the cells, while the blocking of ducts by coagulated milk and exudate will prevent the cells from the areas drained by these ducts from reaching the rest of the milk, and so cause a reduction in the cells present. It is also more probable that when large areas of a quarter are affected with acute lobular mastitis that the ducts may also show lesions, and it is quite evident that lesions in the ducts add a high proportion of granular cells to the milk, as was seen in the three quarters with a history of tramped teats.

In five quarters however, (Group II) post-inflammatory involution had not occurred after an acute inflammatory process in the lobules, as shown by the cell counts. Mild acute lesions only remained, showing that an acute inflammatory process may resolve without the intervention of post-inflammatory involution. It is evident however by the cell counts that a number of epithelial cells were cast and it is probable that involution had proceeded to a limited extent, though this was not recognised microscopically.

That a marked rise in cell count may not occur if the lesions are limited in extent is shown by the four /

four quarters in Group I. In three of these quarters severe acute lobular mastitis was present in one lobule in the tissue examined, and the cell counts of the milk had always been low. This was probably due to the fact that the lesion was very small, and of very recent onset, possibly even since the previous milking. The fourth quarter in this group was different, in that an acute lesion was found in the intralobular tissue of an involuted lobule. It would be unlikely for any cells from such a lesion to find their way into the milk.

The eleven quarters in Group IV emphasise the importance of post-inflammatory involution to indicate that acute lesions have occurred in a quarter. The extent of post-inflammatory involution in a quarter is directly related to the number of cells found in the milk. Six quarters which had cell counts ranging from 2 to 7 million cells per ml. showed 33 to 66 per cent. of the quarter affected with post-inflammatory involution, whereas five quarters which had cell counts of from 70,000 to 370,000 cells per ml. showed only 6 to 16 per cent. of the quarter affected. The duration of high cell counts does not appear to have any bearing on the amount of post-inflammatory involution, but four of the /

the five quarters which had raised cell counts for more than 24 weeks showed sub-acute duct lesions, suggesting that these latter are secondary to a prolonged affection of the lobules. This supports the theory that the primary lesions in sub-clinical mastitis occur in the lobules. The extent of acute residual lesions in lactating lobules bears no relation to the extent of post-inflammatory involution, to the period during which the cell count was raised or to the maximum count obtained. It depends to some extent on the amount of lactating tissue remaining in the quarter.

These quarters with post-inflammatory involution as the predominant lesion stress the economic importance of sub-clinical mastitis, due to the drop in milk yield. The question arises as to whether, if infection is overcome, the lobules which have undergone post-inflammatory involution can evolve into lactating lobules in the next lactation. As there is little if any fibrosis it is probable that this may take place.

The three quarters which had a history of trauma are not strictly cases of sub-clinical mastitis. The findings in the other quarters showing sub-clinical mastitis have, however, been applied to these quarters with /

with a view to explaining the cell counts in relation to the lesions found. In quarter C 37 LH it is probable that acute lobular mastitis occurred after injury to the teat and by the time the cell count had reached 66,000,000 cells per ml. (88 per cent. granular leucocytes) the majority of the lobules in the quarter were affected. The milk yield would by this time be markedly reduced, both by the presence of the acute lesions and by the fact that the quarter had not been milking freely, thus concentrating the cells in the milk. It is probable that the sub-acute lesions found in the ducts had appeared at this time, eleven weeks after the injury, and the cells from these lesions would be added to the milk. On the day of slaughter there were 6,000,000 cells per ml. in the milk only 53 per cent. being granular leucocytes. Ninety per cent. of the lobules showed post-inflammatory involution with acute exudate in the ductules, and there were sub-acute lesions in all the ducts. Thus as lobules had involuted the cell count had dropped. As no acute lesions were found in lactating lobules the cells in the final count must have been derived from the ducts and from involuted lobules.

In /

In quarter C 30 LH, though reported as having a tramped teat, it is possible that the lesions followed the bruising of the caudal aspect of the quarter. This was the oldest lesion found in the quarter and the other lesions found were in its drainage area. The majority of the 660,000 cells per ml. found a week after the supposed tramping of the teat came from the bruised area, whereas when the cell count had reached 6,000,000 cells per ml. acute lobular mastitis had occurred in the majority of the lobules showing post-inflammatory involution after slaughter. The fall of the cell counts in subsequent samples would indicate the occurrence of this process. The terminal rise in cell counts starting nine days before slaughter appears to have been due to the sub-acute lesions in the ducts becoming active. It is therefore evident that large numbers of granular leucocytes - over three and a half million per ml. in the final count made from this quarter - may be derived mainly from sub-acute lesions in the duct system.

The most striking feature of quarter C 31 RH is the relatively small proportion of the lobules showing post-inflammatory involution although high cell counts had been obtained for seven weeks. It is probable that /

that the first increase in the cell count was due to the lesion in the teat cistern caused by the tramping and the small lesion found in the upper part of the gland. It may be inferred that very high cell counts, 2,000,000 in this case, with 87 per cent. granular leucocytes, may be caused by relatively small but very severe lesions. The further rise in cell count to 6,000,000 cells per ml. two weeks before slaughter probably marked the development of the more generalised acute lobular lesions and sub-acute duct lesions.

The "blind" quarter is of interest in that it shows that a severe inflammatory lesion confined to the lower part of the teat cistern can give rise to a cell count of 40,000,000 cells per ml. 90 per cent. of them granular leucocytes.

High cell counts were obtained from only four quarters histologically normal, and three of these were from the same animal found histologically to be in late lactation. It is evident that during the process of involution some granular leucocytes find their way into the milk even to the extent of 30 per cent. of the total cells.

THE PATHOGENESIS OF THE EARLY LESION IN MASTITIS

As stated before the primary lesion of mastitis in
the /

the lactating udder takes the form of an acute cellular exudate into the acini of a lobule. That the lesion appears in a lactating lobule rather than in an involuted lobule, the latter being present in small numbers in the majority of lactating udders, may be explained by chance; the lactating lobules being much more abundant. But to explain why the lesion occurs in a lobule and not in the wall of the duct is more difficult. If the lesion is caused by micro-organisms gaining access to the quarter by way of the streak canal it would have to be based on the greater resistance of the two-layered epithelium of the ducts compared with the single layered epithelium of the acini. But even in this case the infinitely greater internal surface area of the acini of the quarter as compared with that of the ducts might have a bearing. If organisms reached the site of the lesion by way of the bloodstream the explanation is simpler. The capillary bed formed by the intercinar capillaries is very much greater than that of the duct system and by chance alone it would be more probable for organisms to be held up in the former. In quarter C 36 RH, a lactating quarter, the only lesion found was an acute inflammatory focus in the interstitial tissue of a normally /

normally involuted lobule, which points to chance being the determining factor in the site of the primary lesion. In this particular quarter it is difficult to understand how organisms could reach this site by way of the streak canal and the duct system, pointing to an infection by way of the bloodstream.

MACROSCOPIC EXAMINATION OF THE BOVINE UDDER

Study of the duct system of the udder has shown that after primary branching on leaving the gland cistern, the main ducts tend to radiate in straight lines to the borders of the quarter. It is as if there was an attempt during development to grow into as large a space as possible, leaving the intervening spaces to be filled later by outgrowth of ducts of varying size. In a fully lactating udder no space is left unused, single lobules bud out from the walls of the larger and smaller ducts to achieve this full utilization of space. It is convenient to regard each quarter of an udder as an aggregation of lobules.

Macroscopic examination of the udder tissue has shown that it is possible to recognise the state of lactation of a lobule by its size, its amount of protrusion from the cut surface and its degree of opacity. /

opacity. A lobule in full lactation measures 3.0mm. or more in diameter, protrudes markedly from the cut surface, and is opaque, due to the presence of milk in the acini. During the process of involution the size, amount of protrusion and opacity are reduced until in its fully involuted state a lobule measures about 0.5 mm. in diameter, does not protrude at all from the cut surface and is translucent. As a rule the lactating lobule is pink and the involuted lobule fawn, but either may be chrome-coloured.

It has not been found possible to recognise the early lesions of mastitis by macroscopic examination, though comparison of the normal and abnormal quarters of the same udder has occasionally shown a slight colour difference. The process of involution may be more advanced in abnormal quarters than in normal ones.

BACTERIOLOGY

None of the typical mastitis streptococci, coliform bacteria or Corynebacterium pyogenes, were found in the milk or tissues of any of the thirteen heifers which were examined post-mortem. Haemolytic staphylococci were found comparatively rarely in the milk. /

milk. They were obtained from the tissues of four mastitic quarters but, with one exception, only on enrichment. It is possible that they were associated with the lesions in these quarters. On the other hand, they may have been merely commensals in the udder as they were also found in three normal quarters. In 21 of the 27 mastitic quarters, non-haemolytic staphylococci were found only rarely in the milk, but were obtained from the tissues of nine of them, although with one exception on enrichment only. In the other six mastitic quarters these organisms were frequently found in the milk and in four of these quarters they were obtained from the tissues on enrichment. It is therefore possible that they were associated with the lesions in these quarters. However, they may have been merely commensals, as they were found with equal frequency in the milk and tissues of normal quarters.

SUMMARY

Using a differential staining technique, total and differential cell counts were carried out on more than 5,000 milk samples. A bacteriological examination of the samples was also made. In 1,710 of the samples the stage of lactation of the cows was known. Pathological and bacteriological examinations were made on the udders of 13 of the heifers, from which milk samples had been examined at regular intervals.

The following is a brief list of the main findings.

1. The majority of cells in both normal and abnormal milk fall into three groups:- a. granular leucocytes, b. lymphocytes and c. epithelial cells.
2. In the diagnosis of mastitis the total and differential cell counts combined showed no marked advantage over the total cell count alone, except when the milk came from cows in late lactation.
3. A rise in cell count with a high proportion of granular leucocytes in the milk, was invariably associated with acute mastitis as shown by pathological examination of the quarter. Acute mastitis may however exist if the proportion of granular leucocytes is low.
4. The presence of 150,000 to 200,000 granular leucocytes /

leucocytes per ml. in the milk was found to correlate with the fact that about 4 per cent. of the lobules of the mammary tissue were affected with acute mastitis.

5. The earliest lesion of mastitis in a lactating udder consists of an acute cellular exudate into the acini of a lactating lobule. As a rule an acute lesion causes the affected lobule to involute.

6. A lobule which has undergone post-inflammatory involution may be differentiated from one which has involuted normally by the cellularity of its intra-lobular tissue.

7. The occurrence of post-inflammatory involution indicates that acute lesions have existed in a quarter. Lesions in the ducts appear to be, as a rule, secondary to lesions in the lobules.

8. Of the 52 quarters of the 13 heifers examined post-mortem 25 were normal and 27 abnormal. Only 4 quarters found to be normal had cell counts of over 100,000 per ml. and in three of these the proportion of granular leucocytes was under 30 per cent. This shows that during normal involution these cells may escape into the milk up to a proportion of 30 per cent. of the cells present.

9. The micro-organisms found in the milk ante-mortem and in the tissues post-mortem of the 52 quarters examined /

examined were haemolytic staphylococci, non-haemolytic staphylococci, atypical streptococci, Streptococcus bovis and diphtheroids. Except for Streptococcus bovis there was little or no difference in the incidence of the various organisms in the normal and abnormal quarters. With the exception of haemolytic staphylococci, none of the typical mastitis organisms were obtained from the milk or the tissues.

Evidence is presented to show that infection of the udder by way of the blood stream is probable.

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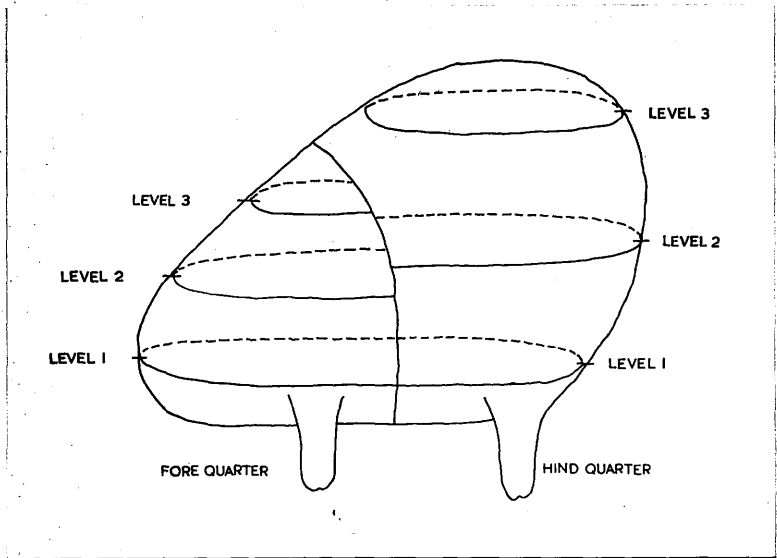


Fig. 1. Diagram of lateral surface of half an udder showing the levels in the fore and hind quarters from which representative slices were taken.

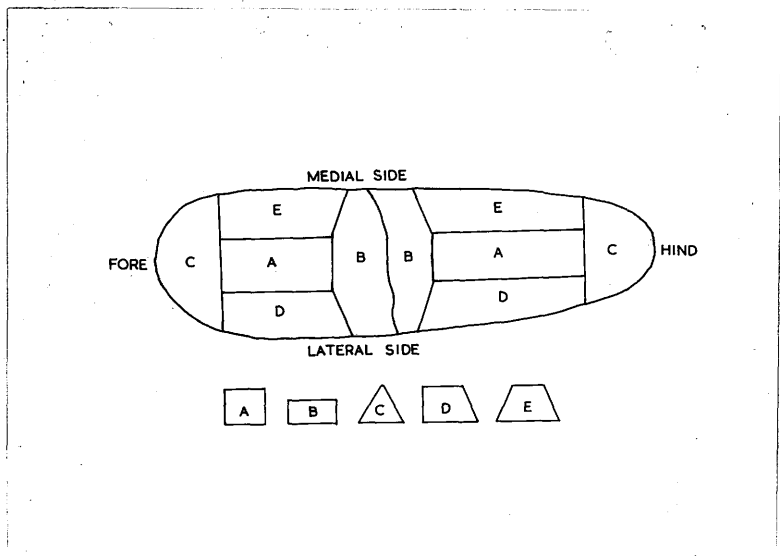


Fig. 2. Diagram of a slice of udder showing the areas described by the letters A to E. The shape of the blocks of tissue taken from these areas is shown below.

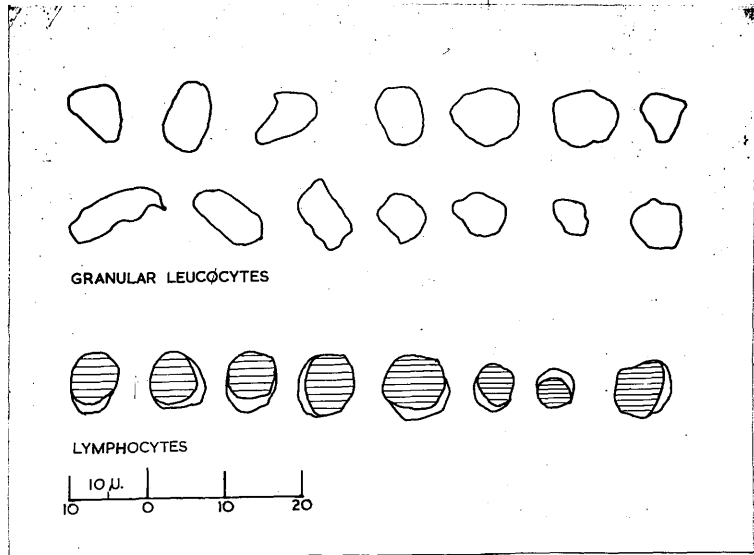


Fig. 3. Camera lucida drawings of granular leucocytes and lymphocytes, as seen in a Prescott and Breed smear of milk treated with formaldehyde.

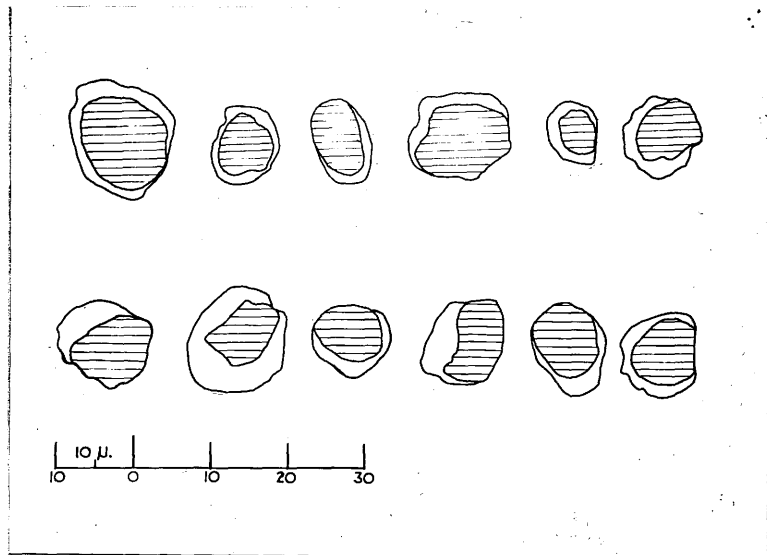


Fig. 4. Camera lucida drawings of large nucleated epithelial cells as seen in a Prescott and Breed smear of milk treated with formaldehyde.

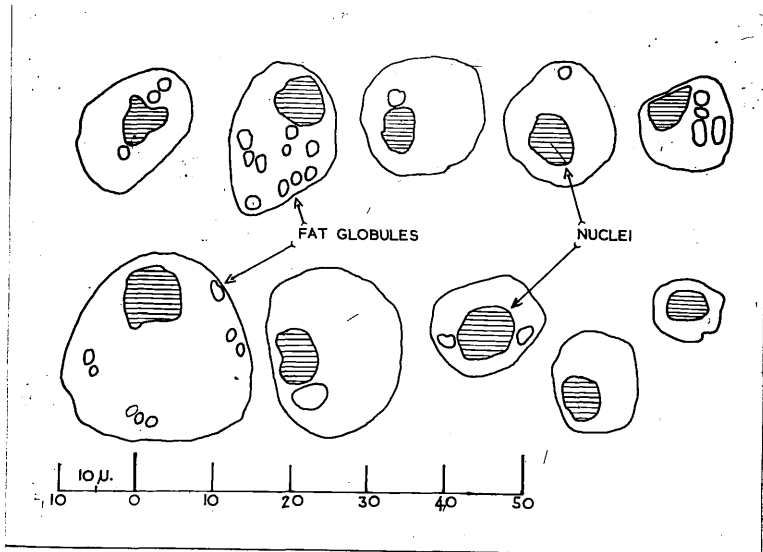


Fig. 5. Camera lucida drawings of large epithelial cells with vacuolated cytoplasm.

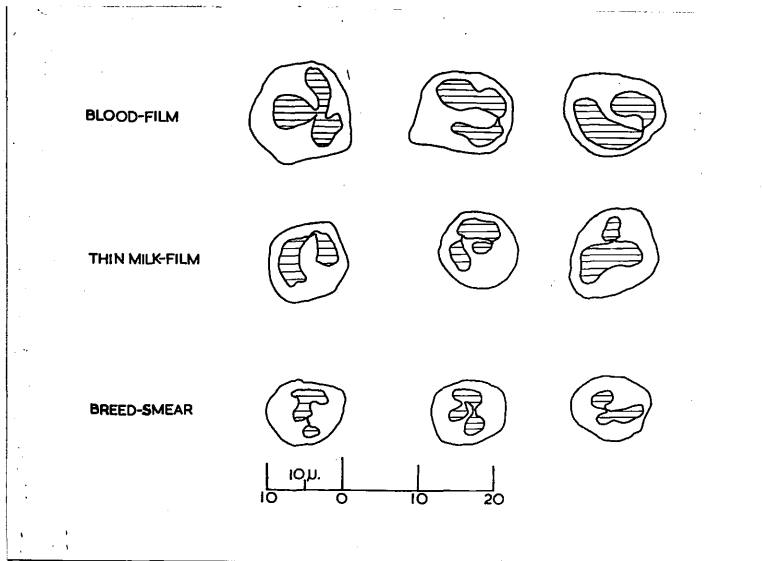


Fig. 6. Camera lucida drawings showing the difference in size of granular leucocytes in blood films, thin milk-smears and Prescott and Breed smears. The milk smears were prepared from unformalised milk.

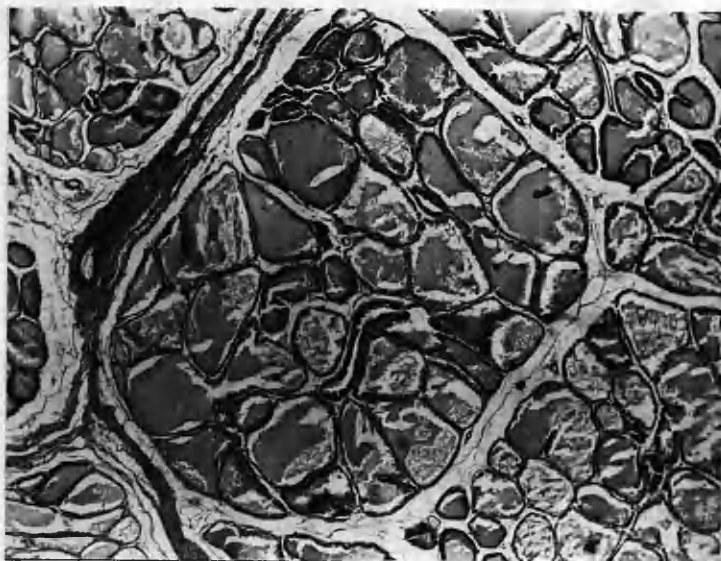


Fig. 7. Photomicrograph of a lobule in full lactation.
(C14 RF, level 2, A.) H & E x 45.

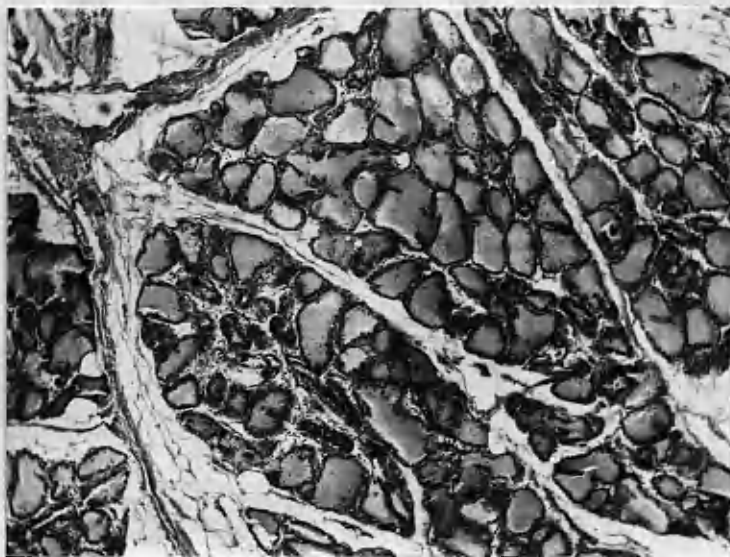


Fig. 8. Photomicrograph of lactating lobules.
(C30 RF, level 2, D.) H & E x 45.

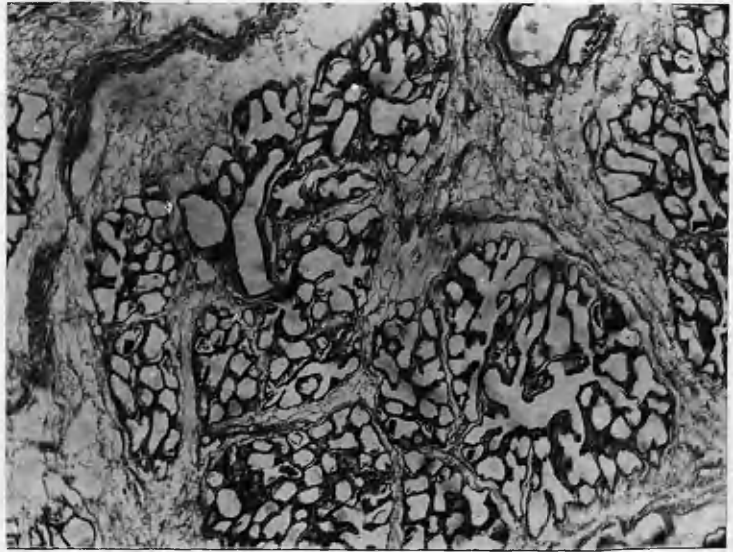


Fig. 9. Photomicrograph of partially involuted lobules.
(C19 LH, level 3, E.) H & E x 45.



Fig. 10. Photomicrograph of involuted lobules.
(C13 LF, level 3, C.) H & E x 45.

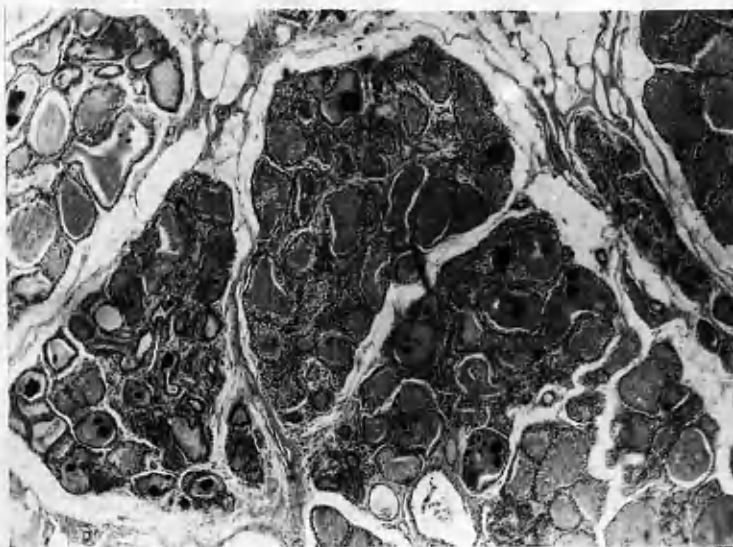


Fig. 11. Photomicrograph of lactating lobules with vacuolated acinar epithelium. Corpora amylacea are present in some acini. (C17 RF, level 3, E.) H & E x 45.

