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CELL COUNTS OF MILK IN RELATION TO THE
PATHOLOGY AND BACTERIOLOGY OF
BOVINE MASTITIS

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CELL COUNTS OF MILK IN RELATION TO THE PATHOLOGY AND
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SUMMARY

The author prepared and stained 2,500 milk smears and counted the cells present. Centrifugalisation of milk failed to sediment all cells. Volumes lifted by various wire loops were studied. All cells, other than mammary epithelial, in milk appeared identical to blood cells. Most samples contained polymorphs, epithelial cells and lymphocytes.

Variations in type and severity of lesions occurred in different parts of the same quarter. Pathology of 94 quarters was compared by a scoring system based on severity and extent of lesions. Total counts were generally directly related to extent of pathological changes. Polymorph proportions generally exceeded 70 per cent. in milk from acute inflamed quarters and were below 40 per cent. during involution without acute mastitis.

Pathological changes in the ratio 8:4:2:1 were

found associated respectively with C. pyogenes and Str. agalactiae: Str. uberis and coagulase-positive Staph. aureus: coagulase-negative Staph. aureus and sterile quarters: other bacteria. Ten most diseased quarters had larger circumferences at the canal rosette. Liability to mastitis appeared unaffected by pockets and ridges in teats. Transport of cows by lorry increased fivefold, on average, the cell counts of milk from 28 of 30 quarters and increased polymorph proportions in milk from acutely inflamed quarters.

P A R T O N E

INTRODUCTION

THE IMPORTANCE OF MASTITIS

The literature concerning mastitis is probably greater than that of any other disease of domestic animals. The condition not only reduces the daily and total milk yields during the lactation in which it occurs. It may damage the udder permanently to such an extent that affected cows may be slaughtered for economy long before the milking life would normally be completed. The great economic importance of mastitis was outlined by the Survey Committee of the National Veterinary Medical Association of Great Britain and Ireland (1941). After consulting most of the authorities on the subject and studying figures from many dairy herds the committee estimated that at least 25 per cent of the 3,200,000 cows in milk were affected by mastitis and that the national average annual yield of about 500 gallons was reduced in affected cows by at least twelve per cent. It concluded mastitis caused an annual deficiency of 48,000,000

gallons of milk worth £3,000,000 and of 80,000 calves worth £200,000. About ten per cent of affected cows were slaughtered or died owing to the condition and the £2,000,000 cost of their replacement made the total loss through mastitis about £5,200,000 per annum. The committee considered that Streptococcus agalactiae accounted for about 85 per cent of cases of mastitis.

Wilson (1953) stated that in over 1,000 cows in 25 herds the average lactation increased by 70 gallons after the eradication of Streptococcus agalactiae. Hughes (1954) recorded an annual incidence of clinical mastitis of 14 per cent among 4,267 cows. The Milk Marketing Board (1947) estimated from a random sample of 67,611 lactation records of dairy cows that the average number of lactations was only 3.1 per cow. Most cows are almost two and a half years old when they first calve and it seems many are butchered when only five years old. Generally milk secretion increases with each lactation until the seventh when most cows are about ten years old. When cows milk for at least seven lactations less young cows need be introduced to maintain a constant number in a herd and more surplus young cows can be sold for great profit. Mastitis in the older cows is one of the main factors reducing such a surplus.

The milk secreted by a quarter suffering from mastitis may appear to be normal but may possess a peculiar taste or smell and such milk may be unfit for human consumption or for butter or cheese making. When a quarter is seriously affected by mastitis there is often a macroscopic change in appearance and texture of the secretion. In extreme cases the secretion is yellow or green pus. In mild cases the secretion may not be macroscopically very different from milk. Such secretion consists of diluted pus and is frequently distributed for human consumption. Occasionally bovine udders become infected by Str. pyogenes from attendants and then the mastitis may be associated with epidemics of sore throat among the persons drinking the raw infected milk.

DIAGNOSIS

Clinical mastitis is generally easily diagnosed by palpation of the udder and observation of change in the secretion. The more common sub-clinical mastitis may be diagnosed in the laboratory and for this purpose many tests have been used which may be roughly divided into three classes.

1. Bacteriological Tests.

Attempts are made to culture from samples of the milk those bacteria which have been found usually associated with inflammation of the udder. These bacteria include Streptococcus agalactiae, Str. dysgalactiae, Str. uberis, Staphylococcus pyogenes aureus, Corynebacterium pyogenes, Bacterium coli and micrococci.

2. Cellular Tests.

Smears of the milk are examined in order to estimate the total number of cells and the differential count of those cells associated with inflammatory processes, especially polymorphonuclear leucocytes.

3. Physical or Chemical Tests.

The electrical conductivity, acidity reaction and chloride content may be measured and the number and size of clots observed.

There is considerable difference of opinion as to the diagnostic value of the various methods of examination. Some workers rely chiefly on the culture tests for diagnostic purposes regarding the presence of

certain pathogens in the milk as a positive criterion of mastitis. It has been shown by Malcolm, King and Campbell (1942); McFarlane (1947); Chu (1949); Stableforth (1953) and Hughes (1954) that some quarters affected with mastitis are apparently sterile. There is thus a limit to the reliability of culture tests. The cellular content of milk is a recognised indication of mastitis although it is thought to give no indication as to the aetiology of the disease.

BIOTICS

Penicillin, streptomycin and aureomycin therapy during the last decade greatly assisted in the control of bovine mastitis. Those mastitis organisms which are sensitive to such therapy appear to have been eliminated from some herds of dairy cows. While further success from therapy is expected there is need for further investigations into the factors which initiate mastitis. The understanding of the fundamental causes may lead to improved dairy husbandry which would be complementary to therapeutic advances. Some mastitis pathogens, such as Bacterium coli, resist biotic therapy and, while evidence of increased resistance of streptococci and staphylococci to biotics may be lacking, there is the

danger that insufficient doses of biotics might allow development in the future of resistant strains of these bacteria by natural selection and mutation.

COMBINED TOTAL AND DIFFERENTIAL CELL COUNTS

It was felt that information was needed of the occurrence of cells in milk in various types of mastitis. The total cellular content would be studied along with the proportions of the various types present and an attempt would be made to relate this output of cells to certain types of bacteria which are associated with mastitis. Any test which can be used to assist in more effective diagnosis of mastitis will be of great value in any eradication scheme. The combined total and differential cell count test can be carried out anywhere within half an hour of the collection of the milk sample. The technique is cheap and can be carried out competently by most laboratory technicians. It was therefore considered that this test was well worthy of further investigation.

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P A R T T W OHISTORICAL

Savage (1906) counted between 35,000 and 4,380,000 cells per ml. in samples from 40 cows and considered that all the cells were leucocytes. Slack (1906) set a standard technique of counting cells in order to define whether milk contained pus. Russell and Hoffman (1907) generally found over 500,000 cells per ml. in milk from cows with clinical mastitis and sometimes over 1,000,000 cells per ml. in normal milk. They also thought all cells were leucocytes.

Pennington and Roberts (1908) found what they considered to be pus in the milk of 75 per cent of cows examined towards the end of lactation. Hewlett, Villar and Revis (1909-10) rarely observed phagocytosis of bacteria by the cells of milk. Although they found many multinucleate cells they stated that most cells in milk differed markedly from leucocytes. They added six drops of formalin to 60 ml. of milk to increase the deposit after centrifuging. They found strippings were twice as rich in cells as fore and mid milk.

Prescott and Breed (1910) introduced their direct method of counting cells in milk and considered that no

method using the centrifuge can yield a satisfactory cell count. Savage (1910) observed that in milk from bovine and human purulent mastitis 80 per cent or more of cells were polymorphonuclear. Counts above 800,000 cells per ml. he classes as abnormal. Breed and Stidger (1911) considered that daily counts of quarter samples from three cows tended to vary in cycles of intervals of three days.

Breed (1914) found that leucocytes and epithelial cells were discharged in the milk of all cows throughout lactation. Baker and Breed (1920) used milk samples from three herds, measured the pH and calculated some of the earliest differential cell counts. In samples with very high leucocyte counts they usually observed streptococci. Varrier-Jones (1924) described polymorphonuclear leucocytes having fine and others having coarse eosinophile granules, the former being phagocytic. Large epithelial cells occurred in nearly every sample and were abundant towards the end of lactation. He injected streptococci through the teat canal into a goat's udder and found that the deposit obtained after centrifuging the milk was then ten times what it had been before the injection. This was mainly due to increased output of polymorphonuclear leucocytes, many

of which were seen to have phagocytosed bacteria.

Runnells and Huddleson (1925) found chronic diffuse mastitis most often and thought proliferative changes occurred first in the ducts and later in the parenchyma. Bourgeois (1927) found that in samples from ten normal quarters about half of the cells were polymorphonuclear leucocytes while the remainder were lymphocytes and monocytes. In nine cases of streptococcal and four of staphylococcal mastitis he estimated that between 77 and 92 per cent of all cells were polymorphonuclear leucocytes. He considered mastitis was indicated when over 70 per cent of cells in a sample were polymorphs. Breed (1929) considered that variable numbers of leucocytes were found in normal milk.

McFadyean (1930) stated that Ottolenghi (1901) found very many corpora amylacea surrounded by multinuclear giant cells, while Lenfers (1907) found corpora amylacea mostly in the udders of cows towards the end of lactation. McFadyean considered that the multinuclear giant cells appeared to be phagocytes. He occasionally found corpora amylacea partly excavated at the points of contact with giant cells but quoted that Joest and Steck (1924) found irregular cells with shrunken nuclei close to corpora amylacea.

Scholl and Torrey (1931) described interstitial, exudative, suppurative and fibrous types of mastitis from 92 cases. They recovered streptococci from 115 quarters in 83 of which interstitial mastitis was found. Variations in severity and type of mastitis often occurred in different quarters of a cow and even in different parts of a quarter. Mastitis was found in 124 of 165 quarters, bacteriological examination of which was negative.

Cherrington, Hansen and Halvarsen (1933) found cells in all samples but considered they were all leucocytes. They counted a mean of 3,000,000 cells per ml. in 168 samples from seven cows having clinical mastitis and only 43,000 in 144 samples from six healthy cows. In their opinion the leucocyte count gave the most satisfactory indication as to whether a quarter was affected by mastitis compared with counts of bacteria grown on plain and blood agar plates and with measurements of pH.

Hopkirk (1933) also thought all cells were leucocytes and that counts from formalinised monthly samples indicated whether a quarter contained mastitis. Holm (1934) thought all cells in milk were leucocytes and that polymorphs occurred in mastitic samples only, while only lymphocytes occurred in normal milk. Malcolm (1937) considered that mastitic milk contained many polymorph

leucocytes. Minett (1937) quoted that Steck (1930) concluded that the polymorph leucocyte count in milk was directly correlated with the bacterial count. Minett found that 40 per cent of samples from 415 cows contained Staphylococcus aureus.

Morrill (1938) described the pathology of 20 udders. In his opinion streptococcal mastitis was a chronic process associated with areas of acute exudative mastitis. He found more fibrosis in lower levels of the glands around the sinus and that in some cases the presence of polymorphonuclear leucocytes was associated with vacuolisation of epithelial cells lining the acini. Turner (1939) described the anatomy and histology of the bovine mammary gland and reviewed the relevant literature.

Watts (1940) reported an experiment in which staff of one laboratory prepared smears from 56 samples by pipette while staff of another laboratory made smears from the same samples by platinum loop. Both staffs counted cells in both smears of all samples. Smears made by pipette contained about twice as many cells as those made from the loop. He found that in most smears cells counted by one staff were about twice those counted by the other staff. Watts concluded that the cell count test showed no definite differentiation

between infected and non-infected samples and that it showed an excessive number of false results whatever standard of cell count was chosen whether fore-milk, mid-milk or strippings were used.

MacLean (1940) found that 92 per cent of counts on sterile samples from 86 quarters were below 100,000 cells per ml. while 62 per cent of counts on infected samples from 82 quarters were over 200,000 cells per ml.

Sheehan (1939) stained leucocyte granules by Sudan Black B and improved the method with Storey (1947). Malcolm (1940) found that culture tests on samples of milk often failed to detect mastitis in quarters yielding these samples. He considered that counts over 1,000,000 cells per ml. indicated mastitis while those below 500,000 probably indicated normal quarters. The advantages of a cell count test were that it was performed more quickly than culture tests and that the cell count was not affected by contamination.