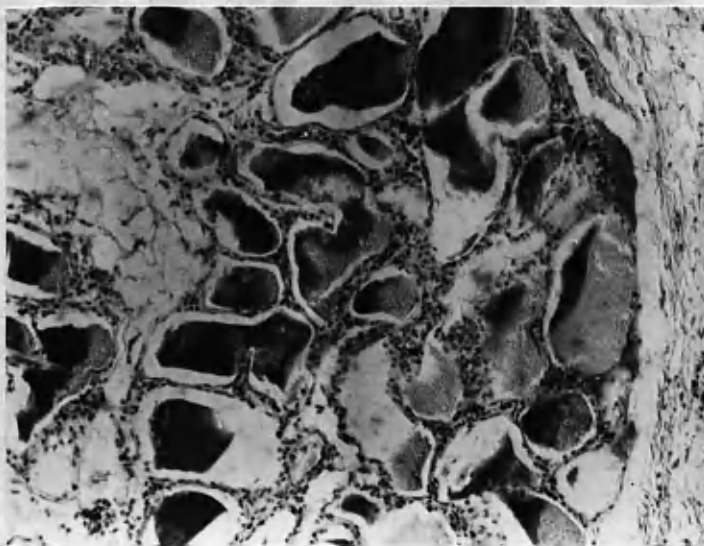


Fig. 12. Photomicrograph of mild acute inflammation in a lactating lobule. (C19 LF, level 2, E.) H & E x 155.

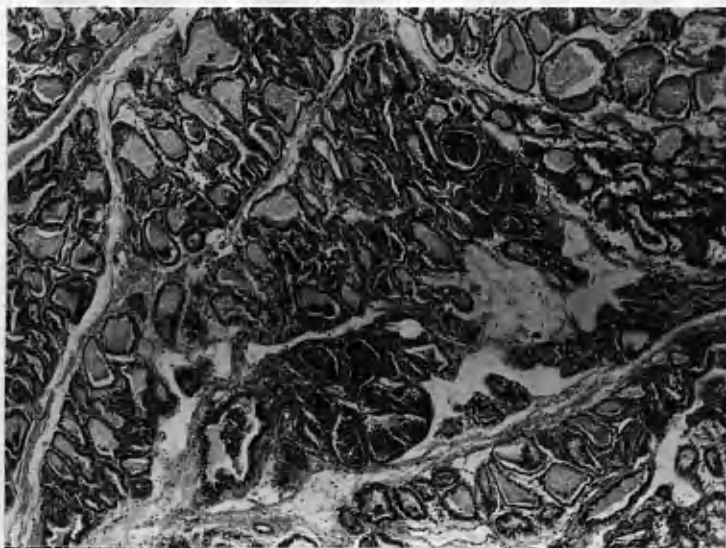


Fig. 13. Photomicrograph of severe inflammation in lactating lobules. (C31 RH, level 1, A.) H & E x 56.

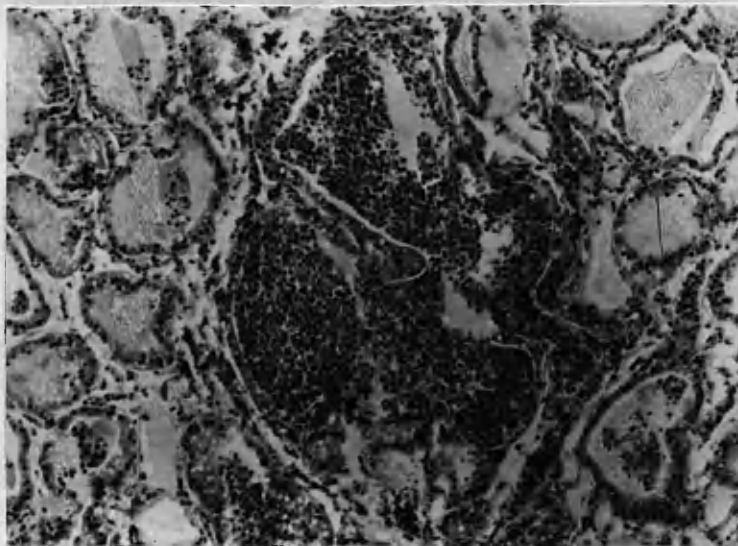


Fig. 14. Photomicrograph of severe acute inflammation in a lactating lobule. (C31 RH, level 3, D.) H & E x 155.

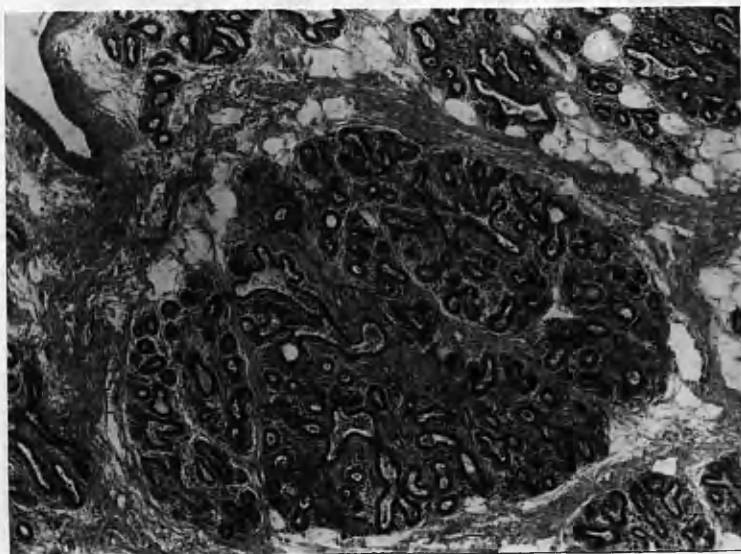


Fig. 15. Photomicrograph of post-inflammatory involution of a lobule with acute inflammatory exudate in the ductules. (Compare with Fig. 10.) (C13 LF, level 1,C.) H & E x 45.

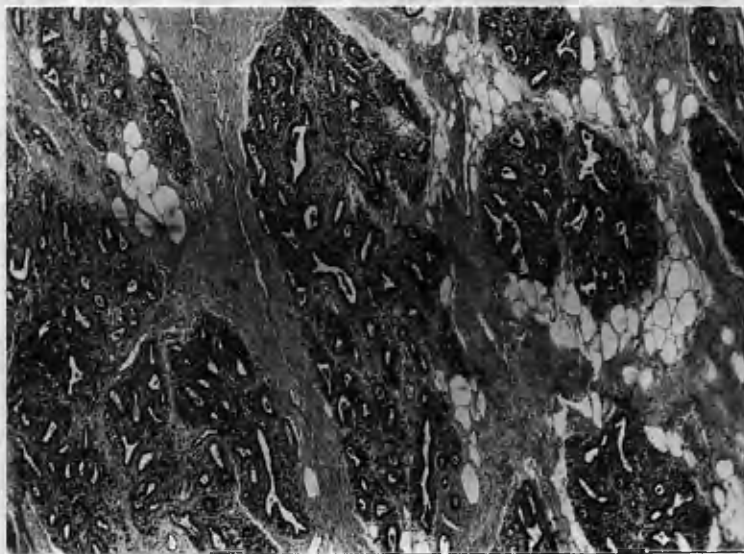


Fig. 16. Photomicrograph of post-inflammatory involution. (C37 LH, level 2, A.) H & E x 45.

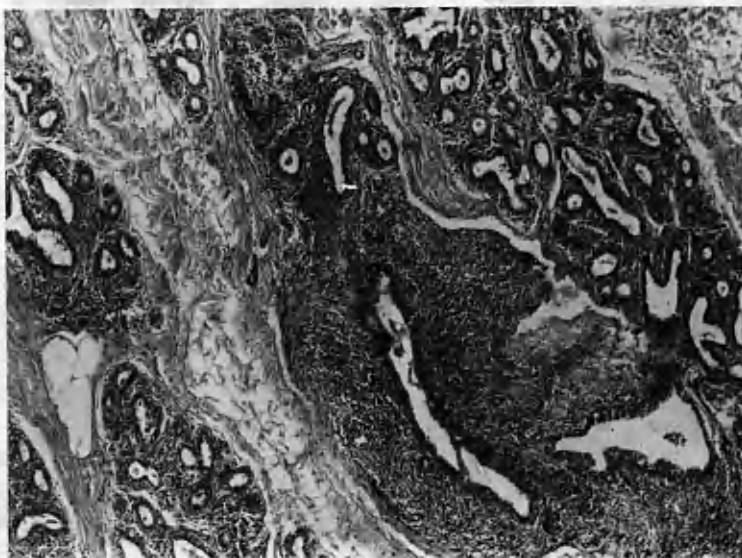


Fig. 17. Photomicrograph of a duct showing severe sub-acute inflammation.
(C30 LH, level 1, C.) H & E x 65.



Fig. 18. Photomicrograph of a duct showing severe sub-acute inflammation, with vacuolation of the epithelium.
(C30 LH, level 1, C.) H & E x 65.

APPENDIX.

In 1942 Malcolm and Smillie (unpublished) carried out an investigation with the view to standardising the technique for estimating the total cell content of milk by the Prescott and Breed's smear method. They examined three factors which they thought were chiefly responsible for the variation in the counts obtained by this method:-

- (1) variation in the measurement of the milk used in preparing the smears, (2) errors in the counting of the cells due to the personal factor and (3) uneven distribution of the cells in the milk and in the dried smear.

The following is a summary of the results obtained by them.

- (1) When cell counts were made by the Prescott and Breed's smear method, there was no significant variation in count according to whether the milk was measured by a graduated pipette or a standard size of platinum loop.
- (2) The method was found to be capable of being standardised so that it could be consistently applied by experienced workers at different laboratories; the difference in counts which occurred were no greater than could be ascribed to ordinary random error.

- (3) The close agreement obtained between the counts of duplicate samples of milk tested in the different laboratories indicated that by the procedure employed the cells were evenly distributed in the samples and in the smears made from them.
- (4) Except in threshold cases (about 500,000 cells per ml.), counts in 30 fields were sufficiently accurate, while for very low or very high counts, counts in 15 fields were sufficient.

BOVINE MASTITIS

THE DIFFERENTIAL CELL CONTENT
OF MILK IN RELATION TO
SUB-CLINICAL MASTITIS

A Thesis submitted to the University of
Glasgow for the Degree of Doctor of
Philosophy in the Faculty of Science

by

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September, 1952.

The Pathology Department,
The Western Infirmary,
Glasgow.

Volume II.

**Protocols of the examination
of the milk and udder tissue
of thirteen heifers.**

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Introduction.

In order to supplement the résumés of each quarter given in the text, full details are given in this volume. After a summary of the main features of each quarter as full a history of the animal as could be obtained is given. This is followed by the detailed findings in each quarter in turn, under the headings left forequarter, left hindquarter, right forequarter and right hindquarter. After these headings is given the letter and figures used to refer to the particular quarter in the text. The findings in each quarter are arranged under four headings; 1. Examination of the milk, 2. Macroscopic examination of the sliced tissues, 3. Microscopic examination, and 4. Post-mortem cultures of the tissues.

Under the heading Examination of the milk there are six columns. In the first is given the number of weeks before slaughter the sample of milk was taken, in the second the total cell count made by the Bacteriology Department of the West of Scotland Agricultural College (Lab. 1.), and in the third column that made in this laboratory (Lab. 2.). The percentage of granular leucocytes is given in the fourth column. A differential count was only carried out on samples received in this laboratory, and then as a rule on those with more than 50,000 cells per ml. The results

of the bacteriological examination are given in the next column and are designated as follows:-

Neg. = no typical mastitis organisms were found in samples examined only for their presence or absence.

Sterile = no organisms were found in samples in which a full examination was made.

Organisms are named and prefixed by a numeral indicating the number of colonies grown from 0.01 ml. of milk.

Staphylococci are denoted as "Staph" and are qualified as h. (haemolytic), n h. (non-haemolytic) and c+ (coagulase positive).

Many milk samples were tested for electrical conductivity by means of the Rapid Abnormality Meter, and the meter readings are given in the last column.

The levels and areas mentioned under the heading Macroscopic examination of the sliced tissue are those shown in figures 1 and 2. Lobules described as lactating were soft, opaque and pink, and those described as involuted were firm, translucent and fawn unless otherwise stated. Under the heading Conclusion is given the conclusion as to the state of lactation of the quarter and whether it appeared normal from macroscopic examination alone.

Under the heading Microscopic examination each block of tissue taken from the quarter is described. The fraction prefixed is the area in sixteenths of the

section referred to by the description. In the summary the extent of the various lesions and the state of lactation are brought together as a percentage of the whole quarter. The organisms recovered from the tissues are given under the heading Post-mortem cultures of the tissues. The abbreviations used are the same as for the organisms found in the milk.

Animal No. C4.

Summary of the main features of each quarter of the udder

C4 LF. Normal.

C4 LH. Post-inflammatory involution.

C4 RF. Normal.

C4 RH. Post-inflammatory involution.

Animal No. C4.

Ayrshire heifer, Auchincruive No. 29. Calved 25/8/48; slaughtered 24/1/49, 22 weeks after calving. Udder frozen 24/1/49 and examined 25/1/49.

C4, left forequarter, (C4 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (Thousands per ml.) | | Percentage of granular cells | Micro- organisms present. | Electrical Conductivity (x 10 ⁻⁴ mhos) |
|------------------------------|---|--------|---------------------------------------|---------------------------------|---|
| | Lab. 1 | Lab. 2 | | | |
| 19 | 20 | | | neg. | 40 |
| 18 | under 10 | | | neg. | |
| 17 | 50 | | | neg. | 40 |
| 16 | under 10 | | | neg. | 39 |
| 14 | 40 | | | neg. | 40 |
| 6 | 30 | | | neg. | 42 |
| 5 | 30 | | | 1 diphtheroid | 42 |
| 4 | 20 | | | neg. | 39 |
| 3 | 20 | | | neg. | |
| 1½ | 10 | 10 | | sterile | 42 |
| 4 days | 50 | 40 | 40 | sterile | 39 |
| 1 day | 20 | | | 2 diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 130,000 cells per ml., 20 per cent. being granular cells.

Macroscopic examination.

Teat cistern - shallow pockets in wall.

Gland cistern - very small; lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 1.5mm. in diameter.
Area C - involuted; lobules 0.5mm. in diameter.

C4 LF (contd.).

Level 2. - Areas A, B, D and E - lactating; lobules 1.5mm. in diameter.

Area C - involuted; lobules 0.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 1.5mm. in diameter.

Conclusion.- This quarter was apparently normal and in process of involution.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|---|
| Gland cistern. | 16/16 normal | 16/16 lactating; normal. |
| Level 1. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 involuted; normal; perivascular aggregation of lymphocytes in one lobule. |
| D. | 16/16 normal | 10/16 lactating; normal 6/16 involuted; normal; perivascular aggregation of lymphocytes in one lobule. |
| E. | 16/16 normal | 10/16 lactating; normal 6/16 involuted; normal |
| Level 2. - A. | 16/16 normal | 16/16 partially involuted; normal; much interlobular fat present. |
| C. | 16/16 normal | 16/16 involuted; normal; much interlobular fat present. |
| D. | 16/16 normal | 14/16 lactating; normal 2/16 involuted; normal. |
| E. | 16/16 normal | 14/16 full lactation; normal 2/16 involuted; normal. |

C4, left hindquarter, (C4, LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (Thousands per ml.) | | Percentage of granular cells | Micro- organisms present. | Electrical Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|--------|---------------------------------------|---|--|
| | Lab. 1 | Lab. 2 | | | |
| 19 | 110 | | | neg. | 43 |
| 18 | 10 | | | neg. | |
| 17 | 210 | | | neg. | 41 |
| 16 | 100 | | | neg. | 41 |
| 14 | 520 | | | neg. | 45 |
| 6 | 5,000 | | | neg. | 62 |
| 5 | 1,100 | | | 4 diphtheroids | 65 |
| 4 | 500 | | | neg. | 66 |
| 3 | 380 | | | neg. | |
| 1½ | 880 | 450 | 50 | sterile | 69 |
| 4 days | 1,080 | 670 | 31 | 2 n h staph citreus, 4 diphtheroids | 64 |
| 1 day | 550 | | | 1 diphtheroid | |

A sample taken after the animal had been transported to the abattoir showed 1,110,000 cells per ml., 29 per cent. being granular cells.

Macroscopic examination.

Streak canal - upper part narrower than lower part;
fibrous band around upper part.

Teat cistern - shallow pockets in wall; lobules in upper part.

Gland cistern- very small; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 1.5 mm. in diameter.

Areas C and D - involuted; lobules 0.5mm. in diameter.

Level 2. - Areas A and E - lactating; lobules 1.5mm. in diameter.

Areas B, C and D - involuted; lobules 0.5mm. in diameter.

C4, LH (Contd.).

Level 3. - Areas A and D - lactating; lobules 1.5mm. in diameter.

Areas B, C and E - involuted; lobules 0.5mm. in diameter.

Conclusion:-

This quarter was apparently normal and in process of involution, but the involution was more advanced than in the other three quarters.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|--|
| Gland cistern. | 16/16 normal | 16/16 involuted; post-inflammatory involution. |
| Level 1. - A. | 16/16 normal | 15/16 lactating; normal 1/16 involuted; post-inflammatory involution. |
| B. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 8/16 involuted; normal 8/16 involuted; post-inflammatory involution. |
| D. | 16/16 normal | 8/16 involuted; normal 8/16 involuted; post-inflammatory involution. |
| E. | 16/16 normal | 8/16 lactating; normal 2/16 lactating; suppressed; mild acute. 3/16 involuted; normal 3/16 involuted; post-inflammatory involution. |
| Level 2. - A. | 16/16 normal | 8/16 lactating; normal 2/16 lactating; suppressed; mild acute. 3/16 involuted; normal 3/16 involuted; post-inflammatory involution. |

C4, LH (Contd.).

| | Ducts. | Lobules. |
|----------------|--------------|--|
| Level 2. - B. | 16/16 normal | 8/16 lactating; normal 1/16 partially involuted; suppressed; mild acute. 3/16 involuted; normal 4/16 involuted; post-in- :flammatory involution with polymorphs in some ductules. |
| C. | 16/16 normal | 1/16 lactating; normal 15/16 involuted; post-in- :flammatory involution. |
| D. | 16/16 normal | 5/16 lactating; normal 1/16 lactating; mild acute 4/16 involuted; normal 6/16 involuted; post-in- :flammatory involution. |
| E. | 16/16 normal | 3/16 lactating; normal 2/16 partially involuted; suppressed; mild acute 4/16 involuted; normal 7/16 involuted; post-in- :flammatory involution. |
| Level 3. -A.1. | 16/16 normal | 14/16 lactating; normal 2/16 involuted; normal; perivascular aggregation of lymphocytes in one lobule. |
| A.2. | 16/16 normal | 12/16 lactating; normal 2/16 involuted; normal 2/16 involuted; post-in- :flammatory involution. |
| B. | 16/16 normal | 2/16 lactating; suppressed; mild acute. 14/16 involuted; post-in- :flammatroy involution. |
| C. | 16/16 normal | 16/16 involuted; post-in- :flammatory involution. |
| D.1. | 16/16 normal | 15/16 lactating; normal. 1/16 involuted; normal. |

C4, LH (Contd.).

| | Ducts. | Lobules. |
|-----------------|--------------|--|
| Level 3. - D.2. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 10/16 lactating; normal 2/16 partially involuted; suppressed; mild acute 4/16 involuted; post-in- :flammatory involution. |

Supramammary lymph node - no abnormality seen.

Summary.

Ducts normal throughout.

Lobules, 48% lactating; normal
14% involuted; normal
33% post-inflammatory involution.
5% lactating; suppressed with vacuolated
epithelial cells; mild acute.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|------------------------------------|--------------------------|---|--|
| Level 1 | Sterile | Sterile | Strep. bovis. |
| Level 2 | Sterile | Sterile | Sterile. |
| Level 3 | Sterile | Sterile | Sterile. |
| Supra- mammary lymph node | Sterile | Sterile | Strep. bovis. |

C4, right forequarter, (C4, RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro- organisms present. | Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|---------------------------------|--|
| | Lab. 1 | Lab. 2 | | | |
| 19 | 10 | | | neg. | 40 |
| 18 | 30 | | | neg. | |
| 17 under | 10 | | | neg. | 39 |
| 16 under | 10 | | | neg. | 39 |
| 14 | 20 | | | neg. | 38 |
| 6 | 50 | | | neg. | 43 |
| 5 under | 10 | | | 1 Staph. albus | 41 |
| 4 | 20 | | | neg. | 43 |
| 3 under | 10 | | | neg. | |
| 1½ under | 10 | under 10 | | neg. | 41 |
| 4 days | 10 | 10 | | 1 n h Staph albus | 43 |
| | | | | 1 n h Staph aureus | |
| 1 day | 10 | | | 8 diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 370,000 cells per ml., 28 per cent. being granular cells.

Macroscopic examination.

Teat cistern - shallow pockets in wall; lobules in upper part.

Gland cistern - small: lobules in wall.

Level 1. - Areas A and B - lactating; lobules 1.5mm. in diameter.

Areas C, D and E - involuted; lobules 0.5mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 1.5mm. in diameter.

Area C - involuted; lobules 0.5mm. in diameter.

C4, RF (Contd.).

Level 3. - Areas A, B, C, D and E - lactating; lobules 1.5mm. in diameter.

Conclusion.-

This quarter was normal and in process of involution.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|---|
| Gland cistern. | 16/16 normal | 16/16 lactating; normal |
| Level 1. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 involuted; normal |
| D. | 16/16 normal | 14/16 full lactation; normal 2/16 involuted; normal |
| E. | 16/16 normal | 14/16 full lactation; normal 2/16 involuted; normal |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 8/16 lactating; normal 8/16 involuted; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 13/16 full lactation; normal 3/16 involuted; normal |
| Level 3. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 partially involuted; normal; focus of round cells around a large pink staining body. |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 16/16 full lactation; normal |

Summary.

Ducts normal throughout.

Lobules normal throughout, 76% lactating
8% partially involuted
16% involuted.

G4, RF (Contd.).

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|---------|--------------------------|---|--|
| Level 1 | Sterile | Strep. bovis | Sterile |
| Level 2 | Sterile | Strep. bovis | Sterile |
| Level 3 | n h staph | n h Staph | Sterile |

C4, right hindquarter, (C4, RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells | Micro- organisms present | Electrical Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|--------|---------------------------------------|---|--|
| | Lab. 1 | Lab. 2 | | | |
| 19 | 190 | | | neg. | 43 |
| 18 | 30 | | | neg. | |
| 17 | 90 | | | neg. | 40 |
| 16 | 140 | | | neg. | 41 |
| 14 | 260 | | | neg. | 40 |
| 6 | under 10 | | | neg. | 44 |
| 5 | 20 | | | 3 n h Staph albus 2 h. staphs | 42 |
| 4 | 40 | | | neg. | 42 |
| 3 | 10 | | | neg. | |
| 1½ | 90 | 30 | 10 | Sterile | 44 |
| 4 days | 30 | 10 | 55 | 1 n h Staph albus 2 h. Staph albus 4 diphtheroids | 43 |
| 1 day | 50 | | | | |

A sample taken after the animal had been transported to the abattoir showed 620,000 cells per ml., 28 per cent. being granular cells.

Macroscopic examination.

Teat cistern - shallow pockets in wall; lobules in upper part.

Gland cistern - small; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 1.5mm. in diameter.

Areas C and D - involuted; lobules 0.5mm. in diameter.

G4, RH (Contd.).

Level 2. - Areas A, B and E - lactating; lobules in 1.5mm. in diameter.

Areas C and D - involuted; lobules 0.5mm. in diameter.

Level 3. - Areas A, B, D and E - lactating; lobules 1.5mm. in diameter.

Area C - involuted; lobules 0.5mm. in diameter.

Conclusion:-

This quarter was apparently normal and in process of involution.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|---|
| Gland cistern. | 16/16 normal | 12/16 involuted; normal 4/16 involuted; post-inflammatory involution |
| Level 1. - A. | 16/16 normal. | 16/16 full lactation; normal |
| C. | 16/16 normal | 6/16 lactating; normal 6/16 involuted; normal 4/16 involuted; post-inflammatory involution |
| D. | 16/16 normal | 6/16 lactating; normal 5/16 involuted; normal 5/16 involuted; post-inflammatory involution. |
| E. | 16/16 normal | 15/16 full lactation; normal 1/16 involuted; normal |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 4/16 lactating; normal 8/16 involuted; normal 4/16 involuted; post-inflammatory involution. |

C4, RH (Contd.).

| | Ducts. | | Lobules |
|---------------|--------------|-------|---|
| Level 2. - D. | 16/16 normal | 16/16 | lactating; normal |
| E. | 16/16 normal | 12/16 | lactating; normal |
| | | 2/16 | lactating; suppressed; mild acute. |
| | | 2/16 | involuted; normal |
| Level 3. - A. | 16/16 normal | 12/16 | lactating; normal |
| | | 3/16 | involuted; normal |
| | | 1/16 | involuted; post-in- :flammmatory involution. |
| C. | 16/16 normal | 4/16 | involuted; normal |
| | | 12/16 | involuted; post-in- :flammmatory involution. |
| D. | 16/16 normal | 16/16 | lactating; normal |
| E. | 16/16 normal | 13/16 | lactating; normal |
| | | 3/16 | involuted; normal |

Supramammary lymph node. - no abnormality seen.

Summary.

Ducts normal throughout.

Lobules, 65% lactating; normal
 20% involuted; normal
 14% post-inflammatory involution.
 1% lactating; suppressed with vacuolated
 epithelial cells; mild acute.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|-----------------------------------|--------------------------|---|--|
| Level 1 | Sterile | Sterile | Sterile |
| Level 2 | Sterile | Sterile | Sterile |
| Level 3 | Sterile | Sterile | Sterile |
| Supra mammary lymph node | Sterile | Sterile | Sterile |

Animal No. C13.