Malcolm, King and Campbell (1942) using culture tests failed to reveal mild latent forms of streptococcal and staphylococcal mastitis in about one fourth of cases even where cell counts remained high. They considered over 500,000 cells per ml. indicated mastitis and this count test agreed with culture tests in 95 per cent of

quarter samples. Much higher percentages of polymorph leucocytes were found in mastitic than in normal milk. They stated that correct diagnosis was shown by the culture test in only 74 per cent of quarters, by the conductivity test in 90 per cent, the cell count test in 93 per cent and by the combined conductivity and cell count tests in every quarter. From 46 quarters with clinical mastitis bacteria were cultured from the milk of only 31 and in 14 of these Staphylococcus aureus was the only organism.

Malcolm and Smillie (1942) compared ten random cell counts on each of five different samples of 0.01 ml. of milk delivered from a pipette with ten random counts on each of the five samples from a platinum loop. They considered the variation of counts was insignificant, but the counts on loop samples were always lower. From their figures it appears that counts on smears from a loop are only about three quarters of counts on smears from a pipette. They conclude that counts by various technicians on the same samples reveal no significant variation and found that the distribution of cells in smears was usually even and that calculation of cell count based on the number of cells counted in 32 random fields of the one twelfth objective was sufficiently

accurate. Samples from quarters affected with streptococcal mastitis in five cows generally contained more than 1,000,000 cells per ml. and seldom less than 500,000 cells per ml.

Malcolm, King and Campbell (1944) found that samples from half of the mastitic quarters during the first lactation showed increased cell counts and conductivity prior to the presence of pathogenic bacteria. Cell counts and conductivity increased simultaneously with the occurrence of staphylococci from samples of the other quarters. They concluded "the primary cause of the initial mastitis in heifers is so far obscure. Certainly none of the organisms to which sub-acute mastitis is usually attributed is even presumptively implicated except occasionally staphylococci..." Malcolm and Campbell (1946) found that of 27 first lactation cows which developed mastitis 19 secreted only sterile milk. Earliest indications of abnormality were increased cell counts and conductivity which preceded by one to three months the detection of staphylococci or other pathogenic bacteria in the milk. Cell counts were valuable in their opinion compared to the unreliable culture tests in diagnosing early mastitis. Of their cases of non-specific mastitis in

the first lactation about one third developed specific mastitis during the second lactation. Different bacteria were recovered at different times from milk from some mastitic quarters while in many samples mixed infections were found.

Zlotnik (1947) studied the cells in quarter samples from seven cows. In his opinion normal milk contained no polymorphonuclear leucocytes. In abnormal milk he found neutrophil polymorphonuclear leucocytes similar to those of the blood which he called pseudopolymorphs thinking they were epithelial and these constituted from six to 40 per cent of cells. McEwen and Cooper (1947) examined frequent quarter samples from all cows in one large herd. Streptococcus agalactiae was recovered from the milk of 46 quarters, half of which produced milk persistently having many large clots and the milk of 31 of which contained over 1,000,000 cells per ml. They concluded that as the severity of the mastitis increases and clots appear in the milk so does Streptococcus agalactiae become the predominating organism and that udder corynebacteria, coagulase negative haemolytic staphylococci and non-haemolytic micrococci may be held responsible for increased cell counts in milk, indicative of at least a mild inflammatory reaction. "No evidence

was found that infection with one bacterium predisposed the quarter to infection with a more pathogenic bacterial infection." They found that quarters which were easily milked had a higher incidence of mastitis than "hard milkers". "When all affected quarters, both those giving milk with a count of 250,000 cells or more and those showing clots are grouped together the coagulase positive haemolytic staphylococci are found associated with the greatest number of affected quarters."

McFarlane (1947) summarised work by McEwen, Malcolm, Slavin and Blackburn on the bacteriology and pathology of 200 quarters. Progressive mastitis was exudative and spreading while dormant mastitis showed mostly macrophages especially in the lumina of alveoli, but appeared not to be spreading. Of 32 sterile quarters eleven showed progressive mastitis, 14 showed dormant mastitis and only seven showed no active or progressive changes. Streptococcus agalactiae was cultured from 13 quarters most of which showed severe diffuse mastitis and in eleven of which the milk contained from three to seven million cells per ml. It was concluded that the presence of pathogenic staphylococci in udder tissue had not greatly affected the cell counts when compared with those of sterile quarters.

Chu (1949) classified 87 pathological quarters into five groups according to the predominant lesion. He found pathological changes in a quarter secreting milk with 21,000 cells per ml. and assumed a healthy quarter would produce milk with less cells. When assessed on the pathological findings he considered that the chloride test was reliable in 87 per cent of cases, the catalase test in 92 per cent, the Whiteside test in 82 per cent and the total cell count test reliable in every case. The culture test was reliable in only 45 per cent of cases, pathogenic bacteria being cultured from 39 of the 87 quarters. He considered culture tests should not be used as a basis for assessing the diagnostic value of the indirect tests. He cited Petersen, Hastings and Hadley (1938) and McFarlane, Rennie and Blackburn (1947) that in normal mammary tissue lymphocytes are usually present in small numbers but that polymorphonuclear leucocytes are rare.

McFarlane, Blackburn, Malcolm and Wilson (1949) studied the pathology and bacteriology of 54 quarters and found that persistently high cell counts in the milk in mid-lactation are a reliable criterion of mastitis. Their results showed close agreement between culture tests of the milk and of udder tissue. The cell count

test was more reliable than the culture tests of the milk in diagnosing mastitis. Of 31 mastitic glands twelve were sterile. Transport of one cow by lorry was thought to account for an increased cell count despite no finding of pathological change in the quarter.

Spencer and McNutt (1950) studied the pathology of 25 quarters and considered the cell count a valuable indication of sub-clinical mastitis and that normal milk contained less than 1,000,000 cells per ml. Owing to retention of milk for one or two days in alveoli they often found vacuolisation of the epithelial cells in areas of acute inflammation. Hyperplasia of the epithelium of larger ducts occurred in chronic mastitis. They found great variation in type and severity of lesions in different parts of the same quarter and state that "quarters in which the approximate duration of infection was less than six weeks showed lesions similar to quarters infected for six months or longer". Foci of acute inflammation were found in most quarters affected by chronic streptococcal mastitis and from this they conclude that the development of a lesion is a periodic extension to new areas as the earlier affected areas undergo atrophy. They considered that generally mastitis appeared more severe than might have been

expected from the small number of organisms recovered from samples of milk taken from the quarter post-mortem.

Aynsley (1953) isolated 500 cultures of bacteria, including 126 strains of Str. agalactiae and 116 Staph. pyogenes, from cases of bovine mastitis and found no evidence of increased resistance of streptococci to penicillin. She isolated no highly resistant staphylococci. Stableforth (1953) recorded that of 2,005 mastitis samples examined 27 per cent were bacteriologically negative, 18 per cent contained Staph. pyogenes, 12 per cent had Str. uberis, 9 per cent Str. agalactiae and 8 per cent had Str. dysgalactiae. Hughes (1954) recorded an annual incidence of clinical mastitis of 14 per cent among 4,267 cows. Of 2,684 cases of clinical mastitis during five years 25 per cent had Str. agalactiae, 18 per cent had Str. uberis, 13 per cent had Staph. pyogenes, 12 per cent had Str. dysgalactiae while 5.4 per cent were negative. Teat patency appeared of secondary importance in relation to the entry of Str. agalactiae. He stated that probably as a result of indiscriminate use of antibiotic treatments many areas in U.S.A. now have formidable problems associated with *Pseudomonas*, coliforms and yeasts which are relatively unusual in Britain.

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P A R T T H R E E

MATERIALS AND METHODS

The pathology and bacteriology of 94 quarters were studied in the present work. The 24 cows used came from farms most of which lay within 20 miles of Glasgow. The West of Scotland Agricultural College Clean Milk Department every three months examined composite samples of milk from some of the cows of these and many other farms. The composite sample is a mixture of samples from all quarters of a cow. No cows were bought for the present work. Farmers informed the Department when a certain cow was about to be sold for slaughter. An attempt was made to have collected at least one batch of quarter samples of milk taken early on the morning just before the cow left the farm. All cows were in their fifth or subsequent lactation.

Most of the cows were slaughtered in the casualty section of Glasgow Corporation Abattoir. Generally quarter samples were taken from the cow after her arrival. Samples were also taken from the udder post-mortem. The author collected the udders of some of the cows from slaughter-houses at Ayr, Hamilton, Dumbarton and Kilmarnock. These udders were brought at once to

the Veterinary Laboratory at Glasgow Abattoir in which the present work was carried out. Great care was taken during removal of the udder from the carcass to insure that the udder tissue was not penetrated by the knife. In the laboratory the double elastic membrane separating the two halves of the udder was very carefully dissected and surplus skin and fat was removed. Each half udder was then laid flat on a tray and kept in the deep freeze chamber until frozen solid. It is considered that mastitis organisms are unaffected by such treatment. All bacteriological work was undertaken by the Bacteriology Department of the West of Scotland Agricultural College. A bacteriologist collected samples of tissue from the frozen udder and cultured any bacteria present.

Technique of Collection of Milk Samples

The udder was gently washed with a standard hypochlorite solution and then wiped with a dry sterile cloth. The teats were wiped with a cotton wool swab soaked in surgical spirit. The first two streams of milk from each quarter were discarded into a strip cup and about 20 ml. drawn into a sterile McCartney bottle, the cap of which was screwed on securely. Quarter samples collected on farms by the College staff were used throughout the present studies.

Technique of Bacteriological Examination

Quarter samples collected as described above were taken immediately to the Bacteriology Department of the West of Scotland Agricultural College. In the appendix this is referred to as Lab. 1 (Laboratory No. 1). Samples from the left fore and hind quarters were each inoculated on to one half of a sterile plain blood agar plate. Those from the right quarters were inoculated on to a second plate and the plates were incubated at 37°C. for 48 hours.

In order to exclude the faster growing more common staphylococci samples were also inoculated on to Edwards' crystal violet medium. By this means occasionally sparse colonies of streptococci were cultured which otherwise might have been overlooked. Coagulase-negative staphylococci were previously considered to be non-pathogenic. In this work the abbreviation n.p.s. has been used to designate these bacteria. Streptococci were identified by the precipitin tests and by reactions in solutions of various sugars. All bacteriological technique and interpretations were carried out by the staff of the Bacteriology Department.

Formalinising of Milk

Immediately after the plating out of samples for

bacteriological examination two drops of formalin were added to each quarter sample which was then shaken to ensure thorough distribution of the formalin. The formalin fixed the cells satisfactorily and usually prevented the appearance of the degenerated cells which have caused much confusion in the past. There is very much greater adherence of smears of milk to glass slides after formalin treatment. Previously it was found that smears made from untreated milk were very liable to be washed off the slide during the staining and washing processes.

Technique of Preparation of Milk Smear

During the present work the author prepared and stained, without technical assistance, about 2,500 milk smears and counted the cells present. The Veterinary Laboratory is referred to in the appendix as Lab. 2 (Laboratory No. 2). The author twice a week collected bottles containing quarter samples from the West of Scotland Agricultural College. Each quarter sample was shaken vigorously by hand. To achieve uniform distribution of cells a standard shaking was used comprising ten complete up and down movements of the arm, the bottle moving one foot with each arm movement. The bottle was then stood on a bench for 30 seconds to allow

the escape of air bubbles. The cap was then removed and the bottle held at an angle of 45° to the vertical. A sterile platinum loop was then inserted into the sample about 2.0 cm. and withdrawn as quickly as possible without touching the sides of the tube. Slides were cleaned with a silk cloth and placed over a metal slide in which were cut four holes each 1.0 cm. square. One smear, 1.0 cm. square, from each quarter sample of a cow was placed on each slide in the order left fore, left hind, right fore and right hind quarter. The number of the cow was marked on the slide by a diamond pencil. Since it was important to ensure that reproducible results were obtained a special study, described below in PART THREE (a), was made of the volume of milk lifted by loops of different types as compared with pipette.

Technique of Staining

The smears were dried on a level hot plate, defatted by immersion for two minutes in tetrachlorethane, drained and dried. They were immersed for 20 minutes in the Sudan Black B. solution used for staining cytoplasmic granules in leucocytes by Sheehan and Storey (1947), treated with 0.1 per cent acid alcohol for 30 seconds to remove the stain from any fat globules, washed in water for two minutes, drained, dried and counterstained by

Leishman's method.

Technique of Sampling Udder Tissue

Areas about three inches in diameter on the lateral surface of the quarter were sterilised by cautery. This was achieved by repeated application of red-hot painter's scrapers to the area of sub-cutaneous tissue until it was charred. A sterile twist drill was then carefully attached to a brace and the centre of the charred area was drilled to a depth of about two inches. The drilled udder tissue was collected by sterile forceps immediately and inserted into tubes of bouillon. Spirals of frozen tissue often adhered to the drill on withdrawal and these were also collected. From a single point of entry drillings were made in five directions into the udder tissue in order to achieve more efficient sampling.

In some large quarters tissue was collected from three such charred areas, in some quarters from only two areas while from some small quarters one area was used for sampling. In those quarters which suffered most serious clinical mastitis it was considered that one central area provided samples typical of the whole quarter. The three areas corresponded to the three levels of the udder. Level 1 included the gland sinus

and the larger lateral ducts; Level 2 was about the middle of the quarter; Level 3 was near the centre of the dorsal half of the quarter. The above technique is that used by McFarlane (1947) and later modified by Blackburn (1948, unpublished).

Technique of Counting Cells

For observation of cells during counting a five times eyepiece was used in conjunction with an oil immersion lens. The diameter of the field under observation was 0.20 mm. when the tube length was 170.0 mm. The area of the smear as described by Prescott and Breed (1910) is 1.0 sq.cm. which is about 3,200 times the area of the field observed during the present work. The number of cells in the Breed smear was estimated by counting those in a sample of 32 fields which covered about one hundredth of the total area. No attempt was made to search for cells. Counting was begun in a field near the bottom right hand corner of the smear. By means of the adjustable moving stage the 32 fields examined were spaced as regularly as possible over the smear. The Breed smear is made from about 0.01 ml. of milk and the estimated number of cells in 1.0 ml. of milk is therefore the number of cells in the 32 fields times 10,000. Where cells were plentiful then 200 or

300 were counted to facilitate calculation of percentages.

Three tally counters were secured to a board so that the thumb and first two fingers of one hand might be used to record cells as they were observed. The first counter recorded polymorphonuclear leucocytes, the second lymphocytes and the third epithelial cells. This method of working three counters simultaneously by one hand was devised by Blackburn (1948, unpublished).

Technique of Pathological Examination

During the present work the author cut, fixed, embedded and prepared all 928 blocks and cut, stained and examined all sections without technical assistance. At least two sections were cut from each block by means of a rocking microtome. One section was stained by haematoxylin and eosin. The other and any extra sections were stained by methods including Gram's, Van Gieson's, Weigert's elastica and Lendrum's carbol chromotrope.

Generally four blocks A, C, D and E were cut from each of the same three levels as those from which tissue was drilled for bacteriological examination. A block was also cut from the gland sinus. Block A was from the centre of the level and was square; block C was cut from the anterior angle of a fore quarter and from the

posterior angle of a hind quarter and was triangular. Block D was from the lateral surface of the level and was rectangular except that one corner was cut off. Block E was from the medial surface of a quarter and was rectangular except that two corners were cut off. Block B, cut only infrequently, was rectangular and included the supposed line of junction of the two quarters in one half of an udder. In most udders this line of junction could not be determined macroscopically nor microscopically. Blocks from left fore quarters were stained during fixation by brilliant green, those from right fore quarters stained orange by potassium dichromate and those from right hind quarters stained red by carbol fuchsia. Left hind quarter tissues were fixed without stain. The above techniques of shaping and staining blocks were used by MacFarlane (1947).

Treatment of Blocks of Mammary Glands

Duffy (1948, personal communication) advised the following treatment. The blocks were put into bottles of corrosive formol fixative for three hours to harden. They were then trimmed more accurately into shape and the surface required for sectioning was cut smooth and they were left overnight in the fixative. Next day they were put into 80 per cent methylated spirit and

were left overnight in methylated spirit containing eight per cent phenol which softened the tough mammary tissue. The next day they passed through two bottles of absolute alcohol and were left on the third night in a mixture of equal parts absolute alcohol and benzol. On the fourth day they were passed through two bottles of benzol until clearing was complete when they were left overnight in molten paraffin wax. After passing into the third tin of wax they were blocked.

Treatment of Blocks of Bovine Teats

The blocks were fixed for 24 hours in Bouin's solution as modified by Fitch (1948, personal communication) in that the solution contained 0.5 per cent trichloroacetic acid and no acetic acid. Blocks were then transferred to 80 per cent methylated spirit for 24 hours. They were left overnight in methylated spirit containing eight per cent phenol. During the next 24 hours the specimens were in three changes of absolute alcohol, then one hour in a mixture of equal parts absolute alcohol and amyl acetate. After 24 hours in three changes of amyl acetate they were cleared in benzol for ten minutes and blocked in paraffin. To reduce contamination during fixation, dehydration and clearing of the solutions used all blocks were caught by nickel forceps and allowed to

drain. They were dried quickly on blotting paper before being dropped into the next solution.

P A R T T H R E E (a)

COMPARISON OF THE VOLUMES OF MILK OBTAINED

BY VARIOUS SIZES OF WIRE LOOP

For making Breed smears Malcolm (1948, personal communication) used a loop formed by wrapping a platinum wire as closely as possible round his standard glass tubing of 3.75 mm. external diameter. The platinum wire used was No. 26 Gauge of diameter 0.4572 mm. Malcolm considered such a loop generally lifted about 0.01 ml. of milk and this standard loop was used by his staff in Lab. 1. In the present work the author made the first 750 smears by means of a pipette, but this method was so slow that a loop was used subsequently and so that counts on the same samples by Lab. 1 and the author's Lab. 2 would be more comparable it was decided to use Malcolm's loop throughout the main part of the work. However, it was felt that investigations should be made to confirm whether this standard loop lifted about 0.01 ml. of milk and to ascertain the variation using several samples of milk. It was noted that

usually no milk was obtained if the loop was withdrawn quickly. Burri (1928) found less than ten per cent variation in weights of water picked up by a loop but suggested that a complete ring of platinum wire was preferable to a loop.

Methods

The volumes lifted by a loop were measured to the nearest 0.5 cu. mm. in a serological pipette. The tip of the pipette was applied to the base of the loop and capillary attraction drew all the milk into the pipette in an unbroken column. Between readings milk was withdrawn from the pipette by dabbing it in cotton wool. The distance of insertion is important for an appreciable amount of milk runs down the wire to increase the drop in the loop. Volumes were lifted with the platinum wire shortened to 1.5 cm., when only the loop was immersed; with the same wire 3.0 cm. long, of which 2.0 cm. were immersed, and with Nichrome wire, No. 24 Gauge, 0.5588 mm. thick. The ten milk samples were well shaken and air bubbles removed by cotton wool swabs. Formalin was used as preservative at the rate of two drops to 10.0 ml. of milk. Twenty readings were recorded of volumes lifted from each sample by each of the loops. Using a haematocytometer pipette data were recorded on five

volumes lifted from a sample of milk by each of eight sizes of platinum loop.

Results

The tables below show the means of 20 volumes lifted for each sample and their ranges, standard deviations, coefficients of variation and standard errors. Each table comprises 200 measurements.

Table 1. Details concerning volumes lifted by a loop, of 3.75 mm. internal diameter, of platinum wire 1.5 cm. long, No. 26 Gauge and 0.4572 mm. thick. Only the loop was immersed.

<u>Sample No.</u>	<u>Order of Size</u>	<u>Mean Volume (cu.mm.)</u>	<u>Range</u>	<u>Standard Deviation (cu.mm.)</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
39 RF	1	4.4	3.0-5.5	0.690	15.67	0.153
27 LF	2	4.7	2.5-7.5	1.084	23.10	0.241
56 ARF	3	4.9	3.5-7.0	1.044	21.4	0.232
59 RF	4	4.9	3.5-6.5	0.911	18.57	0.203
26 ALH	5	5.0	3.5-6.0	0.947	18.94	0.211
56 ALF	6	5.0	3.5-7.0	0.940	18.8	0.209
26 ALF	7	5.3	3.0-8.0	1.308	24.7	0.291
39 LF	8	5.9	3.5-7.5	1.187	20.14	0.264
49 LH	9	6.1	5.0-7.5	0.877	14.38	0.173
X	10	6.4	5.0-7.5	0.894	13.98	0.199
Mean		5.3	3.6-7.0	0.99	18.97	0.22

Table 2. Details concerning volumes lifted by a loop, of 3.75 mm. internal diameter, of platinum wire 3.0 cm. long, No. 26 Gauge and 0.4572 mm. thick. Two cm. of wire were immersed.

<u>Sample No.</u>	<u>Order of Size</u>	<u>Mean Volume (cu.mm.)</u>	<u>Range</u>	<u>Standard Deviation (cu.mm.)</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
39 RF	7	7.6	6.0- 9.5	1.346	17.70	0.300
27 LF	1	6.5	5.0- 8.0	0.898	13.81	0.200
56 ARF	3	7.0	4.0- 9.5	1.212	17.30	0.269
59 RF	7	7.6	4.5- 9.5	1.085	14.28	0.237
26 ALH	3	7.0	5.0- 9.0	1.322	18.88	0.294
56 ALF	6	7.5	6.0- 8.5	0.714	9.50	0.159
26 ALF	5	7.3	5.5- 9.5	1.136	15.56	0.252
39 LF	9	7.9	6.5- 9.5	0.769	9.73	0.171
49 LH	2	6.9	4.0-10.0	1.219	17.65	0.270
X	10	8.7	6.5-11.0	1.089	12.52	0.242
Mean		7.4	5.4- 9.4	1.08	14.7	0.24

Table 3. Details concerning volumes lifted by a loop, of 3.75 mm. internal diameter, of Nichrome wire 3.0 cm. long, No. 24 Gauge and 0.5588 mm. thick. Two cm. of wire were immersed.

<u>Sample No.</u>	<u>Order of Size</u>	<u>Mean Volume (cu.mm.)</u>	<u>Range</u>	<u>Standard Deviation (cu.mm.)</u>	<u>Co-efficient of Variation</u>	<u>Standard Error</u>
39 RF	1	7.9	6.0-10.0	1.177	14.90	0.262
27 LF	3	8.2	6.0-10.0	1.367	16.66	0.304
56 ARF	7	9.3	8.0-11.0	1.015	10.92	0.226
59 RF	5	8.8	7.0-11.0	1.085	13.57	0.241
26 ALH	3	8.2	6.5-10.5	0.987	12.04	0.219
56 ALF	6	8.9	6.5-10.0	0.857	9.62	0.190
26 ALF	10	10.9	6.0-15.0	2.016	18.50	0.447
39 LF	8	9.9	6.5-12.0	1.800	18.17	0.400
49 LH	2	8.0	4.0-11.0	1.738	21.30	0.386
X	9	10.3	7.5-12.5	1.263	12.28	0.281
Mean		9.0	6.4-11.4	1.330	14.80	0.30

From the above tables it is seen that in all ten samples the Nichrome loop lifted the largest while the short platinum wire lifted the smallest mean volume. The average of the mean volumes lifted by the Nichrome loop was 9.0 cu.mm. while that lifted by the short platinum wire was 5.3 cu.mm. In Table 1 samples are arranged in order of increasing size and this order is maintained in Tables 2 and 3. There is a tendency for

all three loops to lift larger volumes of samples No. X, 39 LF and 26 ALF and lesser volumes of samples 39 RF, 27 LF and 56 ARF. Since samples 39 LF and 39 RF were from the same cow the difference in viscosity of these two samples was due to differences not of environment or nutrition but of conditions in the tissues of these two quarters.

In Table 1 the standard deviation of 20 readings of the ten samples varied from 0.69 to 1.3 cu.mm., the coefficient of variation from 13.98 to 24.7 per cent and the standard error from 0.15 to 0.29 cu.mm. In Table 2 the standard deviation varied from 0.71 to 1.35 cu.mm., the coefficient of variation from 9.5 to 18.9 per cent and the standard error from 0.159 to 0.3 cu.mm. In Table 3 these calculations respectively varied from 0.86 to 2.0 cu.mm., 9.6 to 21.3 per cent and from 0.19 to 0.44 cu.mm.