Summary of the main features of each quarter of the udder.

- C13 LF. Post-inflammatory involution
and sub-acute duct lesions.
- C13 LH. Post-inflammatory involution.
- C13 RF. Post-inflammatory involution
and sub-acute duct lesions.
- C13 RH. Post-inflammatory involution
and sub-acute duct lesions.

Animal No. C13.

Ayrshire heifer, Basket No. 64. Calved 10/1/49; slaughtered 30/11/49; 46 weeks after calving; udder frozen 30/11/49 and examined 1/12/49. Never treated for mastitis.

Daily milk yields - 6/6/49, 25.5 lbs.
 13/6/49, 19.5 lbs.
 25/7/49, 17.5 lbs.
 22/8/49, 12.0 lbs.

C13, left forequarter, (C13 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical Conductivity. (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|--|---|
| | Lab.1 | Lab.2 | | | |
| 24 | 480 | 880 | 52 | Sterile | |
| 21 | 1,680 | 2,880 | 59 | 70 diphtheroids | |
| 20 | 3,800 | 3,800 | 59 | 35 n h Staph. albus, 30 diphtheroids | |
| 18 | 1,940 | 770 | 58 | neg. | |
| 17 | 5,500 | 1,600 | 63 | 1 n h Staph. aureus, 21 diphtheroids | |
| 16 | 550 | 1,200 | 47 | 7 n h Staph. aureus, 25 diphtheroids | |
| 15 | 2,700 | 960 | 23 | 12 diphtheroids | |
| 14 | 1,060 | 1,000 | 40 | neg. | |
| 13 | 3,840 | 4,000 | 66 | 4 n h Staph. albus | |
| 12 | 1,270 | 2,000 | 39 | 2 n h Staph. albus | |
| 11 | 2,070 | 1,140 | 24 | Num. n h Staph. aureus | |
| 10 | 1,220 | 940 | 40 | Num. n h Staph. aureus | |
| 9 | 1,560 | 1,410 | 28 | neg. | |
| 8 | 600 | | | Sterile | |
| 7 | 180 | | | 3 n h Staph. aureus, 1 diphtheroid | |

(C13 LF). Contd.

Examination of the milk, (contd.)

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- Organisms present. | Electrical Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|--|--|
| | Lab.1 | Lab.2 | | | |
| 5 | 1,980 | | | 1 n h Staph. aureus, 8 diphtheroids | |
| 4 | 1,950 | | | Sterile | |
| 3 | 1,720 | | | 40 diphtheroids | |
| 2 | 5,800 | | | 11 diphtheroids | |
| 9 days | 2,910 | | | 1 n h Staph. aureus, 16 diphtheroids | |
| 2 days | 6,900 | | | 15 diphtheroids | |

α 5 months after calving.

A sample taken after the animal had been transported to the abattoir showed 14,000,000 cells per ml., 59 per cent. being granular cells.

Macroscopic examination.

Teat cistern - Shallow pockets in wall; no lobules.

Gland cistern - Very large; no lobules.

Level 1. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter, chrome-coloured; protruding very little from the cut surface.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter, chrome-coloured, protruding very little from the cut surface.

Area C - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter; chrome-coloured; protruding very little from the cut surface.

Conclusion. - A quarter in late lactation.

(C13 LF). Contd.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--|---|
| Gland cistern. | 16/16 normal | 16/16 involuted; post-in: -flammatory involution; polymorph exudation into many ductules. |
| Level 1. - C. | 16/16 normal | 12/16 involuted; normal 4/16 involuted; post-in: -flammatory involution; polymorph exudation into many ductules. |
| D. | 10/16 normal 6/16 mild focal sub- :acute | 14/16 involuted; post-in- :flammatory involution; polymorph exudation into many ductules. 2/16 lactating; normal. |
| E. | 11/16 normal 5/16 mild focal sub- :acute | 15/16 involuted; post-in- :flammatory involution; polymorph exudation into many ductules. 1/16 lactating; mild acute. |
| Level 2. - A. | 16/16 normal | 15/16 lactating; normal 1/16 lactating; mild acute. |
| C. | 10/16 normal 6/16 mild focal sub- :acute | 14/16 involuted; post-in- :flammatory involution; polymorph exudation into many ductules. 2/16 lactating; mild focal acute. |
| D. | 12/16 normal 4/16 mild focal sub- :acute | 14/16 involuted; post-in- :flammatory involution; polymorph exudation into many ductules. 2/16 lactating; mild to mod- :erate focal acute. |
| E. | 16/16 normal | 12/16 lactating; normal 3/16 lactating; moderate to focal acute. 1/16 involuted; normal. |

(C13 LF). Contd.

Microscopic examination. (Contd.)

| | Ducts. | | Lobules. |
|---------------|--------------|------------------|-------------------------------|
| Level 3. - A. | 16/16 normal | 10/16 lactating; | normal |
| | | 2/16 lactating; | mild focal acute. |
| | | 4/16 involuted; | post-inflammatory involution. |
| C. | 16/16 normal | 6/16 lactating; | normal. |
| | | 2/16 lactating; | moderate acute |
| | | 6/16 involuted; | normal |
| | | 2/16 involuted; | post-inflammatory involution. |

Irregular shaped corpora amylacea of varying size abundant in the lactating parts of this quarter.

Summary.-

| | |
|----------|---|
| Ducts, | 90% normal. |
| | 10% mild sub-acute |
| Lobules, | 50% involuted; post-inflammatory involution; acute exudate in ductules. |
| | 16% involuted; normal |
| | 8% lactating; mild to moderate acute. |
| | 26% lactating; normal |

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | n h Staph. | Sterile |
| Level 3. | Sterile | Sterile | Sterile |

C13, left hindquarter (C13 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. |
|------------------------------|---|-------|---|--|
| | Lab.1 | Lab.2 | | |
| 24 | 640 | 1,100 | 48 | Sterile |
| 21 | 540 | 1,200 | 60 | 2 h Staph. aureus, 9 diphtheroids |
| 20 | 2,040 | 2,300 | 55 | 40 diphtheroids |
| 18 | 840 | 550 | 58 | neg. |
| 17 | 740 | 570 | 46 | 7 n h Staph. aureus, 10 diphtheroids |
| 16 | 360 | 370 | 47 | 3 n h Staphs. aureus, 26 diphtheroids |
| 15 | 1,350 | 430 | 63 | 4 h Staph. aureus, 30 diphtheroids |
| 14 | 1,180 | 700 | 52 | neg. |
| 13 | 240 | 360 | 66 | 65 diphtheroids |
| 12 | 120 | 10 | | 40 diphtheroids |
| 11 | 280 | 140 | 25 | 8 diphtheroids |
| 10 | 800 | 80 | 48 | 20 diphtheroids |
| 9 | 300 | 60 | 25 | neg. |
| 8 | 230 | | | 5 diphtheroids |
| 7 | 80 | | | 11 diphtheroids |
| 5 | 860 | | | 14 diphtheroids |
| 4 | 650 | | | 3 diphtheroids |
| 3 | 660 | | | 7 diphtheroids |
| 2 | 3,000 | | | 21 diphtheroids |
| 9 days | 2,700 | | | 2 n h Staph. albus, 11 diphtheroids |
| 2 days | 2,700 | | | 1 n h Staph. albus, 25 diphtheroids |

■ 5 months after calving.

A sample taken after the animal had been transported to the abattoir showed 4,800,000 cells per ml., 65 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets or Lobules in wall.

Gland cistern - very large with small main ducts opening into it; no lobules in wall.

C13 LH (Contd.).

Macroscopic examination. (Cont'd.).

Level 1. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter, chrome-coloured; protruding very little from the cut surface.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter, chrome-coloured; protruding very little from the cut surface.

Area C - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter, chrome-coloured; protruding very little from the cut surface.

Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--------------|--------------|---|
| Gland cistern. | 16/16 normal | 16/16 | involved; post-inflammatory involution. |
| Level 1. - A. | 16/16 normal | 12/16 | lactating; normal |
| | | 2/16 | lactating; mild acute in relation to corpora amylacea |
| | C. | 2/16 | involved; post-inflammatory involution. |
| | | 16/16 normal | 16/16 |
| D. | 16/16 normal | 12/16 | involved; post-inflammatory involution; polymorph exudation in many ductules. |
| | | 3/16 | lactating; normal |
| | | 1/16 | lactating; mild acute mainly in relation to corpora amylacea |

C13 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|--------------|-------|---|
| Level 1. - E. | 16/16 normal | 14/16 | involuted; post-inflammatory involution; polymorph exudation in a few ductules. |
| | | 2/16 | lactating; normal |
| Level 2. - A. | 16/16 normal | 12/16 | partially involuted; normal |
| | | 2/16 | partially involuted; mild acute |
| | | 2/16 | involuted; post-inflammatory involution |
| - C. | 16/16 normal | 16/16 | partially involuted; normal |
| D. | 16/16 normal | 10/16 | partially involuted; normal |
| | | 4/16 | partially involuted; mild acute |
| | | 2/16 | involuted; post-inflammatory involution |
| E. | 16/16 normal | 12/16 | partially involuted; normal |
| | | 1/16 | partially involuted; mild acute |
| | | 3/16 | involuted; post-inflammatory involution |
| Level 3. - A. | 16/16 normal | 8/16 | lactating; normal |
| | | 8/16 | involuted; normal |
| C. | 16/16 normal | 8/16 | lactating; normal |
| | | 7/16 | involuted; normal |
| | | 1/16 | involuted; post-inflammatory involution |

Supramammary lymph node - mild sinus catarrh.

Irregular corpora amylacea abundant in the lactating parts of this quarter.

C13 LH (Contd.).

Microscopic examination. (Contd.).

Summary.-

Ducts, normal throughout.

Lobules, 17% involuted; post-inflammatory involution.
16% involuted; post-inflammatory involution;
acute exudation in ductules.
17% involuted; normal
6% lactating; mild acute (in relation to
corpora amylacea in Level 1.)
44% lactating; normal

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|------------------------------------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | n h Staph. | Sterile |
| Level 3. | Sterile | Sterile | Sterile |
| Supra- mammary lymph node | Sterile | Sterile | Sterile |

C13, right forequarter, (C13 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. |
|------------------------------|---|-------|---|---|
| | Lab.1 | Lab.2 | | |
| 24 | 800 | 1,400 | 46 | Sterile |
| 21 | 310 | 900 | 56 | 4 h Staph. aureus, 50 diphtheroids |
| 20 | 1,470 | 1,200 | 39 | 60 diphtheroids |
| 18 | 1,540 | 570 | 44 | neg. |
| 17 | 520 | 410 | 34 | 1 h Staph. aureus, 20 diphtheroids |
| 16 | 1,380 | 1,700 | 44 | 15 diphtheroids |
| 15 | 2,020 | 1,070 | 33 | 18 diphtheroids |
| 14 | 1,220 | 400 | 16 | neg. |
| 13 | 750 | 670 | 45 | 25 diphtheroids |
| 12 | 390 | 470 | 29 | 24 n h Staph. aureus, 4 diphtheroids |
| 11 | 2,370 | 1,600 | 24 | 1 n h Staph. aureus, 19 diphtheroids |
| 10 | 2,460 | 880 | 40 | 4 n h Staph. aureus, 20 diphtheroids |
| 9 | 1,320 | 640 | 18 | neg. |
| 8 | 660 | | | 2 diphtheroids |
| 7 | 1,350 | | | 3 n h Staph. albus, 24 diphtheroids |
| 5 | 2,160 | | | 3 n h Staph. albus, 22 diphtheroids |
| 4 | 2,220 | | | 2 n h Staph. aureus, 9 diphtheroids |
| 3 | 2,140 | | | 20 diphtheroids |
| 2 | 2,840 | | | 9 diphtheroids |
| 9 days | 2,430 | | | 20 diphtheroids |
| 2 days | 7,000 | | | 9 diphtheroids |

5 months after calving.

A sample taken after the animal had been transported to the abattoir showed 14,000,000 cells per ml., 55 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets or lobules in wall.

Gland cistern - globe shaped; lobules in wall.

C13 RF (Contd.).

Macroscopic examination. (Contd.).

Level 1. - Areas B, C, D and E - involuted; lobules
1.0mm. in diameter.

Area A - lactating; lobules 2.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - involuted; lobules
1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - involuted; lobules
1.0mm. in diameter.

Conclusion. - A quarter involuted except for an area of
lactating lobules around the gland cistern.

Microscopic examination.

Ducts.

Lobules.

| | | | | |
|----------------|-------|---|-------|--|
| Gland cistern. | 13/16 | mild focal sub- :acute | 16/16 | involuted; post-in- :flammatory involution; polymorph exudate in many ductules. |
| | 3/16 | moderate focal sub- :acute catarr- :hal. | | |
| Level 1. - A. | 10/16 | mild focal sub- :acute | 5/16 | lactating; mild acute; few polymorphs in many acini. |
| | 6/16 | moderate sub- :acute catarr- :hal with poly- :morphs in the lumina | 6/16 | involuted; post-in- :flammatory involution; polymorph exudate in ductules. |
| | | | 5/16 | involuted; normal |
| G. | 10/16 | mild focal sub- :acute | 6/16 | involuted; post-in- :flammatory involution; polymorph exudate in ductules. |

C13 RF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------------------|---|--|
| Level 1. - C. (Contd.) | 6/16 moderate sub- :acute catarrh- :al | 10/16 involuted; normal |
| | D. 16/16 moderate focal sub- :acute catarrh- :al with poly- :morphs in the lumina. | 8/16 involuted; post-in- :flammatory involution; polymorph exudate in many ductules. 8/16 involuted; normal |
| | E. 8/16 moderate sub- :acute catarrh- :al with poly- :morphs in the lumina. | 8/16 involuted; post-in- :flammatory involution; polymorph exudate in ductules. 8/16 involuted; normal |
| | 8/16 normal | |
| Level 2. - C. | 8/16 moderate sub- :acute catarrh- :al with poly- :morphs in the lumina. | 10/16 involuted; post-in- :flammatory involution; polymorph exudate in some ductules. 6/16 involuted; normal |
| | 8/16 normal. | |

G13 RF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|---|--|----------|
| Level 2. - D. | 8/16 moderate sub-acute catarrhal with polymorphs in the lumina | 10/16 involuted; post-inflammatory involution; polymorph exudate in some ductules. | |
| | 8/16 normal | 6/16 involuted; normal | |
| E. | 8/16 moderate sub-acute catarrhal with polymorphs in the lumina | 10/16 involuted; post-inflammatory involution; polymorph exudate in some ductules. | |
| | 8/16 normal | 6/16 involuted; normal | |
| Level 3. - A. | 6/16 moderate sub-acute catarrhal with polymorphs in the lumina. | 8/16 lactating; mild focal acute; few polymorphs in many acini. | |
| | 10/16 normal; cells in the lumina. | 8/16 involuted; post-inflammatory involution; polymorph exudate in ductules. | |
| C. | 16/16 moderate sub-acute catarrhal with polymorphs in the lumina. | 16/16 involuted; post-inflammatory involution; polymorph exudate in ductules. | |

C13 RF (Contd.).

Microscopic examination. (Contd.).

Corpora amylacea of varying size present in the small areas of lactating tissue.

Summary. -

Ducts, 75% mild to moderate subacute.
25% normal.

Lobules, 66% involuted; post-inflammatory involution;
acute exudate in the ductules.
27% involuted; normal.
7% lactating; mild acute.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | n h Staph. | Sterile |

C13, right hindquarter, (C13 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | Percent- age of granular cells. | Micro-organisms present. |
|------------------------------|---|--|--|
| Lab.1 | Lab.2 | | |
| 24 | 640 | 1,500 | 52 Sterile |
| 21 | 550 | 940 | 58 3 diphtheroids |
| 20 | 510 | 720 | 37 100 diphtheroids |
| 18 | 460 | 760 | 58 neg. |
| 17 | 620 | 320 | 52 1 h Staph. aureus, 17 diphtheroids |
| 16 | 190 | 620 | 55 6 diphtheroids |
| 15 | 680 | 290 | 57 1 n h Staph. aureus, 1 diphtheroid |
| 14 | 1,000 | 1,180 | 66 neg. |
| 13 | 230 | 120 | 49 Sterile. |
| 12 | 110 | 40 | 27 30 diphtheroids |
| 11 | 90 | 70 | 37 3 diphtheroids |
| 10 | 180 | 80 | 36 30 diphtheroids |
| 9 | 140 | 110 | 6 neg. |
| 8 | 20 | | 4 diphtheroids |
| 7 | 110 | | 15 diphtheroids |
| 5 | 410 | | 28 diphtheroids |
| 4 | 720 | | 18 n h Staph. aureus |
| 3 | 210 | | 1 n h Staph. aureus, 1 diphtheroid |
| 2 | 1,340 | | 4 n h Staph. aureus, 28 diphtheroids |
| 9 days | 680 | | 2 n h Staph. albus, 6 diphtheroids |
| 2 days | 3,720 | | 3 n h Staph. albus, 8 diphtheroids |

5 5 months after calving.

A sample taken after the animal had been transported to the abattoir showed 7,200,000 cells per ml., 65 per cent. being granular.

Macroscopic examination.

Teat cistern - no pockets or lobules in wall.

Gland cistern - very large with small main ducts opening into it; no lobules in wall.

C13 RH (Contd.).

Macroscopic examination. (Contd.).

- Level 1. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter; chrome-coloured; protruding very little from the cut surface.
- Area C - involuted; lobules 1.0mm. in diameter.
- Level 2. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter; chrome-coloured, protruding very little from the cut surface.
- Level 3. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter; chrome-coloured; protruding very little from the cut surface.
- Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---|--|
| Gland cistern. | 16/16 normal | 4/16 lactating; normal; cast epithelial cells in acini. 12/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| Level 1. - A. | 16/16 normal | 8/16 partially involuted; mild acute in acini, some in relation to corpora amylacea. 8/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| C. | 14/16 normal 2/16 moderate sub-acute corpora amylacea in duct walls. | 16/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |

C13 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|-----------------|--|
| Level 1. - D. | 16/16 normal | 16/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| | E. 16/16 normal | 8/16 partially involuted; mild acute in acini, some in relation to irregular shaped corpora amylacea. 8/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| Level 2. - A. | 16/16 normal | 16/16 lactating; mild acute; many corpora amylacea in acini with few polymorphs in relation to them. |
| | C. 16/16 normal | 6/16 lactating; normal 4/16 lactating; mild acute, mainly in relation to irregular shaped corpora amylacea. 4/16 involuted; normal 2/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| | D. 16/16 normal | 4/16 lactating; normal 4/16 lactating; mild acute mainly in relation to irregular shaped corpora amylacea. 2/16 lactating; severe focal acute. 4/16 involuted; normal 2/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |

C13 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|----------------------------|--------|---|
| Level 2. - E. 16/16 normal | | 6/16 lactating; normal |
| | | 4/16 lactating; mild acute, some in relation to irregular shaped corpora amylacea. |
| | | 2/16 lactating; moderate acute. |
| | | 2/16 involuted; normal. |
| | | 2/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| Level 3. - A. 16/16 normal | | 5/16 lactating; normal |
| | | 3/16 lactating; mild acute in relation to irregular shaped corpora amylacea. |
| | | 3/16 involuted; normal |
| | | 5/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |
| | | |
| C. 16/16 normal | | 6/16 lactating; normal |
| | | 4/16 lactating; mild acute in relation to irregular shaped corpora amylacea. |
| | | 2/16 lactating; moderate to severe acute. |
| | | 4/16 involuted; normal. |
| D. 16/16 normal | | 4/16 lactating; normal |
| | | 4/16 lactating; mild acute mainly in relation to irregular shaped corpora amylacea. |
| | | 1/16 lactating; severe acute. |
| | | 4/16 involuted; normal |
| | | 3/16 involuted; post-inflammatory involution; polymorph exudate in ductules. |

C13 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------------------|---------------------|--------------------------|
| Level 3. - E. | 16/16 normal | 16/16 involuted; normal. |
| Supra-mammary lymph node. | mild sinus catarrh. | |

Summary. -

| | |
|----------|---|
| Ducts, | 99% normal. 1% moderate subacute in relation to corpora amylacea in wall. |
| Lobules, | 33% involuted; post-inflammatory involution; acute exudate. 17% involuted; normal. 33% lactating and partially involuted; mild to moderate acute in relation to corpora amylacea. 17% lactating; normal. |

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|---------------------------|---------------------|------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | n h Staph. | Sterile |
| Supra-mammary lymph node. | Sterile | Sterile | Sterile |

Animal No. G14.

Summary of the main features of each quarter of the udder.

G14 LF. Normal.

G14 LH. Post-inflammatory involution.

G14 RF. Normal.

G14 RH. Normal.

Animal No. C14.

Ayrshire heifer, Basket No. 32A. Calved 8/9/49; slaughtered 3/12/49, 12½ weeks after calving. Udder frozen 3/12/49 and examined 14/12/49.

C14, left forequarter, (C14 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. |
|------------------------------|---|-------|---|-----------------------------|
| | Lab.1 | Lab.2 | | |
| 12 | 820 | 450 | 36 | Sterile |
| 11 | 120 | 450 | 58 | 2 n h Staph. albus |
| 10 | 90 | | | Sterile |
| 9 | 30 | 20 | 24 | Sterile |
| 8 | 10 | | | Sterile |
| 7 | 110 | | | Sterile |
| 6 | 100 | | | Sterile |
| 5 | 90 | | | Sterile |
| 4 | | | | Sterile |
| 3 | 20 | 140 | 46 | 5 diphtheroids |
| 2 | 450 | 340 | 32 | 1 n h Staph. aureus. |
| 1 | 140 | 320 | 20 | Sterile |

A sample taken after the animal had been transported to the abattoir showed 560,000 cells per ml., 19 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; many lobules.

Gland cistern - globe shaped; many lobules in wall.

Level 1. - Areas A, B, D and E - lactating, lobules 2.0mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 2.0mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

C14 LF (Contd.).

Macroscopic examination (Contd.).

Level 3. - Areas A, B, D and E - lactating; lobules
2.0mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

The lactating lobules in the E area of all levels protruded more from the cut surface than the remainder.

Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|--|
| Gland cistern. | 16/16 normal | 8/16 lactating; normal; cast epithelial cells in many acini; one lobule shows evidence of suppression with vacuolated epithelium. 8/16 involuted; normal |
| Level 1. - A. | 16/16 normal | 3/16 full lactation; normal 13/16 partially involuted; normal |
| C. | 16/16 normal | 16/16 partially involuted; normal |
| E. | 16/16 normal | 4/16 lactating; normal. 6/16 partially involuted; normal 6/16 involuted; normal |
| Level 2. - C. | 16/16 normal | 4/16 lactating; normal 12/16 partially involuted; normal |
| D. | 16/16 normal | 1/16 lactating; normal 15/16 partially involuted; normal |
| E. | 16/16 normal | 8/16 lactating; normal 8/16 partially involuted; normal |

C14 LF (Contd.).

Microscopic examination. (Contd.)

| | Ducts. | | Lobules. |
|---------------|-----------------|--|----------|
| Level 3. - A. | 16/16 normal | 10/16 lactating; normal 6/16 partially involuted; normal | |
| | C. 16/16 normal | 4/16 lactating; normal 12/16 partially involuted; normal | |

Summary. -

Ducts normal throughout.

Lobules normal throughout, 30% lactating.
60% partially involuted.
10% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth |
|---------|--------------------------|--------------------------------------|---|
| Level 1 | Sterile | Sterile | Sterile |
| Level 2 | Sterile | Sterile | Sterile |
| Level 3 | Sterile | m c+ Staph. | Sterile |

C14, left hindquarter, (C14 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. |
|------------------------------|---|-------|---|-----------------------------|
| | Lab.1 | Lab.2 | | |
| 12 | 2,160 | 1,640 | 65 | Sterile |
| 11 | 120 | 100 | 34 | Sterile |
| 10 | 320 | | | Sterile |
| 9 | 90 | 60 | 15 | Sterile |
| 8 | 20 | | | Sterile |
| 7 | 250 | | | Sterile |
| 6 | 200 | | | Sterile |
| 5 | 530 | | | Sterile |
| 4 | | | | Sterile |
| 3 | 480 | 800 | 57 | 4 n h Staph. albus. |
| 2 | 1,700 | 1,390 | 52 | 2 n h Staph. aureus. |
| 1 | 3,000 | 2,200 | 35 | 1 n h Staph. aureus. |

A sample taken after the animal had been transported to the abattoir showed 2,300,000 cells per ml., 30 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; lobules in upper part.

Gland cistern - globe-shaped; few lobules in wall.

Level 1. - Areas A, B, C, D and E - involuted; lobules 0.5mm. in diameter.

Focally in above areas - lactating; lobules 2.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - involuted; lobules 0.5mm. in diameter.

Focally in above areas - lactating; lobules 2.0mm. in diameter.

C14 LH (Contd.).

Macroscopic examination. (Contd.).

Level 3. - Areas A, B, C, D and E - involuted; lobules
0.5mm. in diameter.

Focally in above areas - lactating; lobules
2.0mm. in diameter.

Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. | |
|----------------|--------------|---|--|
| Gland cistern. | 16/16 normal | 16/16 involuted; post-inflammatory involution. | |
| Level 1. - A. | 16/16 normal | 8/16 lactating; normal; cast epithelial cells in acini. | |
| | | 4/16 involuted; normal. | |
| | | 4/16 involuted; post-inflammatory involution. | |
| | C. | 16/16 normal | 4/16 involuted; normal |
| | | | 12/16 involuted; post-inflammatory involution. |
| D. | 16/16 normal | 3/16 lactating; normal; cast epithelial cells in acini. | |
| | | 3/16 involuted; normal | |
| | | 10/16 involuted; post-inflammatory involution. | |
| E. | 16/16 normal | 4/16 lactating; normal; cast epithelial cells in acini. | |
| | | 2/16 partially involuted; normal. | |
| | | 5/16 involuted; normal. | |
| | | 5/16 involuted; post-inflammatory involution. | |

C14 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|-----------------|--|--|
| Level 2. - A. | 16/16 normal | 1/16 lactating; normal; cast epithelial cells in acini. |
| | | 10/16 involuted; normal |
| | | 5/16 involuted; post-inflammatory involution. |
| | C. 16/16 normal | 8/16 involuted; normal; cast epithelial cells in ductules. |
| | | 8/16 involuted; post-inflammatory involution. |
| | D. 16/16 normal | 3/16 full lactation; normal. |
| | | 2/16 lactating; normal; cast epithelial cells in acini. |
| | | 2/16 lactating; mild acute; cast epithelial cells in acini. |
| | | 4/16 involuted; normal; cast epithelial cells in ductules. |
| | | 5/16 involuted; post-inflammatory involution; cast epithelial cells in ductules. |
| | | |
| E. 16/16 normal | 4/16 lactating; normal; cast epithelial cells in acini. | |
| | 8/16 involuted; normal; cast epithelial cells in ductules. | |
| | 4/16 involuted; post-inflammatory involution; cast epithelial cells in ductules. | |
| Level 3. - C. | 16/16 normal | 8/16 involuted; normal; cast epithelial cells in ductules. |
| | | 8/16 involuted; post-inflammatory involution. |

C14 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|---|
| Level 3. - E. | 16/16 normal | 2/16 lactating; normal; cast epithelial cells in acini. |
| | | 8/16 involuted; normal. |
| | | 6/16 involuted; post-in- :flammatory involution. |

There were large amounts of interlobular fat throughout this quarter.

Summary. -

Ducts, normal throughout.

Lobules, 50% post-inflammatory involution
33% involuted; normal.
16% lactating; normal; cast epithelial
cells in acini.
1% lactating; mild acute.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | n h Staph. | Sterile. |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | n h Staph. | Sterile |

C14, right forequarter, (C14 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. | |
|------------------------------|---|-------|---|-----------------------------|---|
| | Lab.1 | Lab.2 | | | |
| 12 | 4,560 | 1,950 | 36 | Sterile | Sample blood stained. |
| 11 | 650 | 1,080 | 31 | Sterile | Red blood cells numerous in sample, but not counted. |
| 10 | 230 | | | Sterile | |
| 9 | 30 | 100 | 20 | Sterile | |
| 8 | 40 | | | Sterile | |
| 7 | 160 | | | Sterile | |
| 6 | 150 | | | Sterile | |
| 5 | 50 | | | 5 n h | Staph. aureus |
| 4 | | | | Sterile | |
| 3 | 150 | 40 | 33 | 1 h. | Staph. aureus |
| 2 | 430 | 380 | 39 | Sterile | |
| 1 | 240 | 440 | 24 | 10 n h | Staph. aureus, 1 n h Staph. albus |

A sample taken after the animal had been transported to the abattoir showed 440,000 cells per ml., 20 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; many lobules.

Gland cistern - globe shaped; many lobules in wall.

Level 1. - Areas A, B, C, D, and part of E - involuted;
lobules 1.0mm. in diameter.

Remainder of Area E - lactating; lobules
2.5mm. in diameter.

Level 2. - Areas A, B, C, D, and part of E - involuted;
lobules 1.0mm. in diameter.

Remainder of Area E - lactating; lobules
2.5mm. in diameter.

C14 RF (CONTD.)

Macroscopic examination. (Contd.).

Level 3. - Areas A, B, C and D - involuted; lobules
1.0mm. in diameter.

Area E - lactating; lobules 2.5mm. in
diameter.

Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|---|
| Gland cistern. | 16/16 normal | 8/16 lactating; normal 8/16 partially involuted; normal. |
| Level 1. - C. | 16/16 normal | 16/16 partially involuted; normal; two perivascular lymphocytic aggregations. |
| D. | 16/16 normal | 8/16 lactating; normal 8/16 involuted; normal |
| E. | 16/16 normal | 10/16 lactating; normal; few cast epithelial cells in acini. 6/16 involuted; normal |
| Level 2. - A. | 16/16 normal | 12/16 full lactation; normal 4/16 partially involuted; normal |
| C. | 16/16 normal | 16/16 partially involuted; normal; perivascular lymphocytic aggregation. |
| D. | 16/16 normal | 4/16 lactating; normal; few cells, mainly cast epithelial cells, in some acini. 4/16 partially involuted; normal; few cells, mainly cast epithelial cells, in some acini. 8/16 involuted; normal. |

C14 RF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|--|
| Level 2. - E. | 16/16 normal | 4/16 full lactation; normal; few cells, mainly cast epithelial cells, in some acini. |
| | | 4/16 partially involuted; normal; perivascular lymphocytic aggregation. |
| | | 8/16 involuted; normal. |
| Level 3. - C. | 16/16 normal | 5/16 full lactation; normal; few cells, mainly cast epithelial cells, in some acini. |
| | | 6/16 partially involuted; normal |
| | | 5/16 involuted; normal. |
| D. | 16/16 normal | 6/16 full lactation; normal; few cells, mainly cast epithelial cells, in some acini. |
| | | 4/16 partially involuted; normal |
| | | 6/16 involuted; normal |
| E. | 16/16 normal | 5/16 full lactation; normal |
| | | 8/16 partially involuted; normal |
| | | 3/16 involuted; normal. |

Large amounts of interlobular fat present throughout the quarter.

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 33% lactating.
33% partially involuted.
34% involuted.

C14 RF (Contd.).

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | n h Staph. | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile |

Cl4, right hindquarter, (Cl4 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro-organisms present. |
|------------------------------|---|-------|---|---|
| | Lab.1 | Lab.2 | | |
| 12 | 1,100 | 620 | 37 | Sterile |
| 11 | 20 | 80 | 60 | Sterile |
| 10 | 140 | | | Sterile |
| 9 | 20 | 40 | 20 | Sterile |
| 8 under | 10 | | | Sterile |
| 7 | 340 | | | Sterile |
| 6 | 100 | | | Sterile |
| 5 | 150 | | | Sterile |
| 4 | | | | 1 n h Staph. aureus |
| 3 | 160 | 50 | 30 | 1 diphtheroid |
| 2 | 410 | 360 | 40 | 3 n h pale Staph. aureus, 1 diphtheroid |
| 1 | 90 | 350 | 30 | 1 n h Staph. albus. |

A sample taken after the animal had been transported to the abattoir showed 700,000 cells per ml., 38 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; lobules in upper part.

Gland cistern - globe-shaped; few lobules in wall.

Level 1. - Areas A, B, C and D - involuted; lobules 1.0mm. in diameter.

Area E - lactating; lobules 2.5mm. in diameter.

Level 2. - Areas B and C - involuted; lobules 1.0mm. in diameter.

Areas A, D and E - lactating; lobules 2.5mm. in diameter.

Level 3. - Areas A, B, C and D - involuted; lobules 1.0mm. in diameter.

Area E - lactating; lobules 2.5mm. in diameter.

C14 RH (Contd.).

Macroscopic examination. (Contd.).

Conclusion. - A quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. | |
|----------------|--------------|---|---|
| Gland cistern. | 16/16 normal | 16/16 partially involuted; normal; cast epithelial cells in ductules. | |
| Level 1. - C. | 16/16 normal | 3/16 lactating; normal; few cast epithelial cells in many acini. | |
| | | 5/16 partially involuted; normal. | |
| | | 8/16 involuted; normal | |
| D. | 16/16 normal | 6/16 full lactation; normal; few cast epithelial cells in many acini. | |
| | | 5/16 partially involuted; normal. | |
| | | 5/16 involuted; normal; cast epithelial cells in ductules. | |
| E. | 16/16 normal | 6/16 lactating; normal | |
| | | 4/16 partially involuted; normal; few cast epithelial cells in acini. | |
| | | 6/16 involuted; normal | |
| Level 2. - C. | 16/16 normal | 16/16 involuted; normal | |
| | D. | 16/16 normal | 6/16 lactating; normal |
| | | | 4/16 partially involuted; normal; cast epithelial cells in acini. |
| | | 6/16 involuted; normal | |
| E. | 16/16 normal | 6/16 lactating; normal | |
| | | 4/16 partially involuted; normal; cast epithelial cells in acini. | |
| | | 6/16 involuted; normal. | |

C14 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|--|
| Level 3. - C. | 16/16 normal | 16/16 involuted; normal. |
| D. | 16/16 normal | 3/16 lactating; normal 6/16 partially involuted; normal 7/16 involuted; normal. |
| E. | 16/16 normal | 3/16 lactating; normal 6/16 partially involuted; normal. 7/16 involuted; normal |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 20% lactating.
30% partially involuted.
50% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|-------------------------------------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | n h Staph. | Sterile |
| Level 3. | Sterile | Sterile | Sterile |
| Supra- mammary lymph node. | Sterile | Sterile | Sterile |

Animal No. C19.

Summary of the main features of each quarter of the udder.

C19 LF. Mild acute lobular mastitis.

C19 LH. Mild acute lobular mastitis.

C19 RF. Mild acute lobular mastitis.

C19 RH. Normal.

Animal No. C19.

Ayrshire heifer, Brownhill No.2. Calved 8/10/49; slaughtered 20/12/49, 10 weeks after calving. Udder frozen, 20/12/49 and examined 21/12/49.

Daily milk yield, 20/10/49, - 22 lbs.

C19, left forequarter, (C19 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro-organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). | |
|------------------------|--------------------------------------|-----------|-------------------------------|-------------------------|--|----|
| | Lab.1 | Lab.2 | | | | |
| 9 | | 10 | | Neg. | | |
| 8 | | under 10 | | Neg. | 28 | |
| 7 | | under 10 | | Neg. | 35 | |
| 6 | | under 10 | | Neg. | 35 | |
| 5 | | No sample | | | | |
| 4 | | 30 | 20 | 40 | Sterile | 41 |
| 3 | | under 10 | | Neg. | 40 | |
| 2 | | 40 | | Neg. | | |
| 9 days | | 40 | 50 | 56 | Sterile | |
| 3 days | | 30 | 20 | 48 | Sterile | |

No sample was taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - deep pockets and lobules in wall.

Gland cistern - small globe lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

A normal lactating quarter.

C19 LF (Contd.).

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|---|
| Gland cistern. | 16/16 normal | 16/16 lactating; normal |
| Level 1. - A. | 16/16 normal | 16/16 full lactation; normal |
| | C. | 16/16 normal 16/16 full lactation; normal |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal |
| | C. | 16/16 normal 16/16 full lactation; normal |
| | D. | 16/16 normal 16/16 full lactation; normal |
| | E. | 16/16 normal 12/16 full lactation; normal 3/16 lactating; focal mild acute. 1/16 involuted; normal. |
| Level 3. - A. | 16/16 normal | 16/16 full lactation; normal |
| | C. | 16/16 normal 16/16 full lactation; normal |
| | D. | 16/16 normal 12/16 full lactation; normal 4/16 lactating; focal mild acute. |
| | E. | 16/16 normal 16/16 full lactation; normal |

Summary. -

Ducts, normal throughout.

Lobules, 95% lactating; normal.
 4% lactating; focal mild acute.
 1% involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C19, left hindquarter, (C19 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells. | Micro- organisms present. | Electrical Conductivity. ($\times 10^{-4}$ mhos). |
|------------------------------|---|----------|--|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 9 | under 10 | | | Neg. | |
| 8 | 10 | | | Neg. | 28 |
| 7 | 20 | | | Neg. | 34 |
| 6 | under 10 | | | Neg. | 35 |
| 5 | 20 | | | Neg. | 36 |
| 4 | under 10 | 10 | 64 | 26 n h Staph. aureus. | 38 |
| 3 | under 10 | | | Neg. | 40 |
| 2 | 130 | | | Neg. | |
| 9 days | 30 | 80 | 48 | Sterile. | |
| 3 days | under 10 | under 10 | | Sterile. | |

No sample was taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - deep pockets and lobules in wall.

Gland cistern - globe; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

C19 LH (Contd.).

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---|--|
| Gland cistern. | 16/16 normal cast ep- ithelial cells in lumina. | 16/16 partially involuted; normal; cast epithelial cells in acini. |
| Level 1. - A. | 16/16 normal. | 16/16 full lactation; normal |
| C. | 16/16 normal. | 16/16 full lactation; normal |
| D. | 16/16 normal. | 16/16 full lactation; normal |
| E. | 16/16 normal. | 16/16 full lactation; normal |
| Level 2. - A. | 16/16 normal. | 16/16 full lactation; normal |
| C. | 16/16 normal | 15/16 lactating; normal 1/16 lactating; focal mild acute. |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 16/16 full lactation; normal |
| Level 3. - A. | 16/16 normal. | 16/16 full lactation; normal |
| C. | 16/16 normal. | 15/16 lactating; normal. 1/16 involuted; normal. |
| D. | 16/16 normal. | 4/16 full lactation; normal 8/16 lactating; normal. 4/16 lactating; focal mild acute. |
| E. | 16/16 normal. | 14/16 full lactation; normal 2/16 lactating; normal. |

Supramammary lymph node - No abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, 90% lactating; normal.
2% lactating; focal mild acute.
8% partially involuted and involuted; normal.

C19 LH (Contd.).

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|--------------------------------------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | n h Staph. | Sterile. |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile |
| Supra- :mammary lymph node. | Sterile | Sterile. | Sterile. |

C19, right forequarter, (C19 RF.).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present | Electrical conductivity. (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|--------------------------------|---|
| | Lab.1 | Lab.2 | | | |
| 9 | under 10 | | | Neg. | |
| 8 | 30 | | | Neg. | 29 |
| 7 | 40 | | | Neg. | 36 |
| 6 | under 10 | | | Neg. | 35 |
| 5 | under 10 | | | Neg. | 36 |
| 4 | 20 | under 10 | 35 | Sterile | 38 |
| 3 | under 10 | | | Neg. | 39 |
| 2 | 20 | | | Neg. | |
| 9 days | 10 | 110 | 40 | Sterile. | |
| 3 days | under 10 | under 10 | | Sterile. | |

No sample was taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - deep pockets and lobules in wall.

Gland cistern - small globe; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|------------------------------|
| Gland cistern. | 16/16 normal | 16/16 lactating; normal |
| Level 1. - A. | 16/16 normal | 16/16 full lactation; normal |

C19 RF (Contd.).

Microscopic examination. (Contd.)

| | Ducts. | Lobules. |
|---------------|--------------|--|
| Level 1. - C. | 16/16 normal | 16/16 involuted; normal |
| D. | 16/16 normal | 14/16 full lactation; normal 2/16 full lactation; mild focal acute. |
| E. | 16/16 normal | 16/16 full lactation; normal |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 partially involuted; normal. |
| D. | 16/16 normal | 14/16 full lactation; normal 2/16 full lactation; mild focal acute. |
| E. | 16/16 normal | 16/16 full lactation; normal |
| Level 3. - A. | 16/16 normal | 16/16 full lactation; normal |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 12/16 lactating; normal 4/16 partially involuted; focal mild acute. |

Summary. -

Ducts, normal throughout.
 Lobules, 80% lactating; normal.
 2% lactating; focal mild acute.
 8% partially involuted; normal.
 2% partially involuted; focal mild acute.
 8% involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------|-----------------------------------|--|
| Level 1. | Sterile. | Sterile | Sterile. |
| Level 2. | Sterile. | n h Staph. | Sterile. |
| Level 3. | Sterile. | n h Staph. | Sterile. |

C19, right hindquarter, (C19 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 9 | under 10 | | | Neg. | |
| 8 | under 10 | | | Neg. | 28 |
| 7 | 40 | | | Neg. | 35 |
| 6 | under 10 | | | Neg. | 36 |
| 5 | 30 | | | Neg. | 38 |
| 4 | under 10 | under 10 | | Sterile | 38 |
| 3 | under 10 | | | Neg. | 40 |
| 2 | 140 | | | Neg. | |
| 9 days | under 10 | 40 | 56 | Sterile | |
| 3 days | under 10 | under 10 | | Sterile | |

No sample was taken after the animal had been transported to the abattoir.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|------------------------------|
| Gland cistern. | 16/16 normal | 16/16 involuted; normal |
| Level 1. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 full lactation; normal |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 16/16 full lactation; normal |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 full lactation; normal |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 16/16 full lactation; normal |
| Level 3. - A. | 16/16 normal | 16/16 full lactation; normal |
| C. | 16/16 normal | 16/16 full lactation; normal |
| D. | 16/16 normal | 16/16 full lactation; normal |
| E. | 16/16 normal | 16/16 full lactation; normal |

C19 RH (Contd.).

Microscopic examination (Contd.).

Supramammary lymph node - No abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 92% lactating.
8% involuted and partially involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------------------------------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | n h Staph. | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile |
| Supra- :mammary lymph node | Sterile | n h Staph. | Sterile. |

Animal No. C20.

Summary of the main features of each quarter of the udder.

C20 LF. Normal.

C20 LH. Normal.

C20 RF. Normal.

C20 RH. Normal.

Animal No. C20.

Ayrshire heifer, Brownhill No. 13. Calved 3/11/49
slaughtered 20/12/49, 7 weeks after calving. Udder
frozen 20/12/49 and examined 9/1/50.

C20, Left forequarter, (C20 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 4 | 30 | | | Neg. | 40 |
| 3 | under 10 | under 10 | | Sterile. | 36 |
| 2 | 10 | | | Neg. | 36 |
| 1 | under 10 | under 10 | | Sterile | |
| 1 day | under 10 | under 10 | | Sterile | |

No sample taken after the animal had been transported
to the abattoir.

Macroscopic examination.

Teat cistern - no pockets; no lobules in wall.

Gland cistern - small globe; lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 3.0mm.
in diameter

Area C - lactating; lobules 1.5mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 3.0mm.
in diameter.

Area C - lactating; lobules 1.5mm. in diameter.

Level 3. - Areas A, B, C, D and E -lactating; lobules
3.0mm. in diameter.

Conclusion. -

A normal lactating quarter.

C20 LF (Contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--------------|-------------------------------------|--|
| Gland cistern. | 16/16 normal | 16/16 | partially involuted; normal; cast epithelial cells in acini. |
| Level 1. - A. | 16/16 normal | 16/16 | lactating; normal. |
| | C. | 16/16 normal | 16/16 partially involuted; normal. |
| | D. | 16/16 normal | 16/16 lactating; normal |
| | E. | 16/16 normal | 16/16 lactating; normal |
| Level 3. - A. | 16/16 normal | 14/16 lactating; 2/16 involuted; | normal normal |
| | C. | 16/16 normal | 15/16 lactating; normal 1/16 involuted; normal |
| | D. | 16/16 normal | 16/16 lactating; normal |
| | E. | 16/16 normal | 16/16 lactating; normal; cast epithelial cells in a few acini. |

Summary. -

Ducts, normal throughout.

Lobules, 76% lactating; normal.
 22% partially involuted; normal
 2% involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C20, Left hindquarter, (C20, LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 4 | under 10 | | | Neg. | 38 |
| 3 | 10 | 40 | | Sterile. | 36 |
| 2 | 10 | | | Neg. | 34 |
| 1 | 10 | under 10 | | Sterile. | |
| 1 day | under 10 | 10 | 25 | Sterile | |

No sample taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - no pockets; no lobules in wall.

Gland cistern - small globe; lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 1.5mm. in diameter.

Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 1.5mm. in diameter.

Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

A normal lactating quarter.

Miscroscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|---|
| Gland cistern. | 16/16 normal. | 16/16 involuted; normal; epithelial cells in ductules. cast |
| Level 1. - A. | 16/16 normal | 16/16 lactating; normal. |

C20 LH (Contd.).

Microscopic examination. (Contd.)

Level 1. - C. 16/16 normal 14/16 lactating; normal
 2/16 partially involuted;
 normal.

D. 16/16 normal 10/16 lactating; normal
 6/16 partially involuted;
 normal

E. 16/16 normal 15/16 lactating; normal
 1/16 partially involuted;
 normal.

Level 3. - A. 16/16 normal 16/16 full lactation; normal

C. 16/16 normal 10/16 lactating; normal
 6/16 partially involuted;
 normal.

D. 16/16 normal 16/16 lactating; normal.

E. 16/16 normal 8/16 lactating; normal.
 4/16 partially involuted;
 normal.
 4/16 involuted; normal.

Supramammary lymph node - No abnormality seen.

Summary. -

Ducts normal throughout.

Lobules, normal throughout, 70% lactating.
 15% partially involuted.
 15% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | n h Staph. | Sterile. |

G20, right forequarter, (G20 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 4 | under 10 | | | Neg. | 37 |
| 3 | under 10 | under 10 | | Sterile | 34 |
| 2 | under 10 | | | Neg. | 34 |
| 1 | under 10 | under 10 | | Sterile | |
| 1 day | under 10 | under 10 | | Neg. | |

No sample was taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - no pockets; no lobules in wall.

Gland cistern - small globe; lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 2.5mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 2.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

A normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|--|
| Gland cistern. | 16/16 normal | 16/16 partially involuted; normal. |
| Level 1. - A. | 16/16 normal | 15/16 lactating; normal 1/16 partially involuted; normal. |

C20 RF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. | |
|------------|------------|--------------|---|--|
| Level 1. - | C. | 16/16 normal | 4/16 lactating; normal 12/16 involuted; normal | |
| | D. | 16/16 normal | 4/16 lactating; normal 4/16 partially involuted; normal 8/16 involuted; normal | |
| | E. | 16/16 normal | 15/16 lactating; normal 1/16 partially involuted; normal | |
| | Level 3. - | A. | 16/16 normal | 16/16 full lactation; normal |
| | | C. | 16/16 normal | 14/16 lactating; normal 2/16 partially involuted; normal |
| D. | | 16/16 normal | 15/16 lactating; normal 1/16 involuted; normal | |
| E. | | 16/16 normal | 16/16 lactating; normal; lymphocytic aggregation in one lobule. | |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 70% lactating.
15% partially involuted.
15% involuted.

Post-mortem cultures from the tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | n h Staph. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C20, right hindquarter, (C20 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 4 | 20 | | | Neg. | 38 |
| 3 | under 10 | 20 | | Sterile | 36 |
| 2 | under 10 | | | Neg. | 35 |
| 1 | 20 | under 10 | | Sterile. | |
| 1 day | under 10 | 10 | | Sterile. | |

No sample taken after the animal had been transported to the abattoir.

Macroscopic examination.

Teat cistern - no pockets; no lobules in wall.

Gland cistern - small globe; lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 2.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 3.0mm. in diameter.

Area C - lactating; lobules 2.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

A normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|-----------------------------------|
| Gland cistern. | 16/16 normal | 16/16 partially involuted; normal |
| Level 1. - A. | 16/16 normal | 16/16 lactating; normal. |

C20 RH. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|--|
| Level 1. - C. | 16/16 normal | 10/16 lactating; normal. 6/16 involuted; normal. |
| D. | 16/16 normal | 16/16 lactating; normal. |
| E. | 16/16 normal | 16/16 lactating; normal. |
| Level 3. - A. | 16/16 normal | 15/16 lactating; normal. 1/16 involuted; normal. |
| C. | 16/16 normal | 6/16 lactating; normal. 10/16 partially involuted; normal. |
| D. | 16/16 normal | 16/16 lactating; normal. |
| E. | 16/16 normal | 16/16 lactating; normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 75% lactating.
20% partially involuted.
5% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

Animal No. C30.

Summary of the main features of each quarter of the udder.

C30 LF. Normal.

C30 LH. Post-inflammatory involution
and sub-acute duct lesions.

C30 RF. Normal.

C30 RH. Normal.

Animal No. C30.

Ayrshire heifer, Auchincruive No. 17, College
Lupin 644-17. Calved 24/9/49; slaughtered 6/3/50,
23 weeks after calving. Udder frozen 6/3/50 and
examined 8/3/50.

13/12/49 - left hindquarter tramped; teat
sphincter (streak canal) enlarged by McLean's knife;
treated with 14 tubes penicillin at end of January.

Daily milk yield, 21/1/50 - 23 lbs.

C30, left forequarter, (C30 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity ($\times 10^{-4}$ mhos). |
|------------------------------|---|---|---|---|
| | Lab.1 | Lab.2 | | |
| 16 ^M | under 10 | | neg. | 36 |
| 15 | under 10 | | neg. | 37 |
| 14 | 30 | | neg. | 41 |
| 12 | under 10 | | neg. | |
| 11 | under 10 | | neg. | |
| 10 | under 10 | | neg. | |
| 9 | under 10 | | neg. | |
| 8 | 40 | | neg. | |
| 6 $\frac{1}{2}$ | under 10 | | neg. | |
| 6 | under 10 | under 10 | 4 diph- -theroids | |
| 5 $\frac{1}{2}$ | 10 | | neg. | |
| 5 | under 10 | under 10 | 2 n h Staph. albus, 1 diph- :theroids | 39 |
| 4 | 10 | under 10 | 10 diph- :theroids | |
| 3 $\frac{1}{2}$ | under 10 | under 10 | Sterile | 37 |
| 2 $\frac{1}{2}$ | under 10 | | Sterile | |
| 2 | under 10 | under 10 | Sterile | 39 |
| 12 days | under 10 | under 10 | 1 h Staph. aureus | 38 |

C30 LF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|--------------|-----------------------|---|
| Level 1. - A. | 16/16 normal | 16/16 full lactation; | normal. |
| C. | 16/16 normal | 16/16 full lactation; | normal. |
| D. | 16/16 normal | 16/16 full lactation; | normal. |
| E. | 16/16 normal | 15/16 full lactation; | normal. 1/16 involuted; normal. |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; | normal. |
| C. | 16/16 normal | 16/16 full lactation; | normal; cast epithelial cells in acini. |
| D. | 16/16 normal | 16/16 full lactation; | normal |
| E. | 16/16 normal | 16/16 full lactation; | normal |
| Level 3. - A. | 16/16 normal | 16/16 full lactation; | normal |
| C. | 16/16 normal | 13/16 full lactation; | normal 3/16 involuted; normal. |
| D. | 16/16 normal | 16/16 full lactation; | normal |
| E. | 16/16 normal | 13/16 full lactation; | normal 3/16 involuted; normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 96% lactating.
4% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | h c+ Staph. | Sterile. |

C30, left hindquarter, (C30 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | Lab.1 | Lab.2 | Percent- :age of granular cells | Micro- organisms present | Electrical Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|-------|--|---------------------------------------|--|
| 16 | under 10 | | | | neg. | 36 |
| 15 | under 10 | | | | neg. | 36 |
| 14 | 40 | | | | neg. | 39 |
| 13 | 10 | | | | neg. | |
| 12 | 20 | | | | neg. | |
| 11 | 660 | | | | neg. | |
| 10 | No sample | | | | | |
| 9 | No sample | | | | | |
| 8 | No sample | | | | | |
| 6½ | 5,990 | | | | neg. | |
| 6 | 2,550 | 1,640 | | 82 | neg. | |
| 5½ | 760 | | | | neg. | |
| 5 | 1,890 | 3,420 | | 73 | 1 n h Staph. aureus | 47 |
| 4 | 1,520 | 850 | | 68 | neg. | |
| 3½ | 1,580 | 1,500 | | 65 | Sterile | 41 |
| 2 | 860 | 800 | | 71 | 3 n h Staph. aureus | 46 |
| 12 days | 560 | 540 | | 54 | 1 n h Staph. aureus | 41 |
| 10 days | | 400 | | 72 | Sterile | 46 |
| 9 days | 1,280 | 1,300 | | 60 | 3 diphtheroids | |
| 4 days | 1,560 | 2,200 | | 76 | 1 h Staph. albus. | |
| 2 days | 2,010 | 1,900 | | 70 | neg. | 53 |
| 0 days | | 6,000 | | 60 | 1 h Staph. aureus 1 diphtheroid | 56 |

■ 7 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 2,200,000 cells per ml., 48 per cent. being granular cells.