Tables 4-7 show corresponding details of volumes from four quarter samples lifted by loops 4.0 and 4.75 mm. internal diameter of platinum and Nichrome wires 30 cm. long. In all four samples the Nichrome loops lifted more than the similar platinum loops and the larger Nichrome loop, with a mean of 9.4 cu.mm., lifted more than the smaller. The larger platinum loop lifted more

from three samples and slightly less from sample Y.LF than the smaller loop. As previously 2.0 cm. of the wires were immersed and the gauges were those given above.

Table 4. Details concerning volumes lifted by a platinum loop 4.0 mm. internal diameter; 2 cm. inserted.

<u>Sample No.</u>	<u>Mean Volume in cu.mm.</u>	<u>Range</u>	<u>Standard Deviation</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
Y.LF	7.8	6.5-9.5	0.95	12.23	0.210
Y.LH	7.5	6.0-9.0	0.87	11.58	0.193
Y.RF	7.5	6.0-9.0	0.81	10.72	0.179
Y.RH	7.7	5.5-9.0	0.97	12.73	0.216
Mean	7.6	6.0-9.1	0.90	11.8	0.20

Table 5. Details concerning volumes lifted by a platinum loop 4.75 mm. internal diameter.

<u>Sample No.</u>	<u>Mean Volume in cu.mm.</u>	<u>Range</u>	<u>Standard Deviation</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
Y.LF	7.7	6.5- 9.5	0.758	9.80	0.168
Y.LH	7.9	6.0- 9.0	0.833	10.60	0.185
Y.RF	8.1	6.5- 9.0	0.67	8.28	0.149
Y.RH	8.1	6.0-10.0	1.04	12.75	0.230
Mean	8.0	6.3- 9.4	0.83	10.4	0.183

Table 6. Details concerning volumes lifted by a Nichrome loop 4.0 mm. internal diameter.

<u>Sample No.</u>	<u>Mean Volume in cu.mm.</u>	<u>Range</u>	<u>Standard Deviation</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
Y.LF	8.2	5.0-10.5	1.47	17.80	0.33
Y.LH	7.8	5.0-10.5	1.61	20.6	0.36
Y.RF	8.0	5.0-12.0	1.82	23.0	0.40
Y.RH	8.3	5.5-11.0	1.14	13.85	0.25
Mean	8.1	5.1-11.0	1.51	18.81	0.33

Table 7. Details concerning volumes lifted by a Nichrome loop 4.75 mm. internal diameter.

<u>Sample No.</u>	<u>Mean Volume in cu.mm.</u>	<u>Range</u>	<u>Standard Deviation</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
Y.LF	8.9	6.0-12.0	1.47	16.50	0.33
Y.LH	10.7	8.5-13.0	1.61	15.00	0.36
Y.RF	9.2	7.0-12.5	1.43	15.55	0.32
Y.RH	9.9	7.0-11.0	1.21	12.25	0.27
Mean	9.4	7.1-12.1	1.43	14.82	0.32

Table 8. Averages of data of Tables 1 - 7.

<u>Table No.</u>	<u>Mean Volume in cu.mm.</u>	<u>Range</u>	<u>Standard Deviation in cu.mm.</u>	<u>% Co-efficient of Variation</u>	<u>Standard Error</u>
1	5.3	3.6- 7.0	0.99	19.0	0.22
2	7.4	5.4- 9.4	1.08	14.7	0.24
4	7.6	6.0- 9.1	0.90	11.8	0.20
5	8.0	6.3- 9.4	0.83	10.4	0.18
6	8.1	5.1-11.0	1.51	18.81	0.33
3	9.0	6.4-11.4	1.33	14.8	0.30
7	9.4	7.1-12.1	1.43	14.82	0.32

The greatest mean volumes, standard deviations and standard errors were found with the three Nichrome loops. The mean volume, 8.0 cu.mm., lifted by the platinum loop of 4.75 mm. internal diameter showed the least standard deviation, percentage coefficient of variation and standard error.

Table 9. Details concerning volumes of one sample lifted by various sizes of loop of platinum wire, 1.5 cm. long, gauge No. 26 and 0.4572 mm. thick. Only the loop was immersed. Volumes measured in haematocytometer pipette.

<u>Internal Diameter of loop in mm.</u>	<u>Mean Volume in cu.mm.</u>	<u>Mean Length of Column in mm.</u>	<u>Range of Length of Column in mm.</u>
2.5	4.2	20.0	13.0 - 27.0
3.0	4.8	22.0	17.0 - 26.0
4.0	6.0	29.0	18.0 - 39.0
5.0	7.5	36.0	30.0 - 40.0
5.25	10.2	48.0	31.0 - 60.0
5.5	10.8	56.0	45.0 - 68.0
6.0	13.0	68.0	48.0 - 80.0
7.0	13.0	68.0	52.0 - 85.0

The data of Table 9 are based on measurements of ten volumes lifted by loops of 4.0 and 5.25 mm. internal diameter and of five volumes by each of the remaining sizes of loop. The haematocytometer pipette was rinsed and dried between each reading. The length of the capillary tube of this pipette to the graduation was 57.0 mm. and the volume was 0.011 ml. While the volumes lifted by the 4.0 mm. loop were about 6.0 cu.mm. cell counts on smears from these volumes were about 75 per cent of those on smears from 10.0 cu.mm. volumes

measured by pipette. It appeared that about one fifth of the cells were left lining the capillary tube and that this was a larger proportion of cells than were left on the loop. Use of the pipette was tedious and time consuming and to adjust the length of the column of milk any excess was gradually absorbed by dabbing the end of the pipette gently against blotting paper. The milk was blown on to the glass slide without splash.

Spreading the milk over one sq.cm. was inaccurate using the pipette which generally retained a small drop of milk. The wire loop was used to make a neat smear and was sterilised and dried quickly in a flame.

When a loop was withdrawn as quickly as possible adequate milk was lifted. When about ten seconds elapsed during withdrawal of a loop held vertically it was found that practically no milk was lifted. When a bottle and loop were held at an angle of about 45 degrees speed of withdrawal had less effect on volumes lifted.

Summary and Conclusions

The volume of milk lifted by a loop, 3.75 mm. internal diameter, of platinum wire 3.0 cm. long, immersed to a depth of 2.0 cm., was on average about one and a half times that lifted after only the loop was immersed. The means of 20 volumes lifted by a loop,

3.75 mm. internal diameter, of Nichrome wire, 24 gauge, immersed to a depth of 2.0 cm., varied from 8.0 to 10.9 cu.mm. in ten samples, the average mean volume lifted being 9.0 cu.mm. The 4.75 mm. diameter loop of Nichrome wire immersed to a depth of 2.0 cm., lifted a mean 0.0094 ml. which was the volume nearest to 0.01 ml. In all samples the mean volume from a Nichrome loop was greater than that from a platinum loop of the same diameter and length but made of thinner wire of gauge 26. Platinum loops of larger diameter tended to lift larger volumes. It appeared that the volumes lifted by a platinum loop of 4.75 mm. internal diameter showed least coefficient of variation. Of the platinum loops used apparently that of 5.25 mm. internal diameter lifted volumes generally nearest 0.01 ml. The internal diameter of the loop, gauge of wire, depth of immersion and the viscosity of the milk all influence the volume obtained when a loop is quickly withdrawn from a sample.

Malcolm's standard loop was found to lift a mean of 0.0074 ml. Nevertheless because the author wished to compare his findings with those of Malcolm and his co-workers it was decided to continue to use the size of loop and technique he had followed. Clearly, however, the cell counts are derived from 0.0074 ml. on average

and not from 0.01 ml. and for accurate estimation of cell numbers a correction four over three should be used.

In view of the other variable factors which might influence the total cell count of milk, e.g. fluctuations in the daily volume of milk yield, it was thought that the observed inaccuracy of the volume measured was not very important so long as it was realised. It seemed more important that the figures should bear ready comparison with those of other workers whose counts would almost certainly be subject to a similar correction.

P A R T T H R E E (b)THE SEDIMENTATION OF CELLS IN MILKHistorical

Prescott and Breed (1910) centrifuged milk in a special tube and estimated that from 2.5 to 50.0 per cent. of cells were found in the deposit and that a greater percentage rose with the cream. They concluded that the cell content of the deposit was an unreliable guide to the total cell count of whole milk. Further study was required to determine whether some types of cell were more readily sedimented than others.

MethodsTest 1.

Ten ml. of each of ten samples were centrifuged for ten minutes at 2,000 revolutions per minute. The cream adhered to the glass, was freed by gently flaming the tube and was transferred to another tube and thoroughly mixed, by means of a tea-spoon handle, with ten ml. of almost cell-free skimmed milk. The latter was obtained from the intermediate layer after centrifuging a sample from which no cells were found in a Breed smear. Smears of cream are too thick to allow cells to be counted and the dilution by the cell-free fluid permits

reliable counting. Dilution of the cream by ether produced gels in which staining of cells was unsatisfactory. After dilution by normal saline cells were masked by crystals and were poorly stained. Cream was not miscible with distilled water. After removal of the cream 9.0 ml. of supernatant fluid were removed by pipette, thoroughly shaken in another tube and a cell count made. The deposit was stirred by a wire in the remaining one ml. of milk and a cell count made. The above technique was carried out on ten samples of milk.

Test 2.

In addition three tubes each containing ten ml. of a sample of milk were centrifuged for one hour at 7,000 revolutions per minute at an angle of 45 degrees and the contents of each tube were treated as follows. The cream, about 0.5 ml., was transferred by a flat disc at the end of a metal rod to a clean tube and the little remaining cream was removed when the top 2.5 ml. of milk were removed by pipette and added to the cream which was thoroughly stirred although dissolution was unsatisfactory. Without rinsing the pipette two amounts each of three ml. were transferred to two clean tubes. The deposit remained in the last ml. Cells were counted in four smears made by a 0.01 ml. pipette and four by a loop,

3.75 mm. internal diameter of Nichrome wire 3.0 cm. long, from whole milk and from each of the twelve portions of centrifuged milk after thorough stirring. All 104 smears were similarly prepared in one day by the author who counted all 34,100 cells during three days.

Results

Test 1

Table 1. Distribution of cells in milk after centrifugalisation.

<u>Sample No.</u>	<u>Total count on whole milk (cells per ml.)</u>	<u>Cell counts as a percentage of the total counts of whole milk</u>					<u>Apparent change</u>
		<u>Cream</u>	<u>Inter-mediate layer</u>	<u>Deposit</u>	<u>Total</u>		
1	1,800	16	15	15	46	54	Loss
2	190,000	10	40	58	108	8	Gain
3	408,000	12	25	58	95	5	Loss
4	3,200,000	13	24	67	104	4	Gain
5	3,500,000	6	40	27	73	27	Loss
6	4,280,000	32	5	53	90	10	Loss
7	4,580,000	25	9	75	109	9	Gain
8	6,000,000	9	11	45	65	35	Loss
9	7,400,000	3	23	54	80	20	Loss
10	13,090,000	10	9	56	75	25	Loss
Mean		13.6	20.1	50.8	84.5	15.5	Loss

Apparently 54 per cent of cells were lost in sample 1 probably owing to scarcity of cells and the relatively

greater chance of error during counting. Only 54 cells were found in the smear of whole milk and only 158 after centrifuging. However, the total count was not related to the apparent loss of cells after centrifuging. The creams of samples 8 and 9 were diluted by distilled water. The deposits of six samples contained from 45 to 58 per cent. of cells. In general about one half of the cells were sedimented, about one fifth were suspended in the intermediate layer of skimmed milk, almost one seventh were taken up with the cream while about one sixth were unaccounted. Samples 5, 8, 9 and 10 showed high cell losses from 20 to 35 per cent. and only from three to ten per cent. of cells in the cream. This suggests that errors of technique with apparent loss of cells are more likely to occur during preparation of the cream. In Table 2 the letter P represents polymorphonuclear leucocytes, L represents lymphocytes and E represents epithelial cells.

Table 2. Differential cell counts as percentages of the total cells found after centrifugalisation of milk.

<u>Sample No.</u>	<u>Cream</u>			<u>Inter-mediate layer</u>			<u>Deposit</u>			<u>Total</u>			<u>Whole Milk</u>		
	P.	L.	E.	P.	L.	E.	P.	L.	E.	P.	L.	E.	P.	L.	E.
2	11	0	89	47	1	52	68	4	28	55	2	43	56	0	44
3	11	2	87	19	4	77	38	12	50	30	9	61	29	8	63
4	57	0	43	68	1	31	70	6	24	68	4	28	71	3	26
5	51	11	38	37	6	57	54	13	33	44	9	47	53	8	39
6	80	0	20	67	2	31	74	9	17	76	5	19	74	5	21
7	27	2	71	58	3	39	61	9	30	53	7	40	59	7	34
8	44	10	46	64	4	32	73	6	21	68	5	27	75	6	19
9	34	5	61	56	7	37	43	23	34	47	16	37	43	14	43
10	62	2	36	62	3	35	65	8	27	65	7	28	65	8	27
Mean	42	4	54	53	3	44	61	10	29	56	7	37	58	7	35

Owing to scarcity of cells and relatively great apparent loss, counts from sample 1 were probably very unreliable and were omitted from the table. In each of eight samples counts were calculated from between 1,100 and 2,000 cells examined and in one sample over 700 were examined. In most samples the proportions of cells of the whole milk are almost identical to those of the totals from addition of cells from the three layers. It appears from this that cells are lost after centrifugalisation in the same proportions as they occur in whole milk. The proportions of polymorphs in the

deposits are greater in eight samples than those in the cream, greater in seven than those of the intermediate layer and equal to or greater than those of whole milk in eight samples. In samples containing only few cells, e.g. sample 1 having 1,800 cells per ml., searching for cells sufficient for differential counts was too time-consuming to be a practicable routine. In such cases the polymorph counts of the deposits of the samples more quickly yield approximate polymorph counts of the whole milk. The polymorph proportion was about 42 per cent. in the deposit of sample 1 while that of the whole milk was 40 per cent.

The mean polymorph content of the deposits was about half as much again as that of the cream and conversely the mean epithelial cell content of the deposits was only about half that of the cream. In the intermediate layer the content of both types of cell was about midway between those of the deposit and the cream. Many epithelial cells containing fat globules were spun up with the cream. Those with little fat were sedimented owing to the weight of the large nucleus. Lymphocytes appeared to be relatively heavy and the deposits contained about three times greater a mean proportion of lymphocytes than the two upper layers.

Table 3 shows the cellular contents of the three layers after centrifuging and of their arithmetical totals compared with those of the whole milk.

Table 3. Estimated number of thousands of polymorphs before and after centrifugalisation.

<u>Sample No.</u>	<u>Cream</u>	<u>Inter-mediate layer</u>	<u>Deposit</u>	<u>Total</u>	<u>Whole Milk</u>	<u>Un-accounted Loss</u>
1	1.4	1	0.9	3.3	6	2.7
2	20	360	760	1,140	1,070	70 (Gain)
3	60	190	900	1,150	1,180	30
4	2,400	5,150	15,000	22,550	22,700	150
5	1,100	5,000	5,100	11,200	18,500	7,300
6	11,000	1,300	16,800	29,100	31,700	2,600
7	3,000	2,200	21,100	26,300	27,100	800
8	2,500	4,500	20,000	27,000	45,000	18,000
9	700	9,500	17,000	27,200	32,000	4,800
10	7,700	7,400	47,500	62,600	85,000	22,400
Total	28,481.4	35,601	144,160.9	208,243.3	264,256	56,012.7
Mean	2,848.14	3,560.1	14,416.09	20,824.33	26,425.6	5,601.27

The table shows that the distribution of about 208,243,300 polymorphs was assessed, which is about 78.8 per cent. of the estimated total number in the ten samples. Of polymorphs accounted for about 144,160,900 or 69.4 per cent. were estimated to be sedimented in the deposits, about 35,601,000 or 17.3 per cent. in the

intermediate layer and 28,481,400 or 13.3 per cent. in the cream.

Table 4. Estimated number of thousands of lymphocytes before and after centrifugalisation.

<u>Sample No.</u>	<u>Cream</u>	<u>Inter- mediate Layer</u>	<u>Deposit</u>	<u>Total</u>	<u>Whole Milk</u>	<u>Unaccounted Loss or Gain</u>
1	0.1	0.7	0.4	1.2	2	0.8 Loss
2	0	7	40	47	0	47 Gain
3	10	40	280	330	330	Nil
4	0	70	1,250	1,320	960	360 Gain
5	250	820	1,200	2,270	3,000	730 Loss
6	0	20	2,000	2,020	2,100	80 Loss
7	230	120	3,100	3,450	3,200	250 Gain
8	500	300	1,300	2,100	4,000	1,900 Loss
9	100	1,200	9,000	10,300	10,000	300 Gain
10	250	360	5,850	6,460	10,500	4,040 Loss
Total	1,340.1	2,937.7	24,020.4	28,298.2	34,092	5,793.8 Loss
Mean	134.01	293.77	2,402.04	2,829.82	3,409.2	579.38 Loss

Table 4 shows the distribution after centrifuging of 28,298,200 lymphocytes or 83.2 per cent. of the total estimated in the ten samples. Of those accounted for about 24,020,400 or 85.4 per cent. were estimated to be sedimented in the deposits, about 2,937,700 or 10.2 per cent. in the intermediate layer and 1,340,100 or 4.4 per cent. in the cream.

Table 5. Estimated number of thousands of epithelial cells before and after centrifugalisation.

<u>Sample No.</u>	<u>Cream</u>	<u>Inter- mediate Layer</u>	<u>Deposit</u>	<u>Total</u>	<u>Whole Milk</u>	<u>Unaccounted Loss or Gain</u>
1	1.3	1.0	1.4	3.7	10	6.3 Loss
2	180	400	310	890	830	60 Gain
3	430	770	1,180	2,380	2,570	190 Loss
4	1,750	2,340	5,150	9,240	8,300	940 Gain
5	850	7,800	3,100	11,750	13,500	1,750 Loss
6	2,700	660	4,000	7,360	9,000	1,640 Loss
7	8,000	1,500	10,400	19,900	15,600	4,300 Gain
8	2,500	2,200	5,700	10,400	11,000	600 Loss
9	1,200	6,300	13,500	21,000	32,000	11,000 Loss
10	4,500	4,200	19,700	28,400	35,400	7,000 Loss
Total	22,111.3	26,171	63,041.4	111,323.7	128,210	16,886.3 Loss
Mean	2,211.13	2,617.1	6,304.14	11,132.37	12,821	1,688.63 Loss

Table 5 shows the distribution after centrifuging of about 111,323,700 epithelial cells or 87.0 per cent. of the total estimated in the ten samples. Of those accounted for about 63,041,400 or 56.6 per cent. were estimated to be in the deposit, about 26,171,000 or 23.4 per cent. in the intermediate layer and 22,111,300 or 20.0 per cent. in the cream.

Table 6. Summary of estimated numbers of
thousands of cells in various layers
after centrifuging at 2,000 r.p.m.

<u>Cells</u>	<u>Cream</u>	<u>Inter- mediate Layer</u>	<u>Deposit</u>	<u>Total</u>	<u>Whole Milk</u>	<u>Loss</u>
Polys	28,481.4	35,601	144,160.9	208,243.3	264,256	56,012.7
Lymphos	1,340.1	2,937.7	24,020.4	28,298.2	34,092	5,793.8
Epis.	22,111.3	26,171	63,041.4	111,323.7	128,210	16,886.3
Total	51,932.8	64,709.7	231,222.7	347,865.2	426,558	78,692.8

Of all cells of known distribution after centrifuging 66.4 per cent. were estimated to be in the deposits, 18.6 per cent. in the intermediate layers and 15.0 per cent. in the creams. Of the cells in the deposits 62.4 per cent. were polymorphs, 10.4 per cent. were lymphocytes and 27.2 per cent. epithelial cells. Of the cells in the intermediate layers 55.0 per cent. were polymorphs, 4.5 per cent. were lymphocytes and 40.5 per cent. were epithelial cells. Of the cells in cream 55.0 per cent. were polymorphs, 2.5 per cent. were lymphocytes and 42.5 per cent. were epithelial cells. Of cells apparently unaccounted for after centrifuging about 71.0 per cent. were estimated to be polymorphs, about 7.5 per cent. were lymphocytes and about 21.5 per cent. were epithelial cells.

Test 2

The four smears of whole milk, made by the Nichrome loop, contained 9.0, 7.8, 9.0 and 10.2 million cells per ml. (mean 9,000,000 cells per ml., standard deviation 980,000 cells per ml. and coefficient of variation 10.8 per cent.). The proportions of polymorphs were 59, 57, 58 and 64 per cent. of cells found (mean 60, deviation 6.3, coefficient of variation 10.5 per cent.). Smears of whole milk made by the 0.01 ml. pipette contained 9.45, 11.4, 10.2 and 10.5 million cells per ml. (mean 10,400,000 cells per ml., standard deviation 780,000 cells per ml. and coefficient of variation 7.5 per cent.). The proportions of polymorphs are 65, 66, 65 and 65 per cent. (mean 65, deviation 1.1, coefficient of variation 1.8 per cent.).

Tables 6 and 7 show the total numbers of cells in millions estimated in each of the four layers of the three tubes after centrifuging.

Table 6. Distribution of cells in milk after centrifuging. Smears made by loop.
Numbers of cells in millions are means of four counts.

<u>Layer</u>		<u>Tube 1</u>	<u>Tube 2</u>	<u>Tube 3</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>% Coefficient of Variation</u>
Cream	3 ml.	17.1	18.0	26.4	20.5	5.11	25.0
Mid	3 ml.	1.5	2.7	1.1	1.8	0.83	46.2
Lower	3 ml.	1.08	0.8	1.1	1.0	0.17	17.2
Deposit	1 ml.	42.0	54.0	45.0	47.0	6.22	13.2
Total	10 ml.	61.68	75.5	73.6	70.3	7.44	10.58

Table 7. Distribution of cells in milk after centrifuging. Smears made by pipette.
Numbers of cells in millions are means of four counts.

<u>Layer</u>		<u>Tube 1</u>	<u>Tube 2</u>	<u>Tube 3</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>% Coefficient of Variation</u>
Cream	3 ml.	33.9	30.0	36.0	33.3	3.05	9.15
Mid	3 ml.	2.16	4.35	2.4	3.0	0.97	32.4
Lower	3 ml.	1.92	1.35	1.9	1.72	0.32	18.8
Deposit	1 ml.	68.0	88.0	67.0	74.0	11.80	15.95
Total	10 ml.	105.98	123.7	107.3	112.0	10.10	9.0

Using the Nichrome loop only about 70,000,000 of the estimated 90,000,000 cells in the ten ml. sample were found after centrifuging. The remaining 20,000,000 cells (22 per cent.) were not accounted for and were apparently lost owing to the shortcomings of the technique.

Of the cells of known distribution about 20,500,000 or 29 per cent. were found in the cream layer, 2,800,000 or 4 per cent. were in the intermediate layers and 47,000,000 or 67 per cent. were found in the deposit.

Using the 0.01 ml. pipette ten ml. of the sample were estimated to contain 104,000,000 cells while after centrifuging the estimated cells in the four layers totalled about 112,000,000 cells which included an apparent gain of 8,000,000 cells (7.7 per cent.). Of the cells of known distribution about 33,300,000 or 30 per cent. were found in the cream layer, 4,720,000 or 4 per cent. were in the intermediate layers and 74,000,000 cells or 66 per cent. were found in the deposit. The intermediate layers were very pale blue and it would appear that the cells found in these layers probably came from small particles of cream left owing to the technique used.

From the differential counts of the four layers after centrifuging it is seen in Table 8 that polymorphs constituted from 26 to 30 per cent. of the cells in the cream, from 20 to 36 per cent. in the intermediate layers and from 78 to 82 per cent. in the deposit. Lymphocytes constituted from 4 to 12 per cent. of the cells in the cream, from 3 to 12 per cent. in the intermediate layers

and from 9 to 13 per cent. in the deposit. Epithelial cells constituted from 59 to 68 per cent. of the cells in the cream, from 44 to 76 per cent. of cells in the intermediate layers and from 8 to 9 per cent. in the deposit. The means of counts on four smears of the whole milk using the loop were 60 per cent. polymorphs, eight per cent. lymphocytes and 32 per cent. epithelial cells while those using the pipette were 65 per cent. polymorphs, eight per cent. lymphocytes and 27 per cent. epithelial cells.