C30 LH (Contd.).

Macroscopic examination.

Streak canal - evidence of surgical interference; small nodule at upper end of canal.

Teat cistern - shrunken; no pockets or lobules in wall.

Gland cistern - globe-shaped; pericisternal lobules in wall.

Level 1. - Areas A, B, C, D, E - involuted; lobules 1.0mm. to 2.0mm. in diameter, chrome-coloured.

Level 2. - Areas A, B, C, D and E - lactating; lobules 2.0mm. to 3.0mm. in diameter, orange-coloured.

Level 3. - Areas A, C, D and E - lactating; lobules 2.0mm. to 3.0mm. in diameter; orange-coloured

Area B - involuted; lobules 1.0mm. to 2.0mm. in diameter, chrome-coloured.

Haemorrhagic zone in Area C between Levels 2 and 3.

Conclusion.-

This quarter was quite distinct from the left forequarter where the tissue was normal lactating tissue.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|-------------------------------|---------------|--|
| Gland cistern. | 16/16 moderate subacute | 8/16 | lactating; normal involuted; post-inflammatory involution. |
| Level 1. - A. | 8/16 normal moderate subacute | 10/16 6/16 | lactating; normal involuted; post-inflammatory involution; polymorphs in ductules in one lobule. |
| | C. 16/16 severe subacute | 16/16 | involuted; post-inflammatory involution. |
| | D. 16/16 moderate subacute | 16/16 | involuted; post-inflammatory involution. |

C30 LH (Contd.).

Microscopic examination.

(Contd.)

| | <u>Ducts.</u> | | <u>Lobules.</u> | |
|---------------|---------------------------------|-------|--------------------------------------|--|
| Level 1. - E. | 16/16 normal | 3/16 | lactating; normal | |
| | | 1/16 | partially involuted; | |
| | | | severe acute | |
| | | 12/16 | involuting; post-in- | |
| | | | flammation; involution. | |
| Level 2. - A. | 8/16 normal | 10/16 | lactating; normal | |
| | 8/16 moderate subacute | 2/16 | lactating; moderate to severe acute. | |
| | | 4/16 | involuting; post-in- | |
| | | | flammation; involution; | |
| | | | polymorphs in ductules, | |
| | | | in two lobules. | |
| C. | 4/16 normal | 16/16 | involuting; post-in- | |
| | 12/16 mild to moderate subacute | | flammation; involution; | |
| | | | polymorphs in ductules | |
| | | | in four lobules. | |
| D. | 12/16 normal | 12/16 | lactating; normal | |
| | 4/16 mild subacute | 4/16 | involuting; post-in- | |
| | | | flammation; involution. | |
| E. | 16/16 normal | 12/16 | lactating; normal | |
| | | 3/16 | involuting; normal | |
| | | 1/16 | involuting; post-in- | |
| | | | flammation; involution. | |

Block from
Carea
between
Level 2
and 3

| | |
|---|--|
| 16/16 severe subacute with peri-ductal fibrosis | 16/16 involuted; post-in- flammation; involution; acute macrophage reaction; macrophages present in ductules; blood pigment abundant. |
|---|--|

| | | | |
|---------------|--------------|-------|-------------------|
| Level 3. - A. | 16/16 normal | 16/16 | lactating; normal |
| C. | 16/16 normal | 16/16 | lactating; normal |

C30 LH (Contd.).

Microscopic examination. (CONTD.).

| | Ducts. | | Lobules. |
|---------------|--------------|-------|------------------------|
| Level 3. - D. | 16/16 normal | 12/16 | lactating; normal |
| | | 1/16 | lactating; mild acute. |
| | | 3/16 | partially involuted; |
| | | | normal; aggregation of |
| | | | lymphocytes in one |
| | | | lobule. |
| E. | 16/16 normal | 14/16 | lactating; normal |
| | | 2/16 | involuting; normal; |
| | | | aggregation of lymph- |
| | | | ocytes in one lobule. |

Supra-mammary lymph node - No abnormality seen.

Summary. -

Ducts, 50% normal
50% mild to severe subacute.

Lobules, 45% involuted; post-inflammatory involution.
3% involuted; post-inflammatory involution;
acute exudate in ductules.
1% involuted; normal.
1% lactating and partially involuted;
moderate to severe acute.
50% lactating; normal.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth |
|----------|--------------------------|--------------------------------------|---|
| Level 1. | Sterile | h. C + Staph. | Sterile |
| Level 2. | Sterile | Sterile. | Sterile |
| Level 3. | Sterile | Strep. bovis. | Sterile. |

C30, right forequarter, (C30 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | |
| 16 [Ⓜ] | under 10 | | neg. | 36 |
| 15 | under 10 | | neg. | 35 |
| 14 | under 10 | | neg. | 38 |
| 13 | under 10 | | neg. | |
| 12 | under 10 | | neg. | |
| 11 | under 10 | | neg. | |
| 10 | under 10 | | neg. | |
| 9 | under 10 | | neg. | |
| 8 | under 10 | | neg. | |
| 6 $\frac{1}{2}$ | under 10 | | neg. | |
| 6 | under 10 | under 10 | Sterile | |
| 5 $\frac{1}{2}$ | under 10 | | neg. | |
| 5 | under 10 | under 10 | Sterile | 38 |
| 4 | under 10 | 10 | Sterile | |
| 3 $\frac{1}{2}$ | under 10 | under 10 | Sterile | 36 |
| 2 $\frac{1}{2}$ | under 10 | | Sterile | |
| 2 | under 10 | under 10 | 3 h. Staph. aureus. | 39 |
| 12 days | under 10 | under 10 | 1 diphtheroid | 38 |
| 10 days | under 10 | under 10 | Sterile | 40 |
| 4 days | under 10 | under 10 | 3 diphtheroids | |
| 2 days | under 10 | under 10 | 1 n h Staph. aureus | |
| | | | 1 n h Staph. albus | |
| | | | 4 diphtheroids | 44 |
| 0 days | | under 10 | Sterile | 42 |

Ⓜ 7 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 10,000 cells per ml.

C30 RF (Contd.).

Macroscopic examination.

Teat cistern. - deep pockets in wall; no lobules.

Gland cistern. - globe-shaped; few lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--------------|-------------------------------------|--|
| Gland cistern. | 16/16 normal | 12/16 lactating; 4/16 involuted; | normal normal |
| Level 1. - A. | 16/16 normal | 16/16 lactating; | normal |
| C. | 16/16 normal | 15/16 lactating; 1/16 involuted; | normal normal |
| D. | 16/16 normal | 16/16 lactating; | normal |
| E. | 16/16 normal | 13/16 lactating; 3/16 involuted; | normal normal; aggregation of lymphocytes in one lobule. |
| Level 2. - A. | 16/16 normal | 16/16 lactating; | normal |
| C. | 16/16 normal | 16/16 lactating; | normal |
| D. | 16/16 normal | 16/16 lactating; | normal |
| E. | 16/16 normal | 16/16 lactating; | normal |

C30 RF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. | |
|---------------|--------------|-------|------------|--------|
| Level 3. - A. | 16/16 normal | 16/16 | lactating; | normal |
| C. | 16/16 normal | 14/16 | lactating; | normal |
| | | 2/16 | involutéd; | normal |
| D. | 16/16 normal | 16/16 | lactating; | normal |
| E. | 16/16 normal | 15/16 | lactating; | normal |
| | | 1/16 | involutéd; | normal |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 95% lactating.
5% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate, | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile. |

C30, right hindquarter, (C30 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| x | | | | | |
| 16 | under 10 | | | neg. | 37 |
| 15 | under 10 | | | neg. | 36 |
| 14 | 30 | | | neg. | 39 |
| 13 | under 10 | | | neg. | |
| 12 | under 10 | | | neg. | |
| 11 | under 10 | | | neg. | |
| 10 | | | | neg. | |
| 9 | under 10 | | | neg. | |
| 8 | | | | neg. | |
| 6 $\frac{1}{2}$ | under 10 | | | neg. | |
| 6 | under 10 | under 10 | | Sterile | |
| 5 $\frac{1}{2}$ | 30 | | | neg. | |
| 5 | under 10 | under 10 | | 3 diphtheroids | 38 |
| 4 | under 10 | under 10 | | 2 diphtheroids | |
| 3 $\frac{1}{2}$ | under 10 | under 10 | | 2 diphtheroids | 37 |
| 2 $\frac{1}{2}$ | under 10 | | | neg. | |
| 2 | 20 | under 10 | | 1 diphtheroid | 39 |
| 12 days | under 10 | under 10 | | 1 h. Staph. aureus | |
| | | | | 9 diphtheroids | 39 |
| 10 days | under 10 | under 10 | | Sterile | 40 |
| 4 days | 10 | under 10 | | Sterile | |
| 2 days | 30 | 30 | | 1 n h Staph. aureus | |
| | | | | 2 diphtheroids | 44 |
| 0 days | 20 | | | Sterile | 43 |

x 7 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 20,000 cells per ml.

C30 RH (Contd.).

Macroscopic examination.

Teat cistern - pockets (not so deep as those in right forequarter) in wall; no lobules.

Gland cistern - globe-shaped; few lobules in wall, some reddish-brown in colour.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion.-

This was a normal lactating quarter.

Microscopic examination.

Ducts.

Lobules.

Gland cistern. 16/16 normal 16/16 lactating; normal; reddish-brown pericisternal lobules seen on macroscopic examination were indistinguishable from the pink lobules microscopically.

Level 1. - A. 16/16 normal 16/16 lactating; normal

C. 16/16 normal 16/16 lactating; normal

D. 16/16 normal 16/16 lactating; normal

E. 16/16 normal 16/16 lactating; normal

Level 2. - A. 16/16 normal 16/16 lactating; normal

C. 16/16 normal 16/16 lactating; normal

D. 16/16 normal 16/16 lactating; normal

E. 16/16 normal 16/16 lactating; normal.

C30 RH (Contd.).

Microscopic examination. (Cont.).

| | Ducts | Lobules. |
|---------------|--------------|-------------------------|
| Level 3. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 16/16 lactating; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |

Supramammary lymph node - No abnormality seen.

Summary.-

Ducts, normal throughout.

Lobules, normal throughout.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth |
|----------|--------------------------|--------------------------------------|---|
| Level 1. | Sterile | h. C + Staph. | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile |

Animal No. C31.

Summary of the main features of each quarter of the udder.

C31 LF. Severe unifocal acute lobular mastitis.

C31 LH. Normal.

C31 RF. Normal.

C31 RH. Severe acute lobular mastitis
and sub-acute duct lesions.

Animal No. C31.

Ayrshire heifer, Auchincruive No. 37, College Lavina 640-37. Born 31/3/47; calved 3/10/49; slaughtered 6/3/50, 22 weeks after calving. Udder frozen 6/3/50, and examined 8/3/50.

Daily milk yield, 21/1/50 - 33 lbs.

The following clinical note refers to right hind-quarter:- "indurated core on the posterior aspect of the udder close to the septum; teat orifice patent and dripping milk; teat tramped and operated on with McLean's knife and consequently the teat orifice is left more patent than usual."

C31, left forequarter, (C31 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | Percentage of granular cells | Micro-organisms present. | Electrical conductivity. (x 10 ⁻⁴ mhos). |
|------------------------|--------------------------------------|------------------------------|--------------------------|---|
| | Lab.1 | Lab.2 | | |
| 17 | 10 | | neg. | 36 |
| 16 | under 10 | | neg. | 34 |
| 15 | under 10 | | neg. | 36 |
| 14 | 40 | | neg. | 41 |
| 13 | 10 | | neg. | |
| 12 | 20 | | neg. | |
| 11 | under 10 | | neg. | |
| 10 | 10 | | neg. | |
| 9 | under 10 | | neg. | |
| 8 | 10 | | neg. | |
| 7 | under 10 | | neg. | |
| 6 | under 10 | 10 | Sterile | |
| 5½ | under 10 | | neg. | |
| 5 | under 10 | under 10 | 6 diphtheroids | 34 |
| 4½ | 10 | 10 | 2 diphtheroids | |
| 4 | 20 | 60 | 2 n h Staph. aureus, | |
| | | | 1 diphtheroid | 35 |
| 3 | under 10 | 20 | 8 diphtheroids | |
| 2½ | 20 | under 10 | 5 diphtheroids | 39 |
| 2 | under 10 | under 10 | 3 h Staph. aureus, | |
| | | | 14 diphtheroids | 37 |
| 1½ | under 10 | under 10 | 11 diphtheroids | 37 |

C31 LF (Contd.).

Examination of the milk. (Contd.).

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|--|--|
| | Lab.1 | Lab.2 | | | |
| 4 days | 10 | 70 | 60 | 4 diphtheroids | |
| 2 days | 40 | 20 | 54 | 2 h pale Staph. aureus, | |
| 0 days | | 30 | 64 | 16 diphtheroids 1 h Staph. aureus. | 46 |

■ 5 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 10,000 cells per ml.

Macroscopic examination.

Teat cistern - no pockets or lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

There was a smooth membranous constriction between the cisterns.

Level 1. - Areas A, B, C, D and E - lactating; lobules
2.0 to 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules
2.0 to 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules
2.0 to 3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

C31 LF (Contd.).

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|---|
| Gland cistern. | 16/16 normal. | 16/16 partially involuted; normal. |
| Level 1. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 16/16 lactating; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |
| Level 2. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 16/16 lactating; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |
| Level 3. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 15/16 lactating; normal 1/16 lactating; severe acute. |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 91.5% lactating; normal
0.5% lactating; severe
acute.
8% partially involuted;
normal.

C31 LF (Contd.).

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | Strep. bovis. | Sterile. |
| Level 2. | Sterile | Sterile. | Sterile. |
| Level 3. | Sterile | Sterile. | Sterile. |

C31, left hindquarter (C31 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical Conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 17 | under 10 | | | neg. | 37 |
| 16 | under 10 | | | neg. | 34 |
| 15 | under 10 | | | neg. | 37 |
| 14 | 10 | | | neg. | 42 |
| 13 | 10 | | | neg. | |
| 12 | under 10 | | | neg. | |
| 11 | under 10 | | | neg. | |
| 10 | under 10 | | | neg. | |
| 9 | under 10 | | | neg. | |
| 8 | under 10 | | | neg. | |
| 7 | under 10 | | | neg. | |
| 6 | under 10 | 10 | | Sterile. | |
| 5½ | under 10 | | | neg. | |
| 5 | under 10 | 40 | | 1 n h Staph. albus | |
| | | | | 3 diphtheroids | 34 |
| 4½ | under 10 | under 10 | | 6 n h Staph. albus | |
| | | | | 1 n h Staph. albus | |
| | | | | 1 diphtheroids | |
| 4 | under 10 | under 10 | | 4 n h Staph. albus | |
| 3 | 10 | under 10 | | 1 diphtheroids | |
| 2½ | under 10 | under 10 | | Sterile | |
| 2 | under 10 | under 10 | | Sterile. | |
| 1½ | under 10 | under 10 | | Sterile. | |
| 4 days | under 10 | under 10 | | Sterile. | |
| 2 days | 30 | 10 | | 2 n h pale Staph. aureus, | |
| | | | | 1 diphtheroids | |
| 0 days | | under 10 | | 1 n h Staph. aureus | |

■ 5 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 10,000 cells per ml.

C31 LH (Contd.)

Macroscopic examination.

Teat cistern - no pockets or lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

There was a smooth membranous constriction between the cisterns.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|------------------------------------|
| Gland cistern. | 16/16 normal | 16/16 lactating; normal |
| Level 1. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 16/16 partially involuted; normal. |
| D. | 16/16 normal | 16/16 partially involuted; normal. |
| E. | 16/16 normal | 16/16 lactating; normal |
| Level 2. - A. | 16/16 normal | 16/16 lactating; normal |
| C. | 16/16 normal | 16/16 lactating; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |
| Level 3. - A. | 16/16 normal | 16/16 lactating; normal |

C31 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|-------------------------|
| Level 3. - C. | 16/16 normal | 16/16 lactating; normal |
| D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal |

Supramammary lymph node - No abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 88% lactating; normal
12% partially involuted;
normal.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|--------------------------|--------------------------------------|--|
| Level 1. | Sterile | n h Staph. | Sterile |
| Level 2. | n h Staph. | Strep. bovis. | Sterile |
| Level 3. | Sterile | Sterile | Sterile |

C31, right forequarter, (C31, RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--------------------------------|--|
| | Lab. 1 | Lab. 2 | | | |
| 17 | under 10 | | | neg. | 36 |
| 16 | 10 | | | neg. | 35 |
| 15 | under 10 | | | neg. | 37 |
| 14 | 40 | | | neg. | 42.5 |
| 13 | 10 | | | neg. | |
| 12 | under 10 | | | neg. | |
| 11 | under 10 | | | neg. | |
| 10 | under 10 | | | neg. | |
| 9 | under 10 | | | neg. | |
| 8 | 10 | | | neg. | |
| 7 | 10 | | | neg. | |
| 6 | 70 | 20 | | Sterile | |
| 5½ | 30 | | | neg. | |
| 5 | 20 | 30 | | 3 diphtheroids | 34 |
| 4½ | under 10 | 10 | | 1 diphtheroid | |
| 4 | 20 | under 10 | | 10 diphtheroids | 34 |
| 3 | 10 | under 10 | | 8 diphtheroids | |
| 2½ | under 10 | 10 | | 7 diphtheroids | |
| 2 | 50 | 50 | | 4 diphtheroids | 38 |
| 1½ | 10 | 60 | | Sterile | 37 |
| 4 days | 30 | 60 | | 10 diphtheroids | |
| 2 days | 10 | 90 | 34 | 6 n h Staph. aureus, | |
| | | | | 12 diphtheroids | |
| 6 days | | 40 | | Sterile | |

5 5 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 20,000 cells per ml.

Macroscopic examination.

Teat cistern - No pockets or lobules in wall.

Gland cistern - Globe-shaped; lobules in wall.

There was a smooth membranous constriction between the cisterns.

C31 RF (Contd.).

Macroscopic examination. (Contd.).

- Level 1. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.
- Level 2. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.
- Level 3. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | | Lobules. | |
|----------------|-----------------|------------------|----------|--|
| Gland cistern. | 16/16 normal | 12/16 lactating; | normal | |
| | | 4/16 involuted; | normal | |
| Level 1. - A. | 16/16 normal | 16/16 lactating; | normal | |
| | C. 16/16 normal | 12/16 lactating; | normal | |
| | | 4/16 involuted; | normal | |
| | D. 16/16 normal | 16/16 lactating; | normal | |
| | E. 16/16 normal | 16/16 lactating; | normal | |
| Level 2. - A. | 16/16 normal | 16/16 lactating; | normal | |
| | C. 16/16 normal | 16/16 lactating; | normal | |
| | D. 16/16 normal | 16/16 lactating; | normal | |
| | E. 16/16 normal | 16/16 lactating; | normal | |
| Level 3. - A. | 16/16 normal | 16/16 lactating; | normal | |
| | C. 16/16 normal | 16/16 lactating; | normal | |
| | D. 16/16 normal | 16/16 lactating; | normal | |
| | E. 16/16 normal | 16/16 lactating; | normal | |

C31 RF (Contd.).

Microscopic examination. (Contd.).

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 96% lactating; normal
4% involuted; normal

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile | Sterile | Sterile |
| Level 2. | Sterile | Sterile | Sterile |
| Level 3. | Sterile | Sterile | Sterile |

C31, right hindquarter, (C31 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|---------------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 17 | under 10 | | | neg. | 37 |
| 16 | under 10 | | | neg. | 35 |
| 15 | under 10 | | | neg. | 37 |
| 14 | 10 | | | neg. | 42 |
| 13 | under 10 | | | neg. | |
| 12 | 100 | | | neg. | |
| 11 | 10 | | | neg. | |
| 10 | under 10 | | | neg. | |
| 9 | 20 | | | neg. | |
| 8 | | | | neg. | |
| 7 | 2,010 | | | neg. | |
| 6 | | 1,940 | 87 | Sterile | |
| 5½ | 1,170 | | | neg. | |
| 5 | | | | neg. | |
| 4½ | 520 | 1,550 | 67 | num. atypical strep. | |
| 4 | 2,400 | 2,600 | 92 | 2 h Staph. | |
| 3 | 460 | 360 | 77 | num. atypical strep. | 38 |
| 2½ | 220 | 160 | 70 | 1 diphtheroid | 42 |
| 2 | 3,960 | 6,300 | 80 | Sterile | 46 |
| 1½ | 4,350 | 6,000 | 82 | atypical strep. | 41 |
| 4 days | 2,670 | 3,260 | 78 | num. atypical strep. | |
| 2 days | 2,010 | 3,500 | 85 | num. atypical strep., h Staph. | 53 |
| 0 days | | 9,000 | 87 | 22 atypical strep., 11 h Staph. | |

■ 5 weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 7,100,000 cells per ml., 87 per cent. being granular cells.

C31 RH (Contd.).

Macroscopic examination. (Contd.).

Streak canal - evidence of operative interference.

Teat cistern - marked roughening of epithelium; no pockets or lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

There was a smooth membranous constriction between the cisterns.

Level 1. - Areas A, B, D and E - lactating; lobules 1.0mm. to 2.0mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 1.0mm. to 2.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 1.0mm. to 2.0mm. in diameter.

There was a small area in the carea above Level 3, where the interlobular ducts contained greenish pus.

Conclusion. -

This quarter was in a more advanced state of lactation than the other three quarters of the udder.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|----------------------|--|
| Gland cistern. | 10/16 mild subacute | 12/16 involuted; post-inflammatory involution. |
| | 6/16 severe subacute | 3/16 lactating; normal |
| | | 1/16 lactating; severe acute. |
| Level 1. - A. | 16/16 mild subacute | 11/16 lactating; normal |
| | | 4/16 lactating; focal severe acute |
| | | 1/16 involuted; post-inflammatory involution. |

C31 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. | |
|--------------------------|---------------------------|------------|--|-----------------------------------|
| Level 1. - B. | 16/16 mild | 12/16 | lactating; normal | |
| | subacute | 4/16 | lactating; focal severe acute. | |
| | C. | 16/16 mild | 10/16 | lactating; normal |
| | | subacute | 6/16 | lactating; focal severe acute. |
| | D. | 16/16 mild | 7/16 | lactating; normal |
| subacute | | 8/16 | lactating; focal severe acute | |
| | | 1/16 | involuted; normal | |
| E. | 8/16 mild | 4/16 | lactating; normal | |
| | subacute | 8/16 | lactating; focal | |
| | 8/16 moderate subacute | | moderate to severe acute | |
| | | 4/16 | involuted; post-in- :flammatory involution. | |
| Level 2. - A. | 16/16 mild | 12/16 | lactating; normal | |
| | subacute | 4/16 | lactating; focal severe acute. | |
| | C. | 16/16 mild | 8/16 | lactating; normal |
| | | subacute | 8/16 | lactating; focal severe acute. |
| | D. | 16/16 mild | 12/16 | lactating; normal |
| subacute | | 4/16 | lactating; focal severe acute. | |
| E. | 16/16 mild | 12/16 | lactating; normal | |
| | subacute | 4/16 | lactating; focal severe acute. | |
| Level 3. - A. | 16/16 mild | 12/16 | lactating; normal | |
| | subacute | 4/16 | lactating; focal moderate to severe acute. | |
| | C. | 4/16 mild | 8/16 | lactating; normal |
| subacute | | 8/16 | lactating; focal | |
| 12/16 severe subacute | | | severe acute. | |

C31 RH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|------------------------|-------------------------------------|----------------------------------|
| Level 3. - D. | 16/16 mild subacute | 12/16 lactating; 4/16 lactating; | normal focal severe acute. |
| E. | 16/16 mild subacute | 13/16 lactating; 3/16 lactating; | normal focal severe acute. |

Block from
Lesion
above Level

| | | | |
|---------|---|-------------------------------------|----------------------------|
| 3. - C. | 16/16 severe subacute lumina packed with pus. | 4/16 lactating; 12/16 lactating; | normal severe acute. |
|---------|---|-------------------------------------|----------------------------|

Supramammary lymph node - Sinus catarrh.

Summary. -

Ducts, 82% mild subacute
18% severe subacute

Lobules, 65% lactating; normal
25% lactating; severe acute.
10% involuted; post-inflammatory involution.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|-----------------------------------|--------------------------|--------------------------------------|--|
| Level 1. Sterile | | h Staph; Strep. bovis | Strep. bovis. |
| Level 2. h Staph; Strep. bovis | | h Staph; Strep. bovis | Strep. bovis. |
| Level 3. Sterile | | h. Staph; Strep. bovis. | Strep. bovis. |

Animal No. C32.