Table 8. Differential cell counts of the four layers after centrifugalisation. Figures are percentages and are the means of four counts.

P = polymorph. L = lymphocyte. E = epithelial cell.

(a) Smears made by Nichrome loop.

<u>Layer</u>		<u>Tube 1</u>			<u>Tube 2</u>			<u>Tube 3</u>		
		P.	L.	E.	P.	L.	E.	P.	L.	E.
Cream	3 ml.	28	4	68	30	8	62	26	10	64
Mid	3 ml.	25	6	69	36	8	56	29	5	66
Lower	3 ml.	31	4	65	30	8	62	33	12	55
Deposit	1 ml.	80	11	9	82	9	9	80	11	9
Whole Milk	10 ml.	60	8	32	(before centrifuging).					

(b) Smears made by 0.01 ml. pipette.

	<u>Layer</u>	<u>Tube 1</u>			<u>Tube 2</u>			<u>Tube 3</u>		
		P.	L.	E.	P.	L.	E.	P.	L.	E.
Cream	3 ml.	26	6	68	29	12	59	29	12	59
Mid	3 ml.	20	4	76	34	7	59	28	9	63
Lower	3 ml.	27	3	70	25	11	44	35	11	54
Deposit	1 ml.	78	13	9	81	11	8	81	11	8
Whole milk 10 ml.		65	8	27 (before centrifuging).						

Table 9. The variation of 24 polymorph counts in each of the four layers of milk after centrifugalisation.

<u>Layer</u>		<u>Mean Poly Percentage</u>	<u>Range</u>	<u>Standard Deviation</u>	<u>% Coefficient of Variation</u>
Cream	3 ml.	28	19 - 33	3.39	12.33
Mid	3 ml.	29	16 - 40	8.56	30.0
Lower	3 ml.	30	20 - 38	4.94	16.47
Deposit	1 ml.	80	70 - 85	3.69	4.61

Half of the counts in Table 9 were on smears made from a 0.01 ml. pipette and half on those made from a loop.

Table 10. The cell content of each layer after centrifuging expressed as a percentage of the total in each tube.

(a) Prepared by loop.

<u>Layer</u>		<u>Tube 1</u>	<u>Tube 2</u>	<u>Tube 3</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>% Coefficient of Variation</u>
Cream	3 ml.	28.0	24.0	36.0	29.0	6.1	21.0
Mid	3 ml.	2.5	3.5	1.5	2.5	1.0	39.6
Lower	3 ml.	1.5	1.5	1.5	1.5	Nil	Nil
Deposit	1 ml.	68.0	71.0	61.0	67.0	5.2	7.7

(b) Prepared by pipette.

Cream	3 ml.	32.0	24.5	34.0	30.0	5.3	17.7
Mid	3 ml.	2.0	3.5	2.0	2.5	0.3	12.4
Lower	3 ml.	2.0	1.0	2.0	1.5	0.6	33.5
Deposit	1 ml.	64.0	71.0	62.0	66.0	4.7	7.2

The results of Test 2 were based on the counting of 34,100 cells as follows: (a) prepared by loop 5,300 in cream, 1,598 in mid 3 ml., 1,200 in lower 3 ml., 6,200 in deposit and 1,200 in whole milk; (b) prepared by pipette 6,090 in cream, 2,100 in mid 3 ml., 1,698 in lower 3 ml., 7,210 in deposit and 1,500 in whole milk.

Table 11. Summary of estimated numbers of thousands of cells in various layers after centrifuging at 7,000 r.p.m.

<u>Cells</u>	<u>Cream</u>	<u>Inter- mediate Layer</u>	<u>Deposit</u>	<u>Total</u>	<u>Whole Milk</u>	<u>Loss</u>
Polys	7,532	1,125	48,400	57,057	60,140	3,083
Lymphos	2,152	262.5	6,655	9,069.5	7,760	1,309.5 Gain
Epis.	17,216	2,362.5	5,445	25,023.5	29,100	4,076.5
Total	26,900	3,750	60,500	91,150	97,000	5,850

Cells in the deposit were about 66 per cent. of the total of known distribution and were in the proportion 80 per cent. polymorphs, eleven per cent. lymphocytes and nine per cent. epithelial cells. Those of the intermediate layer were about four per cent. of the total and were in the proportion 30 per cent. polymorphs, seven per cent. lymphocytes and 63 per cent. epithelial cells. The cream contained about 30 per cent. of cells of known distribution and about 28 per cent. of them were polymorphs, about eight per cent. were lymphocytes and 64 per cent. epithelial cells. From the addition of cells estimated to be in the three layers it appeared that about 62 per cent. of cells of known distribution were polymorphs, about ten per cent. were lymphocytes and about 28 per cent. epithelial cells. In whole milk

also 62 per cent. of cells were polymorphs while eight per cent. were lymphocytes and 30 per cent. were epithelial cells. After centrifuging it appeared that the distribution of 3,083,000 polymorphs and 4,076,500 epithelial cells was unknown while 1,309,500 lymphocytes were calculated to be in the three layers after centrifuging in addition to those estimated in the whole milk.

Summary and Conclusions

It is concluded from the centrifuging of ten samples at 2,000 revolutions per minute for ten minutes that about half of the cells were sedimented, about one fifth were suspended in the intermediate layer, almost one seventh rose with the cream while about one sixth were unaccounted (Table 1). The distribution of about 79 per cent. of all polymorphs was estimated after centrifuging and, of those accounted for, about 70 per cent. were sedimented, about 17 per cent. were in suspension in the intermediate layer and about 13 per cent. were in the cream (Table 3). Of lymphocytes 85 per cent. were sedimented, ten per cent. were suspended and almost five per cent. rose in the cream (Table 4). About 57 per cent. of epithelial cells were sedimented, 23 per cent. were suspended and about 20 per cent. rose in the cream (Table 5).

Of the cells of known distribution after centrifuging about 66 per cent. were sedimented, about 19 per cent. were suspended and about 15 per cent. rose with the cream (Table 6). The increased centrifuging of three tubefuls of one sample at 7,000 revolutions per minute for one hour also sedimented 66 per cent. of cells of known distribution though in this case the remaining cells mostly rose with the cream and only about four per cent. remained in suspension (Table 10). In the latter test polymorphs constituted about 28 per cent. of cells in the creams, about 30 per cent. of those in the intermediate layers, about 80 per cent. of those in the deposit and about 62 per cent. of those in whole milk (Table 8). While the mean polymorph proportion of cells of the ten samples in Test 1 was about 58 per cent. those after centrifuging were about 42 per cent. in the cream, 53 per cent. in the intermediate layer and about 61 per cent. in the deposits (Table 2). Thus it appears that while the faster centrifugalisation caused only a slight increase in the total number of cells accounted for it caused many more polymorphs to be sedimented and many more epithelial cells to be drawn up with the cream. The two histograms attached below show the general distribution and proportions of types of

cell found before and after the centrifugings used in the two tests.

In Test 1 it was found that the polymorph proportion of the deposit in most samples closely resembled that of whole milk and it is suggested that in samples containing as few as 10,000 cells or less per ml. the polymorph proportion of the deposit, after centrifuging at 2,000 revolutions per minute for ten minutes, would be an approximation of that obtained eventually from whole milk after enough cells had been found. In such cases centrifuging would facilitate cell counting.

In Test 2 the whole milk was estimated to contain about 9,000,000 cells per ml. in smears made from the Nichrome loop and 10,400,000 cells per ml. in smears made from the pipette. The proportion of these numbers is almost identical to that of corresponding numbers recorded in Part Three (a). After centrifuging, however, only about 70,000,000 cells were accounted for in smears from the loop while apparently 112,000,000 were accounted for in smears made from pipette. The former figure is about 62 per cent. of the latter. The probable explanation of the larger discrepancy after centrifuging is that fragments of the cream pellicle and particles of the deposit stuck to the loop when smears

were made and thus many cells were not counted.

Further, when the deposit was broken up and stirred in the final ml. it is probable that the larger particles of heavy cell masses would not be retained in the drop lifted by the loop. In view of this shortcoming it is emphasised that the cells found in each layer after centrifuging were of similar proportions of the total cells accounted for whether smears were made by loop or by pipette (Table 10) also that the proportions of the three types of cell were similar whether the loop or the pipette was used to make smears (Table 8).

It is concluded that centrifugalisation, as carried out in these tests, does not sediment all the cells in milk owing to so many cells rising with the cream.

PART THREE (C)THE CELLS IN BOVINE MILK

In milk from udders affected by mastitis and in milk from those containing no inflammatory lesions the cells generally found were polymorphs, epithelial cells and lymphocytes. In addition, monocytes, eosinophils and erythrocytes were occasionally found in milk from udders with mastitis. Samples were formalinised and Prescott and Breed smears stained by the Sudan Black, Leishman method.

Polymorphs

These corresponded to the human polymorphonuclear neutrophil leucocytes although, during the present work, all those examined apparently contained weakly eosinophil granules about $\frac{1}{4} - \frac{1}{2} \mu$ in diameter. These cells were of various shapes due presumably to their amoeboid progression at the moment of formalin fixation. On several occasions streptococci and staphylococci were found to have been phagocytosed by the polymorphs and in purulent samples many degenerated polymorphs were found. In thin films of unformalinised cow's blood these cells became flattened during drying, generally appeared round and the first 50 polymorphs seen varied from 7 - 13 μ in diameter; mean 8.9 μ , coefficient of variation 14.8 per

cent., standard deviation 1.32μ and standard error 0.2μ . After citrated blood from the same cow was mixed with an equal volume of almost cell-free milk and Prescott and Breed smears prepared after formalinisation and of the first 50 polymorphs encountered 20 were 5μ , 25 were 6μ and only five were 7μ in diameter; mean 5.7μ , coefficient of variation 11.25 per cent., standard deviation 0.64μ and standard error 0.09μ . Owing to the formalin fixation and the greater thickness of the Prescott and Breed smears little flattening of these cells occurred. Most appeared to be spherical while many were in various stages of elongation, for example, some were $8 \times 4 \mu$ and others were $12 \times 3 \mu$. The elongated polymorphs were seen much more often in milk which was formalinised soon after being drawn from the cow. After Sudan Black staining the granules in the cytoplasm of polymorphs were generally black and occasionally dark brown.

Eosinophils

These cells corresponded to the human eosinophil leucocytes and contained very intensely eosinophil granules which were from about $\frac{1}{2} - 1 \mu$ in diameter. They were not found in milk from quarters free from pathological changes and were scarce in samples from

diseased quarters. The first 50 eosinophils found in a thin unformalinised film of cow's blood were from 8 - 14 μ in diameter; mean 11.2 μ , coefficient of variation 13.6 per cent., standard deviation 1.5 μ and standard error 0.2 μ . Most of these cells were round unless compressed and distorted by proximity to other cells. The few eosinophils found in Prescott and Breed smears of formalinised milk and mixtures of citrated blood and cell-free milk were 7 - 8 μ in diameter and were generally spherical. They were distinguished most readily by Lendrum's carbol chromotrope method as modified by Blackburn (1949) (personal communication) who used methylene blue counterstain.

Non-granular leucocytes

In both blood films and milk smears stained by Sudan Black a few black granules were occasionally found peripherally in monocytes, none was found in lymphocytes. For simplification of differential counting during most of the present work lymphocytes and monocytes found in milk smears were grouped together. They generally varied from 4 - 10 μ in diameter.

(a) Lymphocytes.

In thin unformalinised bovine blood films 50 lymphocytes measured from 5 - 10 μ in diameter; mean 8 μ ,

coefficient of variation 16 per cent., standard deviation 1.3μ and standard error 0.18μ . After mixing the blood with cell-free formalinised milk 22 lymphocytes in a Prescott and Breed smear measured 4μ and 28 were 5μ in diameter, while most lymphocytes found in formalinised milk smears were also $4 - 5\mu$ in diameter.

(b) Monocytes.