Summary of the main features of each quarter of the udder.

C32 LF. Post-inflammatory involution
and sub-acute duct lesions.

C32 LH. Normal.

C32 RF. Post-inflammatory involution.

C32 RH. Normal.

Animal No. C32.

Ayrshire heifer, Lissens Moss No. 12A. Born March, 1947; calved 1/8/49; slaughtered 13/3/50, 32 weeks after calving. Udder frozen 13/3/50 and examined 15/3/50. "Drying off" at time of slaughter.

C32, left forequarter, (C32 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|---|--|
| | Lab.1 | Lab.2 | | | |
| 28 | 200 | | | Neg. | |
| 27 | 10 | under 10 | 25 | 60 diphtheroids | |
| 26 | 40 | | | Neg. | |
| 25 | 70 | | | Neg. | |
| 24 | 80 | | | Neg. | |
| 23 | 70 | | | Neg. | |
| 22 | 150 | | | Neg. | |
| 21 | 330 | | | Neg. | |
| 18 | 120 | | | Neg. | 42 |
| 17 | 200 | | | Neg. | 44 |
| 16 | 90 | | | Neg. | 42 |
| 15 | 230 | 130 | 56 | 2 n h Staph albus, 7 diphtheroids | 40 |
| 14 | 40 | 160 | 40 | 1 diphtheroids | 38 |
| 13 | 10 | | | Neg. | |
| 12 | 210 | | | Neg. | |
| 11 | 160 | | | Neg. | |
| 8 | 60 | | | Neg. | |
| 7 | 60 | | | Neg. | |
| 6 | 130 | 110 | 50 | 5 diphtheroids | 43 |
| 5 | 170 | | | Neg. | 43 |
| 4 | 190 | | | Neg. | 44 |
| 3 | 100 | 100 | | 9 n h small Staph albus | 41 |
| 2 | 230 | 160 | 41 | 2 h Staph aureus 7 diphtheroids | 40 |
| 1 | 250 | 120 | 48 | 3 n h pale Staph aureus | |
| 0 days | | 300 | 49 | Neg. | |

A sample taken after the animal had been transported to the abattoir showed 600,000 cells per ml., 44 per cent. being granular cells.

C32 LF (Contd.).

Macroscopic examination.

Teat cistern - shallow pockets in wall; lobules present.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, D and E - lactating; lobules 2.0mm. in diameter.

Areas B and C - involuted; lobules 0.5mm. in diameter.

Level 2. - Areas A, D and E - lactating; lobules 2.0mm. in diameter.

Areas B and C - involuted; lobules 0.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter.

Conclusion. -

This was a normal quarter in late lactation.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---|---|
| Gland cistern. | 8/16 normal. 8/16 focal mild subacute | 8/16 lactating; normal. 4/16 involuted; normal. 4/16 involuted; post-in- :flammatory involution. |
| Level 1. - A. | 16/16 normal | 15/16 lactating; normal 1/16 lactating; focal mild acute. |
| C. | 8/16 normal 8/16 focal mild to moderate subacute. | 6/16 lactating; normal 6/16 involuted; normal 4/16 involuted; post-in- :flammatory involution. |
| D. | 8/16 focal moderate subacute 8/16 focal severe subacute. | 16/16 involuted; post-in- :flammatory involution. |

C32 LF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. | |
|---------------|-----------------|-------|-------------|-------------|
| Level 1. - E. | 16/16 normal | 12/16 | lactating; | normal |
| | | 3/16 | involuted; | normal |
| | | 1/16 | involuted; | post-in- |
| | | | :flammatory | involution. |
| Level 2. - A. | 16/16 normal | 16/16 | lactating; | normal |
| | C. 16/16 normal | 4/16 | lactating; | normal |
| | | 12/16 | involuted; | normal |
| | D. 16/16 normal | 16/16 | lactating; | normal |
| | E. 16/16 normal | 16/16 | lactating; | normal |
| Level 3. - A. | 16/16 normal | 16/16 | lactating; | normal |
| | C. 16/16 normal | 13/16 | lactating; | normal |
| | | 2/16 | lactating; | moderate |
| | | | acute. | |
| | | 1/16 | involuted; | post-in- |
| | | | :flammatory | involution. |
| | D. 16/16 normal | 14/16 | lactating; | normal |
| | | 2/16 | involuted; | normal |
| | E. 16/16 normal | 15/16 | lactating; | normal |
| | | 1/16 | lactating; | moderate |
| | | | acute. | |

Summary. -

Ducts, 84% normal.
 16% mild to severe focal subacute.

Lobules, 73% lactating; normal.
 2% lactating; mild to moderate acute.
 14% involuted; post-inflammatory involution.
 11% involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile | n h Staph. | Sterile. |
| Level 2. | Sterile | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C32, left hindquarter, C32 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- ;age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---|--|
| | Lab.1 | Lab.2 | | | |
| 28 | | 40 | | Neg. | |
| 27 | under 10 | under 10 | | Sterile | |
| 26 | | 10 | | Neg. | |
| 25 | | 10 | | Neg. | |
| 24 | under 10 | | | Neg. | |
| 23 | | 30 | | Neg. | |
| 22 | | 20 | | Neg. | |
| 21 | | 30 | | Neg. | |
| 18 | | 20 | | Neg. | |
| 17 | | 10 | | Neg. | |
| 16 | | 40 | | Neg. | 44 |
| 15 | under 10 | 30 | | 2 n h Staph aureus | 38 |
| 14 | under 10 | 50 | 22 | Sterile. | 39 |
| 13 | | 10 | | Neg. | |
| 12 | | 80 | | Neg. | |
| 11 | | 40 | | Neg. | |
| 8 | under 10 | | | Neg. | |
| 7 | under 10 | | | Neg. | |
| 6 | | 20 | 30 | 3 n h Staph aureus, 4 diptheroids | 40 |
| 5 | | 10 | | Neg. | |
| 4 | | 40 | | Neg. | |
| 3 | | 20 | 10 | 3 n h pale Staph.aureus | 39 |
| 2 | | 10 | 10 | 1 h Staph. aureus, 2 diptheroids | 39 |
| 1 | | 40 | 30 | Neg. | |
| 0 days | | 30 | 15 | Neg. | |

A sample taken after the animal had been transported to the abattoir showed 190,000 cells per ml., 8 per cent. being granular cells.

G32 LH. (Contd.).

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter.

Level 3. - Areas A, B and D - lactating; lobules 2.0mm. in diameter.

Areas C and E - involuted; lobules 0.5mm. in diameter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|-----------------|------------------|--|
| Gland cistern. | 16/16 normal. | 8/16 lactating; | normal. |
| | | 8/16 involuted; | normal. |
| Level 1. - A. | 16/16 normal | 16/16 lactating; | normal. |
| | C. 16/16 normal | 16/16 lactating; | normal. |
| | D. 16/16 normal | 16/16 lactating; | normal. |
| | E. 16/16 normal | 8/16 lactating; | normal. |
| | | 8/16 involuted; | normal; |
| | | | focus of round cells in one lobule. |
| Level 2. - A. | 16/16 normal | 16/16 lactating; | normal |
| | C. 16/16 normal | 15/16 lactating; | normal |
| | | 1/16 involuted; | normal. |
| | D. 16/16 normal | 16/16 lactating; | normal |
| | E. 16/16 normal | 14/16 lactating; | normal |
| | | 2/16 involuted; | normal. |
| Level 3. - A. | 16/16 normal | 16/16 lactating; | normal. |

C32 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. | |
|---------------|--------------|-------|-------------|---------|
| Level 3. - G. | 16/16 normal | 8/16 | lactating; | normal. |
| | | 8/16 | involuteds; | normal. |
| D. | 16/16 normal | 16/16 | lactating; | normal. |
| E. | 16/16 normal | 4/16 | lactating; | normal. |
| | | 12/16 | involuteds; | normal. |

Supramammary lymph node - no abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 80% lactating.
20% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C32, right forequarter, (C32 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---|--|
| | Lab.1 | Lab.2 | | | |
| 28 | 40 | | | Neg. | |
| 27 | under 10 | under 10 | | 1 n h Staph. aureus. | |
| 26 | 20 | | | Neg. | |
| 25 | 40 | | | Neg. | |
| 24 | 60 | | | Neg. | |
| 23 | under 10 | | | Neg. | |
| 22 | 60 | | | Neg. | |
| 21 | 10 | | | Neg. | |
| 18 | 20 | | | Neg. | |
| 17 | 10 | | | Neg. | |
| 16 | 260 | | | Neg. | 42 |
| 15 | 40 | 50 | 56 | 2 n h Staph. albus, 2 diphtheroids | 40 |
| 14 | 30 | 180 | 62 | Sterile. | 38 |
| 13 | 30 | | | Neg. | |
| 12 | 120 | | | Neg. | |
| 11 | 180 | | | Neg. | |
| 8 | under 10 | | | Neg. | |
| 7 | 50 | | | Neg. | |
| 6 | 10 | 30 | | 4 diphtheroids | 40 |
| 5 | 60 | | | Neg. | 41 |
| 4 | 90 | | | Neg. | 42 |
| 3 | 50 | 40 | | 8 n h Staph. aureus, 7 diphtheroids | 38 |
| 2 | 80 | 50 | | 9 diphtheroids | 40 |
| 1 | 130 | 190 | 43 | 6 n h Staph. aureus, 6 diphtheroids | |
| 0 days | | 370 | 23 | | |

A sample taken after the animal had been transported to the abattoir showed 210,000 cells per ml., 43 per cent. being granular cells.

C32 RF. (Contd.).

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 2.0mm. in diameter.

Areas C and D - involuted; lobules 0.5mm. in diameter.

Level 2. - Areas A, B and E - lactating; lobules 2.0mm. in diameter.

Areas C and D - involuted; lobules 0.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.0mm. in diameter.

Conclusion. -

This was a quarter in late lactation; the lobules protruded less from the cut surface than did those of the right hindquarter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|-----------------|------------------|-------------------------|
| Gland cistern. | 16/16 normal | 4/16 lactating; | normal |
| | | 6/16 involuted; | normal |
| | | 6/16 involuted; | post-in- |
| | | | :flammatory involution. |
| Level 1. - A. | 16/16 normal | 16/16 lactating; | normal. |
| | | | |
| | C. 16/16 normal | 6/16 lactating; | normal. |
| | | 6/16 involuted; | normal. |
| | | 4/16 involuted; | post-in- |
| | | | :flammatory involution. |
| | | | |
| | D. 16/16 normal | 8/16 lactating; | normal. |
| | | 4/16 involuted; | normal. |
| | | 4/16 involuted; | post-in- |
| | | | :flammatory involution. |
| | | | |
| | E. 16/16 normal | 15/16 lactating; | normal. |
| | | 1/16 involuted; | normal. |

C32 RF. (Contd.).

Microscopic examination. (Contd.)

| | Ducts. | | Lobules. | |
|---------------|---------------|-------|------------|-------------------------------|
| Level 2. - A. | 16/16 normal. | 15/16 | lactating; | normal. |
| | | 1/16 | lactating; | severe acute. |
| C. | 16/16 normal. | 4/16 | lactating; | normal. |
| | | 10/16 | involuted; | normal. |
| | | 2/16 | involuted; | post-inflammatory involution. |
| D. | 16/16 normal. | 14/16 | lactating; | normal. |
| | | 2/16 | involuted; | normal. |
| E. | 16/16 normal. | 16/16 | lactating; | normal. |
| Level 3. - A. | 16/16 normal. | 16/16 | lactating; | normal. |
| C. | 16/16 normal. | 16/16 | lactating; | normal. |
| D. | 16/16 normal. | 15/16 | lactating; | normal. |
| | | 1/16 | lactating; | mild acute. |
| E. | 16/16 normal. | 12/16 | lactating; | normal. |
| | | 4/16 | involuted; | normal. |

Summary. -

Ducts, normal throughout.

Lobules, 73% lactating; normal.
 2% lactating; mild and severe acute.
 17% involuted; normal.
 8% involuted; post-inflammatory involution.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------|------------------------------------|--|
| Level 1. | Sterile. | n h Staph. | Sterile. |
| Level 2. | Sterile. | Strep.bovis. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C32, right hindquarter, (C32, RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|--|--|
| | Lab.1 | Lab.2 | | | |
| 28 | 30 | | | Neg. | |
| 27 | under 10 | under 10 | | Sterile. | |
| 26 | under 10 | | | Neg. | |
| 25 | 30 | | | Neg. | |
| 24 | under 10 | | | Neg. | |
| 23 | under 10 | | | Neg. | |
| 22 | 30 | | | Neg. | |
| 21 | under 10 | | | Neg. | |
| 18 | under 10 | | | Neg. | |
| 17 | 20 | | | Neg. | |
| 16 | 20 | | | Neg. | |
| 15 | 30 | 10 | | 1 n h Staph. albus. | |
| 14 | under 10 | 50 | | 3 n h Staph. albus. | |
| 13 | 20 | | | Neg. | |
| 12 | 10 | | | Neg. | |
| 11 | 10 | | | Neg. | |
| 8 | 30 | | | | |
| 7 | 30 | | | | |
| 6 | 10 | 30 | | 4 diphtheroids | |
| 5 | 10 | | | | |
| 4 | 70 | | | | |
| 3 | 30 | 20 | | 1 h Staph. aureus, 3 n h Staph. aureus. | |
| 2 | 50 | 50 | | 4 h Staph. aureus, 3 n h Staph. aureus. | |
| 1 | 80 | 30 | 20 | 6 diphtheroids | |
| 0 days | | 10 | 10 | | |

A sample taken after the animal had been transported to the abattoir showed 280,000 cells per ml., 6 per cent. being granular cells.

C32 RH. (Contd.).

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules
2.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules
2.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules
2.0mm. in diameter.

Conclusion. -

This was a normal quarter in late lactation; the lobules protruded more from the surface than did those of the right forequarter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|------------------|------------------|--|
| Gland cistern. | 16/16 normal | 4/16 lactating; | normal. |
| | | 12/16 involuted; | normal. |
| Level 1. - C. | 16/16 normal | 15/16 lactating; | normal. |
| | | 1/16 involuted; | normal. |
| | D. 16/16 normal | 16/16 lactating; | normal. |
| | E. 16/16 normal | 16/16 lactating; | normal. |
| Level 2. - A. | 16/16 normal. | 13/16 lactating; | normal. |
| | | 3/16 involuted; | normal; |
| | | | aggregation of lympho- cytes in one lobule. |
| | B. 16/16 normal. | 16/16 lactating; | normal. |
| | C. 16/16 normal. | 14/16 lactating; | normal. |
| | | 2/16 lactating; | normal; |
| | | | large numbers of cast epithelial cells in acini. |
| | D. 16/16 normal. | 16/16 lactating; | normal. |

C32 RH. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|---------------|--|
| Level 2. - E. | 16/16 normal. | 14/16 lactating; normal. 2/16 involuted; normal. |
| Level 3. - A. | 16/16 normal. | 12/16 lactating; normal. 4/16 involuted; normal. |
| | C. | 16/16 normal. 12/16 lactating; normal; epithelial cells cast in 4/16. 4/16 involuted; normal. |
| | D. | 16/16 normal. 16/16 lactating; normal; epithelial cells cast in 4/16. |
| | E. | 16/16 normal. 8/16 lactating; normal; aggregation of lympho- cytes in one lobule. 8/16 involuted; normal. |

Supramammary lymph node - no abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 92% lactating.
8% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | n h Staph. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

Animal No. C33.

Summary of the main features of each quarter of the udder.

C33 LF. Normal.

C33 LH. Post-inflammatory involution.

C33 RF. Severe acute lobular mastitis.

C33 RH. Normal.

Animal No. C33.

Ayrshire heifer, Basket No. 23 A, T.T.F. 44 - 5029.
Calved 13/8/49; slaughtered 15/3/50, 30 weeks after
calving. Udder frozen 15/3/50 and examined 16/3/50.

History:-

9/3/50, 6 days before slaughter - all quarters milking
evenly; right fore teat warm; slight clots in
fore-milk from right forequarter.

13/3/50, 2 days before slaughter - no abnormality seen
in milk or felt in quarter.

14/3/50, 1 day before slaughter - milking evenly in all
quarters, milk from individual quarters measured in tall
glass jar;- LF. 8 ins., LH. 9 ins., RF., 8 ins.,
RH. 8 ins..

Daily milk yield, 27/2/50 - 24 lbs. milk record from
date of calving to 25/2/50 - 500 gallons.

C33, left forequarter, (C 33 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|--|---|--|
| | Lab.1 | Lab.2 | | | |
| 29 | 20 | 50 | 40 | 6 h Staph. aureus | |
| 28 | under 10 | 10 | | 3 h Staph. aureus, 3 diphtheroids | |
| 26 | 10 | 10 | | Sterile | |
| 25 | under 10 | 10 | | 2 diphtheroids | |
| 24 | 10 | | | 4 n h Staph. aureus 10 diphtheroids | |
| 23 | under 10 | | | Sterile | |
| 22 | 10 | | | 1 n h Staph. aureus, 7 diphtheroids | |
| 21 | under 10 | | | 5 diphtheroids | |
| 20 | 50 | | | 2 diphtheroids | 40 |
| 19 | 40 | | | Sterile | |

C33 LF. (Contd.).

Examination of the milk. (Contd.).

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------------|--|--|--|
| | Lab.1 | Lab.2 | | | |
| 18 | | | | Sterile | 41 |
| 17 | under 10 | | | 4 diphtheroids | 38 |
| 16 | under 10 | under 10 | | Sterile | 38 |
| 15 | under 10 | under 10 | | 50 n h Staph. albus | 40 |
| 14 | under 10 | under 10 | | 1 n h Staph. aureus | |
| 13 | | 10 | | Sterile | |
| 12 | under 10 | | | 5 n h Staph. aureus | |
| 10 | under 10 | | | 25 n h Staph. aureus, 5 diphtheroids | |
| 9 | under 10 | | | 3 diphtheroids | |
| 8 | under 10 | | | 12 n h Staph. aureus, 18 diphtheroids | |
| 7 | | 30 under 10 | | 10 n h Staph. aureus, 8 diphtheroids | |
| 6 | | 10 under 10 | | 4 diphtheroids | 40 |
| 5 | | 50 20 | | 3 small n h pale Staph. aureus | |
| 4 | | 70 under 10 | | 3 n h Staph. albus, 1 diphtheroid | 43 |
| 3 | | 50 | | 4 n h Staph. aureus, 6 diphtheroids | 38 |
| 2 | | 40 10 | | 24 diphtheroids | |
| 8 days | | 10 under 10 | | 1 diphtheroid | |
| 5 days | | under 10 | | 2 n h Staph. aureus | |
| 2 days | | 20 under 10 | | Sterile | |
| 0 days | | 30 under 10 | | 2 n h pale Staph. aureus, 3 diphtheroids | 36 |

C33 LF (Contd.).

Examination of the milk. (Contd.).

A sample taken after the animal had been transported to the abattoir showed 400,000 cells per ml., 60 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; few lobules in upper part.

Gland cistern - globe shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0 mm. in diameter.

Areas A, B, C, D and E - lactating; lobules 3.0 mm. in diameter.

Areas A, B, D, D and E - lactating; lobules 3.0mm. in diameter.

Summary.- This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--------------|--------------|--|
| Gland cistern. | 16/16 normal | 16/16 | lactating; normal; few, small laminated corpora amylacea. |
| Level. 1 - A. | 16/16 normal | 16/16 | lactating; normal; few, small laminated corpora amylacea. |
| | C. | 16/16 normal | 14/16 lactating; normal 2/16 involuted; normal |
| | D. | 16/16 normal | 16/16 lactating; normal |
| | E. | 16/16 normal | 16/16 lactating; normal |
| Level 2 - A.1 | 16/16 normal | 16/16 | lactating; normal |
| | A.2 | 16/16 normal | 16/16 lactating; normal |
| | C. | 16/16 normal | 15/16 lactating; normal few cast 1/16 involuted; normal epith- :elial cell in the lumina. |

C33 LF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|--------------|---|
| Level 2. - D. | 16/16 normal | 16/16 lactating; normal |
| E. | 16/16 normal | 16/16 lactating; normal; lymphocytic aggregation in one lobule. |
| Level 3. - A. | 16/16 normal | 16/16 lactating; normal; lymphocytic aggregation in one lobule. |
| C. | 16/16 normal | 16/16 lactating; normal; lymphocytic aggregation in one lobule. |
| D. | 16/16 normal | 16/16 lactating; normal; cast epithelial cells in acini |
| E. | 16/16 normal | 16/16 lactating; normal |

Summary. -

Ducts normal throughout.

Lobules, normal throughout, 97% lactating.
3% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C33, left hindquarter, (C33 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--|--|
| | Lab.1 | Lab.2 | | | |
| 29 | under 10 | 70 | 35 | Sterile | |
| 28 | under 10 | under 10 | | Sterile | |
| 27 | under 10 | under 10 | | Sterile | |
| 26 | 20 | 10 | | 1 n h Staph. albus | |
| 25 | 10 | 10 | | 2 diphtheroids | |
| 24 | under 10 | | | Sterile | |
| 23 | under 10 | | | 1 diphtheroid | |
| 22 | 20 | | | Sterile | |
| 21 | under 10 | | | Sterile | |
| 20 | 30 | | | 1 n h Staph. aureus | 47 |
| 19 | 10 | | | Sterile | |
| 18 | | | | Sterile | 40 |
| 17 | under 10 | | | 2 n h Staph. albus, 3 diphtheroids | 40 |
| 16 | under 10 | under 10 | | Few n h Staph. aureus | 38 |
| 15 | 30 | 10 | | 11 n h Staph. aureus, 3 diphtheroids | 42 |
| 14 | 70 | under 10 | | Sterile | |
| 13 | under 10 | | | Sterile | |
| 12 | under 10 | under 10 | | 2 n h Staph. aureus, 1 diphtheroid | |
| 10 | 10 | | | Sterile | |
| 9 | 20 | | | 1 n h Staph. aureus, 1 diphtheroid | |
| 8 | under 10 | | | 2 n h Staph. aureus, 2 diphtheroids | |
| 7 | 10 | under 10 | | 28 n h Staph. aureus, 8 diphtheroids | |
| 6 | 30 | under 10 | | 1 n h Staph. aureus, 1 diphtheroid | 39 |
| 5 | 30 | 20 | | 8 n h Staph. aureus | 39 |

C33 LH (Contd.).

Examination of the milk. (Contd.)

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---|--|
| | Lab.1 | Lab.2 | | | |
| 4 | 20 | under 10 | | 1 n h Staph. aureus | 40 |
| 3 | 40 | | | 1 n h Staph. aureus, 1 n h Pale Staph.aureus | 38 |
| 2 | 70 | 40 | 50 | 1 diphtheroids | |
| 8 days | 10 | under 10 | | 3 n h Staph. aureus, 4 diphtheroids | |
| 5 days | | under 10 | | 1 n h Pale Staph.aureus | |
| 2 days | 10 | under 10 | | 2 n h Pale Staph.aureus | 36 |
| 0 days | 10 | 60 | 15 | Sterile | |

A sample taken after the animal had been transported to the abattoir showed 260,000 cells per ml., 37 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no lobules or pockets in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules
3.0mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

C33 LH (Contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--------------|--------------|---|
| Gland cistern. | 16/16 normal | 12/16 | lactating; normal |
| | | 2/16 | involuted; normal |
| | | 2/16 | involuted; post-inflammatory involution. |
| Level 1. - A. | 16/16 normal | 15/16 | lactating; normal |
| | | 1/16 | involuted; normal |
| | C. | 16/16 normal | 10/16 lactating; normal |
| | | | 4/16 involuted; normal |
| | | | 2/16 involuted; post-inflammatory involution. |
| | D. | 16/16 normal | 15/16 lactating; normal |
| | | | 1/16 involuted; normal |
| | E. | 16/16 normal | 12/16 lactating; normal |
| | | | 4/16 involuted; post-inflammatory involution; few polymorphs in ductules. |
| Level 2. - A. | 16/16 normal | 16/16 | lactating; normal; lymphocytic aggregation in one lobule. |
| | C. | 16/16 normal | 14/16 lactating; normal. |
| | | | 2/16 involuted; normal. |
| | D. | 16/16 normal | 16/16 lactating; normal. lymphocytic aggregation in two lobules. |
| | E. | 16/16 normal | 16/16 lactating; normal; lymphocytic aggregation in two lobules. |
| Level 3. - A. | 16/16 normal | 12/16 | lactating; normal. |
| | | 4/16 | involuted; normal. |
| | C. | 16/16 normal | 15/16 lactating; normal. |
| | | | 1/16 involuted; normal. |

C33 LH (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|--------------|-------|--|
| Level 3. - D. | 16/16 normal | 16/16 | lactating; normal |
| E. | 16/16 normal | 10/16 | lactating; normal |
| | | 6/16 | involuted; post-inflammatory involution; few polymorphs in ductules. |

Supramammary lymph node - No abnormality seen.

Summary. -

Ducts, normal throughout.

Lobules, 6% involuted; post-inflammatory involution; acute exudate in parts.