In a thin fresh blood film 50 monocytes measured from $10 - 17\mu$ in diameter; mean 12.3μ , coefficient of variation 14.7 per cent., standard deviation 1.8μ and standard error 0.26μ . The first 50 monocytes in a Prescott and Breed smear of mixed blood and formalinised cell-free milk measured from $8 - 13\mu$, mean 10μ , coefficient of variation 10.8 per cent., standard deviation 1.08μ and standard error 0.15μ .

Mammary Epithelial Cells

Those which desquamated from actively secreting lobules contained fat globules of varying size. During preparation of the smear the fat was removed by tetrachlorethane and vacuoles were found in the cytoplasm. Vacuolated epithelial cells were generally large varying from $9 - 24\mu$ in diameter, while non-vacuolated epithelial cells were from $7 - 15\mu$ in diameter. Most

epithelial cells were round or oval and in most the nuclei were oval.

Erythrocytes

These were found only in blood-stained samples of milk and were only occasionally seen during the present work.

Discussion

There has been doubt in the past as to whether the polymorphs found in milk were identical to those found in the blood (Hewlett et al. (1909), Holm (1934) and Zlotnik (1947). In an organ such as the highly developed bovine udder into which as much as ten gallons of fluid may pass from the bloodstream daily it does not seem surprising, even in the normal udder, apparently free from any pathological change, that actively motile granular leucocytes would make their way by diapedesis into the milk. Further, non-motile cells such as lymphocytes might occasionally be passively taken through capillary epithelia during such active transference of fluid. When the alveolar structure becomes pathological diapedesis of polymorphs and passive transference of lymphocytes and erythrocytes would be greatly accelerated. Such occurrences appear to be confirmed

later in the thesis where it is shown that high cell counts in milk are associated with marked pathological changes.

All cells found in the mixed blood and formalinised cell-free milk appeared to be similar in size, shape and staining properties to the corresponding cells found in formalinised milk from normal and from pathological udders. During the present work the author found in histological sections of bovine udders polymorphs in the process of passing through the alveolar epithelium. In gland with acute mastitis many polymorphs invaded the interstitial connective tissue while the lumina of alveoli adjacent to such invaded tissue were often found filled with polymorphs.

Conclusions

It is concluded that all cells, except mammary epithelial cells, found in milk are derived from the blood. The author confirms the findings of Savage (1910) that milk in all stages of lactation contains polymorphs and lymphocytes, and of Breed (1914) that the cells in milk were leucocytes and epithelial cells. The author agrees with Bourgeois (1927) that in normal milk the ratio of multinucleate to mononucleate cells is

approximately 1:1. The author disagrees with the opinions of Hewlett et al. (1909), Holm (1934) and Zlotnik (1947) who considered that the polymorphs in milk were different from those in the blood stream.

PART FOURSYSTEM OF SCORING OF PATHOLOGICAL LESIONS

It was found that in many cases there was great variation in the type and in the severity of lesions in different parts of the same quarter. This confirmed the findings of Scholl and Torrey (1931) and of Spencer and McNutt (1950). To enable comparisons to be made of the various pathological lesions found in different quarters an arbitrary system of scoring was introduced, which was based on the extent and severity of the lesions in each quarter. The pathological changes in the duct system were considered separately from those of the alveolar system and these changes were recorded in sixteenth parts of each section of tissue. From the records of all sections of each quarter examined averages were calculated, representing the summary of the lesions in sixteenth parts of the whole quarter. These latter sixteenths were the units for scoring purposes. The following table indicates the system of scoring for each sixteenth part showing inflammation.

Table 1System of Scoring of Pathological Lesions

Duct system score	Category of lesion	Alveolar system score
3	Mild acute	3
6	Moderate acute	6
12	Severe acute	12
2	Mild sub-acute	4
4	Moderate sub-acute	8
6	Severe sub-acute	12
1	Mild chronic	2
2	Moderate chronic	4
3	Severe chronic	6

Mastitis was classified as acute, sub-acute or chronic, and as mild, moderate or severe. Each lesion was placed in one of nine categories.

The final score for each quarter is the total of scores for sixteenth parts affected by mastitis. The above system of scoring was based on the opinions of the writer as to the importance of the lesions in contributing to the total number of cells in the milk before slaughter. It was considered that, in the lactating quarter, the total epithelial surface of the duct system is less than that of the alveolar system. Hence sub-acute and chronic lesions of the alveolar system were given double the score of similar lesions of the duct system. However, the same score was given for acute lesions in

both systems, owing to the fact that there is a temporary retention of many cells within the lumen of an alveolus when secreting is hindered by acute inflammation of the epithelial cells lining the alveolus. In acute inflammation of the duct system most of the cells arising from the lesion are carried down by milk secreted by adjacent alveoli.

Lesions consisting of fibrosis of the interlobular and, to a lesser extent, the interacinar stroma were considered as chronic and were associated with complete involution of the lobules. This fibrosis was usually accompanied by round cell infiltration but few of the cells appeared to gain access to the milk. Many of the secreting acini had disappeared in these involuted lobules and it appeared that such chronic lesions affected the cell count of the milk less than more acute lesions. Studies of cell counts appeared to be less valuable as a guide to the existence of chronic mastitis than to that of acute and sub-acute mastitis. For these reasons the scores for chronic lesions are only half of those of sub-acute lesions.

In sub-acute and chronic lesions of the same extent the three degrees mild, moderate and severe mastitis appeared to give rise to cells in the lumina of acini and

ductules in the ratio of about 1:2:3. In acute lesions, however, the ratio was generally 1:2:4. These proportions were derived from estimations of the numbers of cells found in lumina of the alveolar and duct systems. In mild lesions up to five cells were seen in each of the lumina of a few of the acini of each lobule. Where polymorphs predominated the lesion was assessed as acute; where epithelial cells predominated it was assessed as sub-acute and where only epithelial cells were found the lesion was assessed as chronic. In moderate lesions there were generally from 5 - 15 cells in some of the lumina of the acini, while in severe acute and sub-acute lesions a few of the lumina of acini in a lobule were packed with cells. In assessing lesions of the larger ductules there may have been only a few cells in the adjacent duct lumina because most had already been washed down by the milk stream. In these cases assessment was based on the types of cell found in the adjacent sub-epithelial tissue. In most quarters the duct and the lobular systems appeared to be affected by mastitis to similar extents.

With this system of scoring the maximum of 384 would be attained by a quarter which showed severe acute inflammation throughout the entire alveolar and duct

systems of the thirteen sections examined. The quarter most affected by mastitis in the present studies had a score of 246 (18 c. 108 sa. 120A) 96 D. 150 L. In this notation c represents chronic, sa sub-acute and A represents acute mastitis, D represents the duct system and L represents the lobular system. The first figure is the total score of pathological lesions, the figures in the brackets represent scores for chronic, sub-acute and acute lesions while the last two figures represent lesions in the duct and lobular systems respectively.

PART FIVE

THE PATHOLOGY OF BOVINE MAMMARY GLANDS IN RELATION
TO THE TOTAL AND DIFFERENTIAL CELL COUNTS AND
TO THE BACTERIOLOGY OF MILK AND UDDER TISSUE

Group A.

CHRONIC MASTITIS ONLY

This group consisted of fourteen glands in which all lesions of mastitis appeared to be chronic. It is conveniently divided into two sub-groups; eleven quarters having a score for pathology of 52 or more and three remaining quarters having a score of 16 or less.

Group A. 1st sub-group.

The scores for pathology of the eleven quarters were from 52 to 144. The average was 98 (30 D. 68 L.). Eight quarters were grossly abnormal in that the teats of three were occluded by fibrosis ('blind' teats); those of two others were almost occluded; two were markedly atrophied and the duct system of the remaining quarter was filled with green pus resulting from infection with Corynebacterium pyogenes. The three glands which were not grossly abnormal were from cow No. 22 which was a dry cow.

Corynebacterium pyogenes was recovered from the frozen udder tissue of the three quarters showing the most severe extensive chronic lesions. All three were from cow No. 26. The remaining R.H. quarter of this cow was found to be sterile.

After slaughter of cow No. 26 a few drops of a very watery fluid were squeezed with difficulty from the teat. This fluid contained 5.7 million cells per ml. and 18 per cent. were polymorphonuclear leucocytes which is among the lowest differential counts recorded. The only other cell counts available were those from all four quarters of cow No. 26 from samples taken eight months before slaughter. In the following tables NPS represents the so-called non-pathogenic staphylococci which were coagulase-negative.

Table showing 11 quarters in Group A. 1st sub-group

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Clinical Remarks</u>	<u>Cell Count</u> $\times 10^6$	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score Total</u>	<u>D.</u>	<u>L.</u>
26 RF	8 +	Almost occluded	-	-	<u>C.pyogenes</u>	144c	48	96
26 LF	8 +	Green pus	-	-	<u>C.pyogenes</u>	144c	48	96
26 LH	8 +	Atrophy	-	-	<u>C.pyogenes</u>	133c	37	96
15 LF	?	Occluded	-	-	Sterile	112c	48	64
26 RH	8 +	Almost occluded (p.m.)	5.7	18	Sterile	103c	35	68
22 RF	?	Dry	-	-	NPS	92c	32	60
10 LF	7	Occluded	-	-	NPS	88c	24	64
47 LF	8	Atrophy	-	-	Sterile	85c	5	80
22 RH	?	Dry	-	-	Sterile	69c	21	48
22 LH	?	Dry	-	-	Str.lactis	58c	14	44
1 LH	21	Occluded	-	-	NPS <u>B.coli</u> <u>Str.bovis</u>	52c	16	36
Mean						98c (30D. 68L.)		

Of the four quarters found to be sterile three were grossly abnormal. One was 'blind', one almost 'blind' and one was atrophied. The average score of these four sterile quarters was 92 (27 D. 65 L.). The three quarters of cow No. 26 from which C.pyogenes was recorded appeared to contain almost negligible amounts of normal tissue. The average score for the pathology of these three quarters was 140 (44 D. 96 L.). Two of these quarters scored the maximum for chronic mastitis of 144.

The average score for the eight remaining quarters was 82 (24 D. 58 L.). The only other cell count

available was of 11.0 million cells per ml. on a sample of 26 RH taken 7½ months before slaughter. No organisms were found in this sample.

Group A. 2nd sub-group.

The three quarters of this sub-group had scores of 5, 12 and 16. The average was 11 (5 D. 6 L.). Cells were counted in watery milk taken after transport from two quarters of cow No. 9 and taken three weeks before slaughter in quarter 28 LH. These last three cell counts averaged 3.7 million cells per ml. with 30 per cent. polymorphonuclear leucocytes. Staphylococcus aureus was recovered from the watery milk of both quarters of cow No. 9 when these last counts were made three weeks before slaughter. In the following tables B.T. represents samples which were collected before the cow was transported to the abattoir while A.T. represents samples taken after transport of the cow.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> x 10 ⁶	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score Total</u>	<u>D.</u>	<u>L.</u>
9 LH	9	8.5	18	A.T. NPS <u>Str.bovis</u>	16	10	6
28 LH	11	0.75	37	A.T. <u>Staph.aureus</u>	12	4	8
9 LF	9	1.8	35	B.T. NPS <u>Str.bovis</u>	5	1	4
Mean 3 qrs.	10	3.7	30	Mean	11	5	6

No bacteria were found in six milk samples from 28 LH taken during the lactation. The average cell count of all four available from Group A is 4.2 million cells per ml. with 27 per cent. polymorphs. The average score is 34 for these four quarters. The mean score for pathology of the 14 quarters in Group A is 80.

Summary of Group 1.

It appears from the data of four quarters of this group that there is a definite association between the finding of only chronic mastitis and the low differential counts which ranged from 18 to 37 per cent. polymorphonuclear leucocytes.

None of the eleven quarters in the 1st sub-group were yielding milk. As involution proceeds at the end of the lactation period the secretion changes from apparently normal milk to a watery fluid. This change occurred in quarter 26 RH and in the two quarters of cow No. 9. Secretion of the tissue of these three quarters had almost ceased. No evidence of activity of polymorphonuclear leucocytes was found. Therefore the differential counts of the fluid of two of these quarters of 18 per cent. is presumably about as low as could be expected. In the present work these were almost the

lowest counts recorded. The outstandingly low count of 16 per cent. made on milk from quarter 6 RH was made on very few cells as the total cell count was only 0.04 million cells per ml. It is probable the differential would have been higher had more cells been available for counting.