84% lactating; normal
10% involuted; normal

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------|------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C33, right forequarter, (C33 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|--|--|
| | Lab. 1 | Lab. 2 | | | |
| 29 | 20 | 20 | | Sterile | |
| 28 | under 10 | under 10 | | 6 h Staph. aureus | |
| 27 | under 10 | under 10 | | 3 h Staph. aureus | |
| 26 | under 10 | under 10 | | 6 n h Staph. aureus | |
| 25 | under 10 | 10 | | 1 n h Staph. aureus, 1 n h Staph. albus, 1 diphtheroid | |
| 24 | under 10 | | | Sterile | |
| 23 | 20 | | | Sterile | |
| 22 | under 10 | | | 1 n h Staph. aureus, 20 diphtheroids | |
| 21 | under 10 | | | 1 n h Staph. aureus, 5 diphtheroids | |
| 20 | 20 | | | 2 n h Staph. aureus | 42 |
| 19 | under 10 | | | 8 diphtheroids | |
| 18 | | | | Sterile | 40 |
| 17 | under 10 | | | Sterile | 40 |
| 16 | under 10 | under 10 | | Sterile | 37 |
| 15 | under 10 | 10 | | Sterile | 42 |
| 14 | 20 | 20 | | Sterile | |
| 13 | under 10 | | | Sterile | |
| 12 | under 10 | under 10 | | 2 n h Staph. aureus | |
| 10 | under 10 | | | 1 diphtheroid | |
| 9 | under 10 | | | 14 diphtheroids | |
| 8 | under 10 | | | 5 diphtheroids | |
| 7 | 10 | under 10 | | 5 n h Staph. aureus, 14 diphtheroids | |
| 6 | under 10 | under 10 | | 5 diphtheroids | |
| 5 | under 10 | 20 | | 3 diphtheroids | |
| 4 | 10 | under 10 | 32 | 2 diphtheroids | 40 |

C33 RF (Contd.)

Examination of the milk. (Contd.).

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent. :age of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 3 | 70 | | | 21 diphtheroids | 39 |
| 2 | 800 | 610 | 66 | 30 diphtheroids | |
| 8 days | 320 | 210 | 78 | 25 diphtheroids | |
| 5 days | | 240 | 77 | 7 diphtheroids | |
| 2 days | 240 | 230 | 73 | 24 diphtheroids | 35 |
| 0 days | 290 | 220 | 62 | 12 diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 4,950,000 cells per ml., 80 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets; lobules extending almost to rosette.

Gland cistern - globeshaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter; slightly darker in colour than those of hindquarter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter; slightly darker in colour than those of hindquarter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter; slightly darker in colour than those of the hindquarter.

Conclusion. -

This quarter had the appearance of a normal lactating quarter, but the lobules were slightly darker than those of the right hindquarter.

G33 RF (Contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|-----------------|-------|--|
| Gland cistern. | 16/16 normal | 15/16 | lactating; normal |
| | | 1/16 | involuted; normal |
| Level 1. - A. | 16/16 normal | 16/16 | lactating; normal |
| | C. 16/16 normal | 12/16 | lactating; normal |
| | | 4/16 | lactating; moderate acute; suppression in one area with vacuolated epithelium. |
| | D. 16/16 normal | 11/16 | lactating; normal |
| | | 1/16 | lactating; focal moderate acute. |
| | | 4/16 | involuted; post-inflammatory involution; polymorphs in ductules. |
| | E. 16/16 normal | 13/16 | lactating; normal |
| | | 3/16 | lactating; focal moderate acute. |
| Level 2. - A. | 16/16 normal | 15/16 | lactating; normal |
| | | 1/16 | involuted; normal |
| | C. 16/16 normal | 12/16 | lactating; normal |
| | | 4/16 | involuted; post-inflammatory involution; polymorphs in ductules. |
| | D. 16/16 normal | 15/16 | lactating; normal; perivascular lymphocytic aggregation in one lobule. |
| | | 1/16 | involuted; normal |
| | E. 16/16 normal | 16/16 | lactating; normal; perivascular lymphocytic aggregation in one lobule. |
| Level 3. - A. | 16/16 normal | 15/16 | lactating; normal. |
| | | 1/16 | involuted; normal. |

C33RF (Contd.).

Microscopic examination. (Contd.)

| | Ducts. | | Lobules. |
|---------------|-----------------|---------------|--|
| Level 3. - C. | 16/16 normal | 16/16 | lactating; normal; very small perivascular lymphocytic aggregation in one lobule. |
| | D. 16/16 normal | 14/16 1/16 | lactating; normal lactating; moderate acute; suppression with vacuolated epithelium. |
| | | 1/16 | involuted; normal |
| | E. 16/16 normal | 13/16 | lactating; normal aggregation of lymphocytes in one lobule. |
| | | 3/16 | involuted; normal |

Summary. -

Ducts, normal throughout.

Lobules, 84% lactating; normal
 4% lactating; moderate acute; suppression
 in parts.
 8% involuted; normal
 4% involuted; post-inflammatory involution;
 acute exudate in ductules.

Post-mortem cultures from tissues.

| | Direct blood plate | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|------------|--------------------------|--------------------------------------|--|
| Level 1 | Sterile | Sterile | Sterile |
| Level 2 | Sterile | Sterile | Sterile |
| Level 3 | Sterile | Sterile | Sterile |
| Level 1 RH | n h Staph. | n h Staph. | n h Staph. |

⊠ In taking the specimen from Level 1 of the right hindquarter the drill penetrated right forequarter.

C33, right hindquarter, (C33, RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|--|--|
| | Lab.1 | Lab2 | | | |
| 29 | 30 | 20 | | Sterile | |
| 28 | under 10 | 10 | | Sterile | |
| 27 | under 10 | under 10 | | Sterile | |
| 26 | under 10 | under 10 | | 1 n h Staph. aureus | |
| 25 | under 10 | under 10 | | Sterile | |
| 24 | under 10 | | | Sterile | |
| 23 | 10 | | | Sterile | |
| 22 | under 10 | | | 3 n h Staph. aureus | |
| 21 | under 10 | | | 8 n h Staph. aureus | |
| 20 | 40 | | | 2 n h Staph. aureus, 1 diphtheroid | 45 |
| 19 | under 10 | | | Sterile | |
| 18 | | | | Sterile | 40 |
| 17 | under 10 | | | Sterile | |
| 16 | 20 | under 10 | | Sterile | |
| 15 | under 10 | under 10 | | 30 h Staph. albus. | |
| 14 | 20 | under 10 | | 18 n h Staph. aureus, 8 diphtheroids | |
| 13 | under 10 | | | Sterile | |
| 12 | 20 | under 10 | | Sterile | |
| 10 | under 10 | | | Sterile | |
| 9 | under 10 | | | 1 n h Staph. aureus | |
| 8 | 20 | | | 1 n h Staph. aureus | |
| 7 | 20 | 30 | | 2 n h Staph. aureus, 14 diphtheroids | |
| 6 | under 10 | under 10 | | 2 n h Staph. aureus | 39 |
| 5 | 20 | under 10 | | Sterile | 39 |
| 4 | under 10 | under 10 | | 1 n h Staph. aureus | 40 |
| 3 | 20 | | | 1 diphtheroid | 39 |

C33 RH (Contd.).

Examination of the milk. (Contd.).

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 2 | 50 | 10 | | 1 diphtheroid | |
| 8 days | under 10 | under 10 | 10 | 3 diphtheroids | |
| 5 days | | under 10 | 10 | Sterile | |
| 2 days | 20 | 50 | | 1 n h Staph. albus | 34 |
| 0 days | 10 | under 10 | | Sterile | |

A sample taken after the animal had been transported to the abattoir showed 190,000 cells per ml., 33 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; lobules extending almost to rosette.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This quarter was normal and lactating.

C33 RH (Contd.)

Microscopic examination.

| | Ducts. | | Lobules. | |
|---------------|--------|--------|-------------------------------------|---|
| Gland cistern | 16/16 | normal | 12/16 lactating; 4/16 involuted; | normal normal |
| Level 1. - C. | 16/16 | norma | 12/16 lactating; 4/16 involuted. | normal normal |
| D. | 16/16 | normal | 12/16 lactating; 4/16 involuted; | normal normal |
| E. | 16/16 | normal | 15/16 lactating; 1/16 involuted; | normal normal |
| Level 2. - A. | 16/16 | normal | 15/16 lactating; 1/16 involuted; | normal normal |
| C. | 16/16 | normal | 16/16 | lactating; normal |
| D. | 16/16 | normal | 15/16 lactating; 1/16 involuted; | normal; small aggregation of lymphocytes in one lobule. normal |
| E. | 16/16 | normal | 16/16 | lactating; normal |
| Level 3. - A. | 16/16 | normal | 13/16 lactating; 3/16 involuted; | normal; small aggregation of lymphocytes in one lobule. normal. |
| C. | 16/16 | normal | 12/16 lactating; 4/16 involuted. | normal; small aggregation of lymphocytes in one lobule. normal. |
| D. | 16/16 | normal | 16/16 | lactating; normal |
| E. | 16/16 | normal | 16/16 | lactating; normal |

Supramammary lymph node - No abnormality seen.

C33 RH (Contd.).

Microscopic examination. (Contd.).

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, 89% lactating.
11% involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|-----------------------|---------------------------|--------------------------------------|--|
| Level 1. [■] | n h Staph. | n h Staph. | n h Staph. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

■ In taking the specimen from Level 1 of this quarter the drill penetrated the right forequarter.

Animal No. C35.

Summary of the main features of each quarter of the udder.

C35 LF. Normal.

C35 LH. Normal.

C35 RF. Blind quarter.

C35 RH. Normal.

Animal No. C35.

Ayrshire heifer, Auchincruive No. 33. Born 2/2/47; calved 26/11/49; slaughtered 29/3/50, 17 weeks after calving. Udder frozen 29/3/50 and examined 30/3/50.

C35, left forequarter, (C35 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------------|--|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | 10 | | | Neg. | |
| 8 | under 10 | under 10 | | Neg. | 34 |
| 7 | under 10 | | | 2 diphtheroids | 38 |
| 6½ | under 10 | | | Neg. | |
| 6 | under 10 | 10 | | 1 diphtheroid | 36 |
| 5½ | | 30 under 10 | | 1 diphtheroid | 37 |
| 5 | under 10 | under 10 | | 2 diphtheroids | 38 |
| 4 | 10 | under 10 | | Sterile. | |
| 3 | 20 | | | Neg. | 38 |
| 2 | 10 | | | Neg. | 42 |
| 6 days | under 10 | under 10 | | 10 diphtheroids | 40 |
| 0 days | 30 | 70 | 78 | | |

A sample taken after the animal had been transported to the abattoir showed 340,000 cells per ml., 68 per cent. being granular cells.

Macroscopic examination.

Teat cistern - Many lobules in wall.

Gland cistern - Globe-shaped; many lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was an overstocked quarter in full lactation.

C35 LF. (Contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|--|-------|---|
| Gland cistern. | 16/16 normal. | 16/16 | lactating; normal; cast epithelial cells in acini and ductules. |
| Level 1. - A. | 16/16 normal. | 16/16 | full lactation; normal. |
| | C. 16/16 normal; cast ep- :ithelial cells in the :luminas. | 16/16 | full lactation; normal. |
| | D. 16/16 normal. | 16/16 | full lactation; normal; lymphocytic focus in interacinar tissue in one lobule. |
| | E. 16/16 normal; cast ep- :ithelial cells in the :luminas. | 16/16 | full lactation; normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, lactating.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile | Sterile. | Sterile. |

C35, left hindquarter, (C35 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos) |
|------------------------------|---|----------|---|---------------------------------|---|
| | Lab.1 | Lab.2 | | | |
| 10 | under 10 | | | Neg. | |
| 8 | 20 | | | Neg. | 34 |
| 7 | under 10 | 20 | | Sterile. | 38 |
| 6½ | 20 | | | Neg. | |
| 6 | 10 | 10 | | 35 diphtheroids | 38 |
| 5½ | under 10 | under 10 | | 2 diphtheroids | 37 |
| 5 | 10 | under 10 | | 12 diphtheroids | 38 |
| 4 | under 10 | 10 | | 8 diphtheroids | |
| 3 | 60 | | | Neg. | 39 |
| 2 | 10 | | | Neg. | 42 |
| 6 days | 10 | under 10 | | 18 diphtheroids | 43 |
| 0 days | 20 | 30 | | Neg. | 41 |

A sample taken after the animal had been transported to the abattoir showed 460,000 cells per ml., 63 per cent. being granular cells.

Macroscopic examination.

Teat cistern - lobules in wall.

Gland cistern - globe-shaped; many lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This quarter was overstocked and in full lactation.

C35 LH. (Contd.).

Microscopic examination.

| | Ducts. | | Lobules. | |
|----------------|------------------|-------|-----------------|---------|
| Gland cistern. | 16/16 normal. | 16/16 | full lactation; | normal. |
| Level 1. - A. | 16/16 normal. | 16/16 | full lactation; | normal. |
| | C. 16/16 normal. | 16/16 | full lactation; | normal. |
| | D. 16/16 normal. | 16/16 | full lactation; | normal. |
| | E. 16/16 normal. | 16/16 | full lactation; | normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, lactating.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |

C35, right forequarter, (C35 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | under 10 | | | Neg. | |
| 8 | | | | | |
| 7 | 1,910 | 4,000 | 90 | Neg. | |

Macroscopic examination.

Teat cistern - lower part obliterated by core of fibrous tissue; only upper 3.0cms. still patent.

Gland cistern - small; contained straw-coloured fluid.

Level 1. - Areas A, B, C, D and E - involuted; lobules 0.5mm. in diameter.

Level 2. - Areas A, B, C, D and E - involuted; lobules 0.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - involuted; lobules 0.5mm. in diameter.

Conclusion. -

A "blind" quarter; ducts distended with straw-coloured fluid.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|--------------------------|
| Gland cistern. | 16/16 normal. | 16/16 involuted; normal. |
| Level 1. - B. | 16/16 normal. | 16/16 involuted; normal. |
| C. | 16/16 normal. | 16/16 involuted; normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout; involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | n h Staph. | Sterile. |

C35, right hindquarter, (C35 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | under 10 | | | Neg. | |
| 8 | 10 | | | Neg. | 35 |
| 7 | 10 | under 10 | | Sterile. | 38 |
| 6½ | 10 | | | Neg. | 36 |
| 6 | 10 | 10 | | 4 diphtheroids | |
| 5½ | under 10 | 10 | | 16 diphtheroids | 38 |
| 5 | 10 | under 10 | | 5 diphtheroids | 37 |
| 4 | 10 | under 10 | | 12 diphtheroids | |
| 3 | 10 | | | Neg. | 38 |
| 2 | 10 | | | Neg. | 39 |
| 6 days | under 10 | under 10 | | 3 diphtheroids | 42 |
| 0 days | 40 | 20 | | Neg. | 40 |

A sample taken after the animal had been transported to the abattoir showed 250,000 cells per ml., 76 per cent. being granular cells.

Macroscopic examination.

Teat cistern - shallow pockets and few lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This quarter was overstocked and in full lactation.

C35 RH. (Contd.).

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|----------------------------------|
| Gland cistern. | 16/16 normal. | 16/16 lactating; normal. |
| Level 1. - A. | 16/16 normal. | 16/16 full lactation; normal. |
| C. | 16/16 normal. | 16/16 full lactation; normal. |
| D. | 16/16 normal. | 16/16 full lactation; normal. |
| E. | 16/16 normal. | 16/16 full lactation; normal. |

Summary. -

Ducts, normal throughout.

Lobules, normal throughout, lactating.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | n h Staph. | Sterile. |

Animal No. C36.

Summary of the main features of each quarter of the udder.

C36 LF. Normal.

C36 LH. Normal.

C36 RF. Post-inflammatory involution.

C36 RH. Severe unifocal acute lobular mastitis.

Animal No. C36.

Ayrshire heifer, Auchincruive No. 83. Born 18/3/47; calved 19/11/49; slaughtered 29/3/50, 18½ weeks after calving. Udder frozen 29/3/50 and examined 30/3/50. Daily milk yield, 21/1/50 22 lbs.

C36, left forequarter, (C36 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousnads per ml.) | | Percentage of granular cells. | Micro-organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------|--------------------------------------|-------|-------------------------------|-------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | 20 | | | neg. | |
| 9 | under 10 | | | neg. | |
| 8 | under 10 | | | neg. | 40 |
| 7 | under 10 | | | neg. | 38 |
| 6 | under 10 | | | neg. | 44 |
| 5 | under 10 | | | neg. | 42 |
| 4 | 10 | | | neg. | |
| 3 | 20 | | | neg. | 39 |
| 2 | 20 | | | neg. | 45 |
| 1 | 50 | | 30 | 10 diphtheroids | 43 |
| 0 days | under 10 | | 10 | 40 neg. | 56 |

■ 8½ weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 30,000 cells per ml.

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.
Areas C and D - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B and E - lactating; lobules 3.0mm. in diameter; chrome-coloured.
Areas C and D - involuted; lobules 1.0mm. in diameter.

C36 LF (contd.).

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter, chrome-coloured.

Conclusion. - This was an overstocked lactating quarter.

Microscopic examination.

| | Ducts. | | Lobules. |
|----------------|------------------|-------|---|
| Gland cistern. | 16/16 normal. | 12/16 | lactating; normal; cast epithelial cells in acini. |
| | | 4/16 | involuted; normal. |
| Level 1. - A. | 16/16 normal. | 16/16 | full lactation; normal; a few cast epithelial cells in acini. |
| | | | |
| | C. 16/16 normal | 14/16 | lactating; normal; a few cast epithelial cells in acini. |
| | | 2/16 | involuted; normal. |
| | | | |
| | E. 16/16 normal. | 16/16 | lactating; normal; a few cast epithelial cells in acini. |

Summary.

Ducts normal throughout.

Lobules - 91% full lactation and lactating; normal.
9% involuted; normal.

Post-mortem cultures from tissues

| | Blood plate Direct from blood enrichment plate. | Potassium tellurite blood plate from enrichment broth. |
|----------|--|--|
| Level 1. | Sterile n h Staph | Sterile |

C36, left hindquarter, (C36 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|--|--------------------------------|--|
| | Lab. 1 | Lab. 2 | | | |
| 10 | 60 | | | neg. | |
| 9 | 20 | | | neg. | |
| 8 | 20 | | | neg. | 39 |
| 7 | under 10 | | | neg. | 38 |
| 6 | under 10 | | | neg. | 40 |
| 5 | under 10 | | | neg. | 43 |
| 4 | 20 | | | neg. | |
| 3 | 20 | | | neg. | 39 |
| 2 | 10 | | | neg. | 40 |
| 1 | 20 | 10 | | Sterile | 44 |
| 0 days | under 10 | under 10 | | neg. | 56 |

■ 8½ weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 40,000 cells per ml.

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.
Areas C and D - involuted; lobules 1.0mm. in diameter; chrome-coloured.

Level 2. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.
Areas C and D - involuted; lobules 1.0mm. in diameter; chrome-coloured.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion.- This was an overstocked lactating quarter.

Microscopic examination.

C36 LH (contd.).

| | Ducts. | | Lobules. |
|----------------|--|---------------|--|
| Gland cistern. | 16/16 normal. | 8/16 | lactating; normal; cast epithelial cells in acini. |
| | | 8/16 | involuted; normal. |
| Level 1. - A. | 16/16 normal; cast epithelial cells in the lumina. | 16/16 | lactating; normal; cast epithelial cells in acini. |
| | C. | 16/16 normal. | 4/16 lactating; normal; cast epithelial cells in acini. |
| | | | 12/16 involuted; normal. |
| | D. | 16/16 normal. | 16/16 lactating; normal; cast epithelial cells in acini. |

Supramammary lymph node.- No abnormality seen.

Summary.

Ducts normal throughout.

Lobules - 70% lactating; normal.
30% involuted; normal.

Postmortem cultures from the tissues

| | | |
|--------|-------------|---------------------|
| Direct | Blood plate | |
| blood | from | Potassium tellurite |
| plate. | enrichment | blood plate from |
| | plate. | enrichment broth. |
| | broth. | |

Level 1. Sterile Sterile Sterile

C36, right forequarter, (C36 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). | |
|------------------------------|---|-------|--|--------------------------------|--|----|
| | Lab.1 | Lab.2 | | | | |
| 10 | | 20 | | neg. | | |
| 9 | | 20 | | neg. | | |
| 8 | under | 10 | | neg. | 36 | |
| 7 | | 20 | | neg. | 37 | |
| 6 | under | 10 | | neg. | 40 | |
| 5 | under | 10 | | neg. | 40 | |
| 4 | | 60 | | neg. | | |
| 3 | | 130 | | neg. | 40 | |
| 2 | | 100 | 90 | 48 | neg. | 39 |
| 1 | | 130 | 100 | 51 | 5 diphtheroids | 47 |
| 0 days | | 360 | 320 | 59 | neg. | 74 |

■ 8½ weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 570,000 cells per ml., 60 per cent. being granular leucocytes.

Macroscopic examination.

Teat cistern - shallow pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.
Areas C and D - involuted; lobules 1.0mm. in diameter; chrome-coloured.

Level 2. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.
Areas C and D - involuted; lobules 1.0mm. in diameter; chrome-coloured.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion.- This was an overstocked lactating quarter.

C36 RF (contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|---------------|--|------------------------------|---|
| Level 1. - A. | 16/16 normal. cast epithelial cells and eosin- :ophils in the lumina. | 9/16 1/16 3/16 3/16 | lactating; normal; a few cast epithelial cells in acini. lactating; mild acute; mainly eosinophils. involuted; normal. involuted; post-in- :flammatory involution. |
| C. | 16/16 normal. | 8/16 5/16 3/16 | lactating; normal; a few cast epithelial cells in acini. involuted; normal. involuted; post-in- :flammatory involution. |
| D. | 16/16 normal. | 8/16 3/16 2/16 3/16 | lactating; normal; a few cast epithelial cells in acini. lactating; mild acute; mainly eosinophils. involuted; normal. involuted; post-in- :flammatory involution. |
| E. | 16/16 normal. | 15/16 1/16 | lactating; normal; a few cast epithelial cells in acini. involuted; post-in- :flammatory involution. |

Summary.

Ducts normal throughout.
 Lobules - 62% lactating; normal.
 6% lactating; mild acute.
 16% involuted; normal.
 16% involuted; post-inflammatory involution.

Post-mortem cultures from the tissues.

| | Blood plate | |
|----------|-------------|---------------------|
| Direct | from | Potassium tellurite |
| blood | enrichment | blood plate from |
| plate. | broth. | enrichment broth. |
| Level 1. | Sterile | Sterile |

C36 right hindquarter, (C36 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|--|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | | 30 | | neg. | |
| 9 | under 10 | | | neg. | |
| 8 | | 10 | | neg. | 38 |
| 7 | under 10 | | | neg. | 37 |
| 6 | under 10 | | | neg. | 39 |
| 5 | | 10 | | neg. | 43 |
| 4 | | 10 | | neg. | |
| 3 | | 20 | | neg. | 39 |
| 2 | | 10 | | neg. | 41 |
| 1 | under 10 | | 20 | Sterile | 42 |
| 0 days | | 20 | under 10 | neg. | 54 |

8 8½ weeks after calving.

A sample taken after the animal had been transported to the abattoir showed 50,000 cells per ml.

Macroscopic examination.

Teat cistern - pockets and lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B and E - lactating; lobules 3.0mm. in diameter.

Areas C and D - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B and E - lactating; lobules 3.0mm. in diameter; chrome-coloured.

Areas C and D - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter; chrome-coloured.

Conclusion.- This was an overstocked lactating quarter.

C36 RH (contd.).

Microscopic examination.

| | Ducts. | | Lobules. |
|---------------------------|----------------------|---------------|--|
| Gland cistern | 16/16 normal. | 16/16 | involuted; normal, except for acute focus in interductular tissue in one lobule. |
| Level 1. - A. | 16/16 normal. | 16/16 | lactating; normal; a few cast epithelial cells in acini. |
| | C. | 16/16 normal. | 4/16 lactating; normal; a few cast epithelial cells in acini. |
| | | | 12/16 involuted; normal. |
| | D. | 16/16 normal. | 12/16 lactating; normal; a few cast epithelial cells in acini. |
| | | | 4/16 involuted; normal. |
| Supramammary lymph node.- | No abnormality seen. | | |

Summary.

Ducts normal throughout.

Lobules - 50% lactating; normal.
50% involuted; normal except for an acute focus in the interductular tissue in one lobule.

Post-mortem cultures from the tissues.

| | Blood plate | | Potassium tellurite |
|----------|------------------|---------|---------------------|
| | Direct from | | blood plate from |
| | blood enrichment | | enrichment broth. |
| | plate. | broth. | |
| Level 1. | Sterile | Sterile | Sterile |

Animal No. C37.

Summary of the main features of each quarter of the udder.

C37 LF. Mild acute lobular mastitis.

**C37 LH. Post-inflammatory involution
and sub-acute duct lesions.**

C37 RF. Mild acute lobular mastitis.

C37 RH. Normal.

Animal No. C37.

Ayrshire heifer, Auchincruive No. 84, College Kindness 620-84. Born 18/3/47; calved 9/12/49; slaughtered 29/3/50, 16 weeks after calving. Udder frozen, 29/3/50 and examined 30/3/50:

Daily milk yield, 21/1/50 - 22 lbs.

History:- left hind teat "tramped" at time of calving and was not milking freely; teat bougie inserted; quarter treated with Udolac, (a sulphone preparation).

C37, left forequarter, (C37 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percentage of granular cells. | Micro-organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------|--------------------------------------|----------|-------------------------------|--------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | under 10 | | | Neg. | |
| 9 | under 10 | | | Neg. | |
| 8 | under 10 | | | Neg. | 42 |
| 7 | 10 | | | Neg. | 34 |
| 6 | under 10 | | | Neg. | 40 |
| 5 | under 10 | | | Neg. | 42 |
| 4 | 10 | | | Neg. | |
| 3 | 100 | | | Neg. | 40 |
| 2 | 80 | 50 | 52 | 14 diphtheroid | 44 |
| 6 days | 20 | under 10 | 40 | 6 diphtheroid | 44 |
| 0 days | | 10 | 48 | Neg. | |

A sample taken after the animal had been transported to the abattoir showed 730,000 cells per ml., 54 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; lobules present.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was an overstocked lactating quarter.

C37 LF (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|----------------|--|--|
| Gland cistern. | 16/16 normal; few cast epithelial cells in the lumina. | 15/16 lactating; normal; few cast epithelial cells in many acini. 1/16 lactating; mild acute. |
| Level 1. - A. | 16/16 normal; many cast epithelial cells in the lumina. | 14/16 lactating; normal; few cast epithelial cells in many acini. 2/16 lactating; mild acute. |
| | C. 16/16 normal. | 16/16 partially involuted. |
| | D. 16/16 normal | 16/16 lactating; normal; few cast epithelial cells in some acini. |
| Level 2. - A. | 16/16 normal | 16/16 lactating; normal; few cast epithelial cells in some acini. |
| | C. 16/16 normal; many cast epithelial cells in the lumina. | 15/16 lactating; normal; few cast epithelial cells in some acini. 1/16 lactating; focal mild acute, mainly eosinophils. |
| | D. 16/16 normal; many cast epithelial cells in the lumina. | 16/16 lactating; normal; few cast epithelial cells in some acini. |
| | E. 16/16 normal; many cast epithelial cells in the lumina. | 16/16 lactating; normal; few cast epithelial cells in some acini. |

C37 LF (Contd.).

Microscopic examination. (Contd.)

Summary. -

Ducts, normal throughout; cast epithelial cells in many.

Lobules, 84% lactating; normal; cast epithelial cells in some acini.
4% lactating; mild acute; cast epithelial cells in some acini.
12% partially involuted.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Strep. bovis. | Sterile. |

C37, left hindquarter, (C37 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|---------|--|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | No sample | | | | |
| 9 | No sample | | | | |
| 8 | No sample | | | | |
| 7 | No sample | | | | |
| 6 | 4,320 | 11,200 | 71 | num. atyp. streps. | 48 |
| 5 | 11,900 | 66,000x | 88 | num. atyp. streps. | 60 |
| 4 | 25,800 | 25,000 | 84 | Sterile. | |
| 3 | 7,240 | 20,000 | 84 | Sterile. | 57 |
| 2 | 3,100 | 3,180 | 71 | 12 diphtheroids | 57 |
| 6 days | 3,900 | 3,960 | 47 | 6 diphtheroids | 53 |
| 0 days | | 6,320 | 53 | Neg. | |

■ Sample blood-stained; contained many small clots.

A sample taken after the animal had been transported to the abattoir showed 16,480,000 cells per ml., 55 per cent. being granular cells.

Macroscopic examination.

Streak canal - small nodule at upper end.

Teat cistern - few lobules in wall; no pockets; epithelial lining rough.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating and involuted; lobules 1.0mm. and 2.0mm. in diameter.

Microscopic examination.

Ducts.

Lobules.

| | | |
|----------------|-----------------------------------|--|
| Gland cistern. | 16/16 moderate to severe subacute | 16/16 involuted; post-inflammatory polymorphs present in interductular tissue in addition to other cells |
|----------------|-----------------------------------|--|

C37 LH. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|---|---------------|---|
| Level 1. - C. | 16/16 moderate to severe subacute | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| E. | 16/16 moderate to severe subacute | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| Level 2. - A. | 16/16 moderate to severe subacute; many polymorphs & other cells in the lumina. | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| B. | 16/16 moderate to severe subacute. | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| C. | 16/16 moderate to severe subacute | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| Level 3. - A. | 16/16 mild to moderate subacute; many polymorphs and eosinophils in the lumina | 12/16 4/16 | lactating; normal, except for suppression in one lobule. involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |
| C. | 16/16 moderate to severe subacute. | 16/16 | involuted; post-inflammatory involution; polymorphs present in interductular tissue in addition to other cells. |

C37 LH (Contd.).

Microscopic examination. (Contd.).

Supramammary lymph node - mild sinus catarrh.

Summary. -

Ducts, all moderate to severe subacute.

Lobules, 90% post-inflammatory involution; polymorphs interstitially.
10% lactating; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile | Sterile. | Sterile. |
| Level 3. | n h Staph. | Sterile. | Sterile. |

C37, right forequarter, (C37 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|----------|---|---------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | 20 | | | Neg. | |
| 9 | 10 | | | Neg. | |
| 8 | 10 | | | Neg. | 43 |
| 7 | under 10 | | | Neg. | 36 |
| 6 | under 10 | | | Neg. | 42 |
| 5 | 10 | | | Neg. | 43 |
| 4 | 90 | | | Neg. | |
| 3 | 540 | | | Neg. | 41 |
| 2 | 150 | 160 | 68 | 12 diphtheroids | 49 |
| 6 days | 60 | 100 | 58 | 17 diphtheroids | 46 |
| 0 days | | under 10 | | | |

A sample taken after the animal had been transported to the abattoir showed 540,000 cells per ml., 58 per cent. being granular cells.

Macroscopic examination.

Teat cistern - no pockets in wall; lobules present.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was an overstocked lactating quarter.

Microscopic examination.

Ducts.

Lobules.

Gland cistern. 16/16 normal 14/16 lactating; normal; few cast epithelial cells in many acini.
2/16 lactating; mild acute; 2 lobules affected; epithelium vacuolated.

C37 RF. (Contd.).

Microscopic examination. (Contd.)

| | Ducts. | | Lobules. |
|---------------|--------------|--------------|---|
| Level 1. - A. | 16/16 normal | 16/16 | lactating; normal; few cast epithelial cells in acini. |
| | C. | 16/16 normal | 16/16 lactating; normal; few cast epithelial cells in acini. |
| | E. | 16/16 normal | 16/16 partially involuted; normal; few cast epithelial cells in acini. |

Summary. -

Ducts, normal throughout.

Lobules, 73% lactating; normal.

2% lactating; mild acute.

25% partially involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------------|--------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |

C37, right hindquarter, (C37 RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells | Micro- organisms present | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|--|--------------------------------|--|
| | Lab.1 | Lab.2 | | | |
| 10 | | | | | |
| 9 | under 10 | | | Neg. | |
| 8 | under 10 | | | Neg. | 43 |
| 7 | under 10 | | | Neg. | 35 |
| 6 | under 10 | | | Neg. | 41 |
| 5 | under 10 | | | Neg. | 42 |
| 4 | under 10 | | | Neg. | |
| 3 | 20 | | | Neg. | 40 |
| 2 | 10 under 10 | | | 6 diphtheroids | 45 |
| 6 days | 10 under 10 | | | Sterile | 43 |
| 0 days | | 20 | | Neg. | |

A sample taken after the animal had been transported to the abattoir showed 40,000 cells per ml.

Macroscopic examination.

Teat cistern - no pockets or lobules in wall.

Gland cistern - globe-shaped; lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 3.0mm. in diameter.

Conclusion. -

This was an overstocked lactating quarter.

Microscopic examination.

Ducts.

Lobules.

Gland cistern. 16/16 normal 16/16 lactating; normal;
few cast epithelial
cells in many acini.

Animal No. C42.

Summary of the main features of each quarter of the udder.

C42 LF. Severe unifocal acute lobular mastitis.

C42 LH. Severe acute lobular mastitis.

C42 RF. Severe acute lobular mastitis.

C42 RH. Severe unifocal acute lobular mastitis.

Animal No. C42.

Ayrshire heifer, Auchincruive No. 9. Born 21/3/47; calved 8/11/49; slaughtered 13/6/50, 31 weeks after calving. Udder frozen, 13/6/50 and examined 15/6/50. Daily milk yield, 21/1/50 - 26 lbs.
2/5/50 - 22 lbs.

The hide of this animal was badly "warbled".

C42, Left forequarter, (C42 LF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells. | Micro-organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------|--------------------------------------|----------|------------------------------------|--|--|
| | Lab. 1 | Lab. 2 | | | |
| 30 | under 10 | | | Neg. | 37 |
| 29 | under 10 | | | Neg. | 39 |
| 28 | | 20 | | Neg. | 41 |
| 27 | under 10 | | | Neg. | |
| 26 | | 10 | | Neg. | |
| 25 | under 10 | | | Neg. | |
| 24 | | 40 | | Neg. | |
| 23 | under 10 | | | Neg. | |
| 22 | | 10 | | Neg. | |
| 21 | under 10 | | | Neg. | |
| 20 | under 10 | | | Neg. | |
| 19 | under 10 | | | Sterile | 39 |
| 18 | | 20 | | Sterile | 38 |
| 17 | under 10 | | | Sterile | 39 |
| 16 | | 10 | | Sterile | 40 |
| 15 | under 10 | | | Sterile | |
| 14 | under 10 | | | Neg. | 40 |
| 13 | under 10 | | | Neg. | 42 |
| 12 | | 20 | | Neg. | 43 |
| 11 | | 10 | | Sterile | 34 |
| 10 | | 10 | | Neg. | 36 |
| 9 | under 10 | | | Neg. | 39 |
| 7½ | | 20 | | Neg. | 39 |
| 7 | | 10 | under 10 | Neg. | 38 |
| 5½ | under 10 | under 10 | | Neg. | 43 |
| 4½ | | 20 | 40 | 1 diphtheroids | 46 |
| 3 | | 60 | 50 34 | 3 diphtheroids | 38 |
| 2 | | 20 | 50 21 | 4 diphtheroids | 38 |
| 1 | | 60 | 50 27 | 2 n h Staph. aureas. 9 diphtheroids | |

C42 LF. (Contd.).

A sample taken after the animal had been transported to the abattoir showed 270,000 cells per ml., 10 per cent. being granular leucocytes.

Macroscopic examination.

Teat cistern - deep pockets and lobules in wall.

Gland cistern - globe-shaped; chrome-coloured lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 2.5mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 2.5mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.5mm. in diameter.

Conclusion.

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|--|
| Gland cistern. | 16/16 normal. | 16/16 lactating; normal. |
| Level 1. - A. | 16/16 normal. | 16/16 full lactation; normal. |
| C. | 16/16 normal. | 8/16 lactating; normal. 8/16 involuted; normal; aggregation of lympho- cytes in one lobule. |
| D. | 16/16 normal. | 16/16 full lactation; normal. |
| E. | 16/16 normal. | 16/16 full lactation; normal. |

C42 LF. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|---------------|--|
| Level 2. - A. | 16/16 normal. | 15/16 full lactation; normal. 1/16 full lactation; severe acute (in 2 acini in one lobule); eosinophils predominate in exudate. |
| C. | 16/16 normal. | 15/16 full lactation; normal. 1/16 involuted; normal. |
| D. | 16/16 normal. | 16/16 lactating; normal. |
| E. | 16/16 normal. | 16/16 full lactation; normal. |
| Level 3. - A. | 16/16 normal. | 16/16 full lactation; normal. |
| C. | 16/16 normal. | 16/16 full lactation; normal. |
| D. | 16/16 normal. | 16/16 full lactation; normal. |
| E. | 16/16 normal. | 12/16 full lactation; normal. 4/16 partially involuted; normal. |

Summary.

Ducts, normal throughout.

Lobules, 93% lactating; normal.
 1% lactating; severe acute; eosinophils predominate in exudate.
 6% involuted and partially involuted; normal.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------|------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | n h Staph. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |

C42, Left hindquarter, (C42 LH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity. (x 10 ⁻⁴ mhos). |
|------------------------------|---|-------|---|---------------------------------|---|
| | Lab.1 | Lab.2 | | | |
| 30 | under 10 | | | Neg. | 38 |
| 29 | under 10 | | | Neg. | 39 |
| 28 | 30 | | | Neg. | 41 |
| 27 | 30 | | | Neg. | |
| 26 | under 10 | | | Neg. | |
| 25 | under 10 | | | Neg. | |
| 24 | 80 | | | Neg. | |
| 23 | 10 | | | Neg. | |
| 22 | under 10 | | | Neg. | |
| 21 | under 10 | | | Neg. | |
| 20 | 10 | | | Neg. | |
| 19 | 10 | | | Sterile. | 40 |
| 18 | 20 | | | Sterile. | 38 |
| 17 | under 10 | | | Sterile. | 39 |
| 16 | under 10 | | | 2 diphtheroids | 40 |
| 15 | 10 | | | Sterile. | |
| 14 | under 10 | | | Neg. | 40 |
| 13 | 20 | | | Neg. | 41 |
| 12 | 10 | | | Neg. | 42 |
| 11 | 50 | | | Sterile. | 34 |
| 10 | under 10 | | | Neg. | 35 |
| 9 | under 10 | | | Neg. | 38 |
| 7½ | 310 | | | Neg. | 40 |
| 7 | 660 | 860 | 64 | Neg. | 40 |
| 5½ | 220 | 290 | 60 | Neg. | 43 |
| 4½ | 560 | 1,130 | 43 | 5 diphtheroids | 45 |
| 3 | 370 | 680 | 68 | 23 diphtheroids | 40 |
| 2 | 240 | 750 | 50 | 12 diphtheroids | 39 |
| 1 | 690 | 770 | 59 | 35 diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 3,840,000 cells per ml., 43 per cent. being granular cells.

C42, Left hindquarter, (Contd.).

Macroscopic examination.

Teat cistern. - deep pockets and lobules in wall.

Gland cistern. - globe-shaped; chrome-coloured lobules
in wall.

Level 1. - Areas A and B and part Areas D and E - lactating;
lobules 2.5mm. in diameter; a few are
chrome-coloured.

Area C and part of Areas D and E - involuted.
1.0mm. in diameter.

Level 2. - Area A and the majority of Area B - lactating;
lobules 2.5mm. in diameter.

Area E and the majority of Area D - lactating;
lobules 2.5mm. in diameter; chrome-coloured.

Area C and small part of Areas B and D -
involved; lobules 1.0mm. in diameter.

Level 3. - Areas A and E and the majority of Areas B and D -
lactating; lobules 2.5mm. in diameter;
chrome-coloured.

Area C and part of Areas B and D - involuted;
lobules 1.0mm. in diameter.

Supra-
:mammary
lymph
node. - No abnormality seen.

Conclusion. -

The process of involution was more advanced in this
quarter than in the other three quarters of the same udder
and chrome-coloured lobules were more abundant.

C42 LH. (Contd.).

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|--------------|--|
| Gland cistern. | 16/16 normal | 12/16 lactating; normal. 2/16 partially involuted; normal. 2/16 lactating; severe acute; large number of eosino- :phils in exudate. |
| Level 1. - A. | 16/16 normal | 14/16 full lactation; normal. 2/16 lactating; severe acute; mainly eosinophils in exudate. |
| C. | 16/16 normal | 6/16 lactating; normal. 4/16 lactating; severe acute; mainly eosinophils in exudate. 6/16 involuted; post-in- :flammatory involution. |
| D. | 16/16 normal | 6/16 lactating; normal. 6/16 lactating; severe acute; mainly eosinophils in exudate. 2/16 involuted; normal. 2/16 involuted; post-in- :flammatory involution. |
| E. | 16/16 normal | 12/16 full lactation; normal 1/16 lactating; severe acute; mainly eosinophils in exudate; acinar epith- :elium vacuolated. 2/16 involuted; normal. 1/16 involuted; post-in- :flammatory involution. |
| Level 2. - A. | 16/16 normal | 16/16 full lactation; normal. |
| C. | 16/16 normal | 13/16 full lactation; normal. 2/16 full lactation; severe acute; mainly eosino- :phils in exudate. 1/16 involuted; post-in- :flammatory involution. |

C42 LH. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|---------------|--------------|-------|--|
| Level 2. - D. | 16/16 normal | 10/16 | full lactation; normal. |
| | | 6/16 | full lactation; severe acute; mainly eosinophils in exudate; acinar epithelium vacuolated in one lobule. |
| E. | 16/16 normal | 11/16 | full lactation; normal |
| | | 4/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 1/16 | involuted; normal. |
| Level 3. - A. | 16/16 normal | 10/16 | full lactation; normal |
| | | 2/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 2/16 | involuted; normal. |
| | | 2/16 | involuted; post-inflammatory involution. |
| C. | 16/16 normal | 5/16 | full lactation; normal |
| | | 2/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 4/16 | involuted; normal. |
| | | 3/16 | involuted; post-inflammatory involution. |
| | | 2/16 | involuted; post-inflammatory involution; acute exudate in ductules. |
| D. | 16/16 normal | 15/16 | full lactation; normal. |
| | | 1/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| E. | 16/16 normal | 14/16 | full lactation; normal. |
| | | 2/16 | involuted; normal. |

Supra-mammary lymph node.

- eosinophils scattered through.

C42 LH. (Contd.).

Microscopic examination. (Contd.).

Summary. -

Ducts, normal throughout.

Lobules, 67% lactating; normal.

17% lactating; severe acute; eosinophils predominate in the exudate.

8% involuted and partially involuted; normal.

8% involuted; post-inflammatory involution.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|--------------------------------------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile | h c + Staph. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |
| Supra- ;mammary lymph node. | n h Staph | n h Staph. | n h Staph. |

C42, right forequarter, (G42 RF).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- :age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁻⁴ mhos). |
|------------------------------|---|--------|---|---------------------------------|--|
| | Lab. 1 | Lab. 2 | | | |
| 30 | under 10 | | | Neg. | 37 |
| 29 | under 10 | | | Neg. | 38 |
| 28 | 10 | | | Neg. | 40 |
| 27 | 20 | | | Neg. | |
| 26 | 10 | | | Neg. | |
| 25 | 30 | | | Neg. | |
| 24 | under 10 | | | Neg. | |
| 23 | under 10 | | | Neg. | |
| 22 | under 10 | | | Neg. | |
| 21 | 10 | | | Neg. | |
| 20 | 20 | | | Neg. | |
| 19 | under 10 | | | 1 n h Staph. aureus. | 38 |
| 18 | 40 | | | 1 n h Staph. albus | |
| | | | | 1 diphtheroid | 38 |
| 17 | under 10 | | | Sterile. | 39 |
| 16 | under 10 | | | Sterile. | 40 |
| 15 | under 10 | | | Sterile. | |
| 14 | under 10 | | | Neg. | 40 |
| 13 | 90 | | | Neg. | 42 |
| 12 | under 10 | | | Neg. | 43 |
| 11 | 20 | | | Sterile. | 33 |
| 10 | 10 | | | Neg. | 36 |
| 9 | under 10 | | | Neg. | 39 |
| 7 $\frac{1}{2}$ | 50 | | | Neg. | 40 |
| 7 | 200 | 360 | 70 | Neg. | 40 |
| 5 $\frac{1}{2}$ | 140 | 240 | 59 | Neg. | 44 |
| 4 $\frac{1}{2}$ | 80 | 100 | 63 | 4 diphtheroids | 43 |
| 3 | 140 | 230 | 51 | 15 diphtheroids | 39 |
| 2 | 90 | 330 | 32 | 30 diphtheroids | 38 |
| 1 | 340 | 410 | 33 | 11 diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 4,000,000 cells per ml., 35 per cent. being granular cells.

C42 RF. (Contd.).

Macroscopic examination.

Teat cistern. - deep pockets in wall; lobules in upper part of wall.

Gland cistern. - globe-shaped; chrome-coloured lobules in wall.

Level 1. - Areas A, B, D and E - lactating; lobules 2.5mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 2. - Areas A, B, D and E - lactating; lobules 2.5mm. in diameter.

Area C - involuted; lobules 1.0mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.5mm. in diameter.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|--|
| Gland cistern. | 16/16 normal. | 3/16 lactating; normal. 12/16 involuted; normal. 1/16 involuted; post-inflammatory involution. |
| Level 1. - A. | 16/16 normal | 6/16 full lactation; normal. 2/16 full lactation; severe acute; mainly eosinophils in exudate. 2/16 partially involuted; normal. 4/16 involuted; normal. 2/16 involuted; post-inflammatory involution. |
| C. | 16/16 normal | 14/16 involuted; normal. 2/16 involuted; post-inflammatory involution. |

C42 RF. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | | Lobules. |
|------------|------------------|---|--|
| Level 1. - | D. 16/16 normal. | 6/16 | full lactation; normal. |
| | | 2/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 8/16 | involuted; normal. |
| | E. 16/16 normal. | 5/16 | full lactation; normal. |
| | | 2/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 7/16 | involuted; normal. |
| 2/16 | | involuted; post-inflammatory involution; acute exudate in ductules. | |
| Level 2. - | A. 16/16 normal. | 15/16 | full lactation; normal. |
| | | 1/16 | involuted; normal. |
| | C. 16/16 normal. | 7/16 | full lactation; normal. |
| | | 1/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 8/16 | involuted; normal. |
| | D. 16/16 normal. | 14/16 | full lactation; normal. |
| | | 1/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| | | 1/16 | involuted; normal. |
| | E. 16/16 normal. | 14/16 | full lactation; normal. |
| | | 2/16 | partially involuted; normal. |
| Level 3. - | A. 16/16 normal. | 16/16 | full lactation; normal. |
| | C. 16/16 normal. | 12/16 | full lactation; normal. |
| | | 1/16 | full lactation; severe acute; mainly eosinophils in exudate. |
| 1/16 | | partially involuted; normal. | |
| | 2/16 | involuted; normal. | |

C42 RF. (Contd.).

Microscopic examination. (Contd.).

Ducts.

Lobules.

Level 3. - D. 16/16 normal. 16/16 full lactation; normal.
E. 16/16 normal. 14/16 full lactation; normal.
2/16 partially involuted.

Summary.-

Ducts, normal throughout.

Lobules, 63% lactating; normal.

4% lactating; severe acute; eosinophils predominate in the exudate.

29% involuted and partially involuted; normal.

4% involuted; post-inflammatory involution.

Post-mortem cultures from tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|----------|---------------------|------------------------------------|--|
| Level 1. | Sterile. | Sterile. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | h c+ Staph. | Sterile. |

C42, right hindquarter, (C42, RH).

Examination of the milk.

| Weeks before slaughter | Total cell count (thousands per ml.) | | Percent- age of granular cells. | Micro- organisms present. | Electrical conductivity (x 10 ⁴ mhos). |
|------------------------------|---|-------|--|---|---|
| | Lab.1 | Lab.2 | | | |
| 30 | | 10 | | Neg. | 38 |
| 29 | under | 10 | | Neg. | 39 |
| 28 | under | 10 | | Neg. | 41 |
| 27 | | 40 | | Neg. | |
| 26 | | 10 | | Neg. | |
| 25 | | 20 | | Neg. | |
| 24 | under | 10 | | Neg. | |
| 23 | | 30 | | Neg. | |
| 22 | under | 10 | | Neg. | |
| 21 | under | 10 | | Neg. | |
| 20 | under | 10 | | Neg. | |
| 19 | under | 10 | | Sterile. | 38 |
| 18 | | 30 | | Sterile. | 38 |
| 17 | under | 10 | | Sterile. | 39 |
| 16 | | 10 | | Sterile. | 40 |
| 15 | under | 10 | | 1 diphtheroids | |
| 14 | under | 10 | | Neg. | 40 |
| 13 | | 270 | | Neg. | 41 |
| 12 | under | 10 | | Neg. | 42 |
| 11 | | 20 | | Sterile | 34 |
| 10 | under | 10 | | Neg. | 36 |
| 9 | | 10 | | Neg. | 38 |
| 7 $\frac{1}{2}$ | under | 10 | | Neg. | 40 |
| 7 | | 20 | under 10 | Neg. | 38 |
| 5 $\frac{1}{2}$ | | 20 | 10 | Neg. | 40 |
| 4 $\frac{1}{2}$ | under | 10 | 20 | Sterile. | 40 |
| 3 | | 20 | 30 | 5 diphtheroids | 37 |
| 2 | under | 10 | 70 | 28 25 diphtheroids | 38 |
| 1 | under | 10 | 10 | 24 (14 n h Staph. (aureus. (few diphtheroids | |

A sample taken after the animal had been transported to the abattoir showed 90,000 cells per ml., 28 per cent. being granular cells.

C42 RH. (Contd.).

Macroscopic examination.

Teat cistern. - shallow pockets in wall.

Gland cistern. - globe-shaped; chrome-coloured lobules in wall.

Level 1. - Areas A, B, C, D and E - lactating; lobules 2.5mm. in diameter.

Level 2. - Areas A, B, C, D and E - lactating; lobules 2.5mm. in diameter.

Level 3. - Areas A, B, C, D and E - lactating; lobules 2.5mm. in diameter.

Supra-
mammary
lymph
node. - No abnormality seen.

Conclusion. -

This was a normal lactating quarter.

Microscopic examination.

| | Ducts. | Lobules. |
|----------------|---------------|--|
| Gland cistern. | 16/16 normal. | 8/16 lactating; normal. 8/16 involuted; normal. |
| Level 1. - A. | 16/16 normal. | 16/16 lactating; normal. |
| C. | 16/16 normal. | 16/16 lactating; normal. |
| D. | 16/16 normal. | 16/16 lactating; normal; white blood cells, marginated in a vessel, mainly eosinophils. |
| E. | 16/16 normal. | 10/16 lactating; normal. 1/16 lactating; severe acute; eosinophils predominate in exudate. 2/16 partially involuted; normal. 3/16 involuted; normal. |

G42 RH. (Contd.).

Microscopic examination. (Contd.).

| | Ducts. | Lobules. |
|---------------|---------------|---|
| Level 2. - A. | 16/16 normal | 16/16 lactating; normal. |
| C. | 16/16 normal | 13/16 lactating; normal. 3/16 involuted; normal. |
| D. | 16/16 normal. | 16/16 lactating; normal. |
| E. | 16/16 normal. | 12/16 lactating; normal. 2/16 partially involuted; normal. 2/16 involuted; normal. |
| Level 3. - A. | 16/16 normal. | 16/16 lactating; normal. |
| C. | 16/16 normal. | 16/16 lactating; normal. |
| D. | 16/16 normal. | 16/16 lactating; normal. |
| E. | 16/16 normal. | 12/16 lactating; normal. 2/16 partially involuted; normal. 2/16 involuted; normal. |

Supra-
:mammary
lymph
node - eosinophils scattered through.

Summary. -

Ducts, normal throughout.

Lobules, 87% lactating; normal.
1% lactating; severe acute; eosinophils
predominate in exudate.
12% involuted and partially involuted;
normal.

C42 RH. (Contd.).

Post-mortem cultures from the tissues.

| | Direct blood plate. | Blood plate from enrichment broth. | Potassium tellurite blood plate from enrichment broth. |
|--------------------------------------|---------------------------|---------------------------------------|--|
| Level 1. | Sterile. | n h Staph. | Sterile. |
| Level 2. | Sterile. | Sterile. | Sterile. |
| Level 3. | Sterile. | Sterile. | Sterile. |
| Supra- :mammary lymph node. | Sterile. | n h Staph. | Sterile. |