Group B.

CHRONIC MASTITIS ASSOCIATED WITH SUB-ACUTE LESIONS

There were 20 quarters in this group. There were two sub-groups.

Group B. 1st sub-group.

There were six quarters in this sub-group having a score for pathology of 52 or more. In the most severely affected quarter the teat was fibrosed. Two other glands were atrophied and one was from a dry cow. The remaining two quarters, the RF and RH of cow No. 28, contained very high cell counts after transport. These averaged 15.0 million cells per ml. of which 70 per cent. were polymorphonuclear leucocytes. Quarter 28 RF contained at least twice as much sub-acute mastitis as any of the 18 other quarters of Group B. The average score for pathology for the 1st sub-group was 84 (74 c. 10 sa.). Details are as follows:-

Group B. 1st sub-group

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Clinical Remarks</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Pathology Score Total</u>
15 RH	?	Teat occluded	-	-	Sterile	136(132c. 4 sa.)
22 LF	?	Cow dry	-	-	Sterile	82(70c.12 sa.)
12 RF	17	Atrophied	-	-	<u>Str.aga-lactiae</u>	81(79c. 2 sa.)
28 RH	11	-	20.8	81	A.T. <u>Str.bovis</u> NPS	78(70c. 8 sa.)
28 RF	11	-	10.0	59	A.T. <u>Staph.</u> <u>aureus</u>	75(51c.24 sa.)
29 RF	20	Atrophied	-	-	NPS	52(40c.12 sa.)
Mean 6 qrs. 15			15.0	70		84(74c.10 sa.)

Str. agalactiae was recovered from the milk of both quarters 28 RF and RH seven weeks before slaughter.

Group B. 2nd sub-group.

The 14 quarters in this sub-group had a score for pathology of 34 or less. The average was 17 (11 c. 6 sa.). The total cell count ranged from 0.03 to 0.68 million cells per ml. and the mean of the counts of 13 quarters was 0.26 million cells per ml. The remaining quarter was blind. Nine differential counts of this sub-group varied from 16 to 51 per cent. The remaining count from quarter 46 LH was 86 per cent. The mean differential count was 40 per cent.

Group B. 2nd sub-group

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
27 RF	10.5	0.68	31	Sterile	34 (26 c. 8 sa.)
34 LH	18	0.55	37	NPS	33 (21 c. 12 sa.)
48 LF	?	0.03	51	-	31 (27 c. 4 sa.)
1 RH	21	0.25	-	NPS. U.S.	27 (19 c. 8 sa.)
21 LF	-	Blind	-	Sterile	24 (20 c. 4 sa.)
1 RF	21	0.37	-	<u>Str. bovis</u>	13 (9 c. 4 sa.)
28 LF	11	0.38	34	Sterile	12 (4 c. 8 sa.)
34 LF	18	0.17	42	Sterile	11 (3 c. 8 sa.)
46 LH	14	0.38	86	<u>Str. bovis</u>	10 (6 c. 4 sa.)
15 RF	?	0.03	38	Sterile	10 (6 c. 4 sa.)
18 LH	?	0.05	40	NPS	8 (4 c. 4 sa.)
10 LH	7	0.15	30	<u>Str. bovis</u> <u>faecalis</u> NPS	8 (4 c. 4 sa.)
6 RH	7	0.04	16	<u>Str. bovis</u> NPS	8 (6 c. 2 sa.)
3 LH	14	0.34	-	<u>Staph. aureus</u>	5 (1 c. 4 sa.)
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14 qrs.	14	0.26	40		17 (11 c. 6 sa.)

Cell counts of samples taken after transport are available from the following quarters of Group B 2nd sub-group.

<u>Cow and Quarter</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
27 RF	0.58	42	34 (26 c. 8 sa.)
34 LH	2.61	41	33 (21 c. 12 sa.)
48 LF	0.12	51	31 (27 c. 4 sa.)
28 LF	0.38	34	12 (4 c. 8 sa.)
34 LF	1.23	40	11 (3 c. 8 sa.)
46 LH	2.00	86	10 (6 c. 4 sa.)
15 RF	0.23	59	10 (6 c. 4 sa.)
18 LH	0.40	30	8 (4 c. 4 sa.)
6 RH	0.04	16	8 (6 c. 2 sa.)
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9 qrs.	0.84	44	17 (11 c. 6 sa.)

The differential count has not altered appreciably whereas the total cell count has been increased from three to four fold after transport.

Group C.

CHRONIC MASTITIS ASSOCIATED WITH SUB-ACUTE AND
ACUTE MASTITIS

Details of the three quarters in this group are as follows:-

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
44 RF	-	No milk	-	<u>C. pyogenes</u>	118 (60c. 34sa. 24A.)
18 RF	9	1.81 A.T.	55	NPS	78 (47c. 16sa. 15A.)
40 LH	13	0.50 A.T.	80	Sterile	48 (26c. 16sa. 6A.)
3 qrs.	11	1.16	68		81 (44c. 22sa. 15A.)

Group D.

CHRONIC MASTITIS ASSOCIATED WITH ACUTE AND
SUB-ACUTE LESIONS

Details of the three quarters in this group are as follows:-

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
47 RF	8	7.0 A.T.	73	<u>Staph. aureus</u>	142 (120c. 4sa.18A.)
47 LH	8	5.5 A.T.	51	<u>Str.agalactiae</u>	135 (83c.22sa.30A.)
47 RH	8	3.5 A.T.	62	<u>Str.agalactiae</u>	131 (52c.28sa.51A.)
3 qrs.	8	5.3 A.T.	62		136 (85c.18sa.33A.)

Group E.CHRONIC MASTITIS ASSOCIATED WITH ACUTE MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
21 LH	8	Green pus	-	<u>C. pyogenes</u>	154 (106 c. 48 A.)
27 RH	10.5	4.26 A.T.	65	Sterile	35 (20 c. 15 A.)
18 RH	9	0.26 A.T.	29	NPS	17 (14 c. 3 A.)
23 RH	19	0.44 P.M.	83	Sterile	8 (6 c. 2 A.)
23 LH	19	1.21 P.M.	95	Sterile	6 (5 c. 1 A.)
23 RF	19	0.60 P.M.	87	NPS	5 (4 c. 1 A.)
6 qrs.	14	1.35 A.T.	72		38 (26 c. 12 A.)

Group F.SUB-ACUTE MASTITIS ASSOCIATED WITH CHRONIC MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly</u> <u>%</u>	<u>Bacteria</u> <u>in udder</u>	<u>Score for</u> <u>Pathology</u>
40 RF	13	0.54	92	Sterile	66 (4c.62sa.)
39 LH	1	3.4	33	Sterile	75 (23c.52sa.)
44 RH	0.5	0.72	69	Sterile	60 (10c.50sa.)
40 LF	13	1.0	90	Sterile	48 (8c.40sa.)
12 LH	17	0.60	80	NPS	56 (22c.34sa.)
24 RF	12	2.7	52	<u>Str. bovis</u> & <u>faecalis</u>	40 (8c.32sa.)
7 LH	6	1.46	30	NPS <u>Str.</u> <u>bovis</u>	36 (8c.28sa.)
7 RF	6	1.5	30	Sterile	36 (8c.28sa.)
44 LH	0.5	0.14	88	NPS	29 (1c.28sa.)
6 LF	7	0.16	90	Sterile	25 (3c.22sa.)
29 LH	20	4.18	40	<u>Staph.aureus</u>	34 (14c.20sa.)
34 RH	18	1.55	32	NPS	32 (16c.16sa.)
29 RH	20	6.0	46	NPS	28 (12c.16sa.)
34 RF	18	3.0	31	Sterile	21 (7c.14sa.)
14 qrs.	11	1.93	57		42 (10c.32sa.)

All the cell counts in Group F were from samples collected after transport. Group F can be conveniently subdivided into two groups according to total cell count and differential count. The first sub-group consists of six quarters having a total count of 1.0 million cells per ml. or less. Their differential count is from 69 to 92 per cent.

Group F. 1st sub-group.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
40 RF	13	0.54	92	Sterile	66 (4c.62sa.)
44 RH	0.5	0.72	69	Sterile	60 (10c.50sa.)
40 LF	13	1.0	90	Sterile	48 (8c.40sa.)
12 LH	17	0.60	80	NPS	56 (22c.34sa.)
44 LH	0.5	0.14	88	NPS	29 (1c.28sa.)
5 qrs.	9	0.60	84		52 (9c.43sa.)

Group F. 2nd sub-group.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
39 LH	1	3.4	33	Sterile	75 (23c.52sa.)
24 RF	12	2.7	52	<u>Str. bovis</u> & <u>faecalis</u>	40 (8c.32sa.)
7 LH	6	1.46	30	NPS <u>Str.</u> <u>bovis</u>	36 (8c.28sa.)
7 RF	6	1.5	30	Sterile	36 (8c.28sa.)
29 LH	20	4.18	40	<u>Staph. aureus</u>	34 (14c.20sa.)
34 RH	18	1.55	32	NPS	32 (16c.16sa.)
29 RH	20	6.0	46	NPS	28 (12c.16sa.)
34 RF	18	3.0	31	Sterile	21 (7c.14sa.)
8 qrs.	12.5	3.0	37		38 (12c.26sa.)

The 1st sub-group of Group F has a mean score for sub-acute mastitis 50 per cent. greater than that of the 2nd sub-group. The total cell count of the 1st sub-group is only about one sixth that of the 2nd sub-group while the differential count is more than double.

Group G.SUB-ACUTE MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
24 LH	12	0.18	52 (P.M.)	<u>Str. bovis</u>	14 (14sa.)
46 RH	14	0.71 A.T.	74	Sterile	10 (10sa.)
1 LF	21	0.26 B.T.	-	NPS <u>Str. bovis</u>	8 (8sa.)
46 RF	14	0.50 A.T.	76	NPS	4 (4sa.)
4 qrs.	15	0.41	67		9 (9sa.)

Group H.SUB-ACUTE MASTITIS ASSOCIATED WITH CHRONIC ANDACUTE MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
21 RF	8	35.0	91	<u>Staph. aureus</u>	158 (6c. 116sa. 36A.)
21 RH	8	4.9	61	Sterile	105 (39c. 60sa. 6A.)
12 RH	17	4.0	80	<u>Str. agalactiae</u>	74 (12c. 38sa. 24A.)
40 RH	13	0.32	77	Sterile	66 (26c. 34sa. 6A.)
7 RH	6	1.63	17	NPS <u>Str. bovis</u>	39 (4c. 32sa. 3A.)
39 RH	1	2.7	84	<u>Staph. aureus</u>	60 (24c. 30sa. 6A.)
24 LF	12	5.7	53	NPS	45 (18c. 24sa. 3A.)
44 LF	0.5	0.36	53	NPS	42 (15c. 24sa. 3A.)
7 LF	6	1.42	40	NPS <u>Str. bovis</u>	37 (10c. 24sa. 3A.)
6 LF	7	0.16	90	Sterile	26 (3c. 22sa. 1A.)
29 LF	20	5.31	62	NPS	35 (12c. 20sa. 3A.)
24 RH	12	4.0	55	NPS <u>Str. bovis</u>	42 (18c. 18sa. 6A.)
3 RF	14	0.57	-	NPS	15 (4c. 8sa. 3A.)
13 qrs.	10	5.1	63		57 (15c. 35sa. 7A.)

All counts in Group H were on samples collected after transport of the cows.

The extremely low differential count of 17 per cent. from quarter 7 RH is exceptional in association with an acute lesion.

Group J.

SUB-ACUTE MASTITIS ASSOCIATED WITH ACUTE MASTITIS

1st sub-group.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
27 LF	10.5	13.2	89	<u>Staph. aureus</u>	164(152sa.12A.)
12 LF	17	36.0	90	<u>Str. agalactiae</u>	191(98sa.93A.)
39 RF	1	8.0	81	<u>Staph. aureus</u>	94(70sa.24A.)
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3 qrs.	9.5	19.0	87		150(107sa.43A.)

The above three counts were on samples collected after transport of the cows.

2nd sub-group.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
3 RH	14	1.30	-	NPS	14(8sa.6A.)
10 RH	7	0.09	30	NPS <u>Str.bovis</u>	14(8sa.6A.)
1 week b.t.					

It is regretted that the only count available from quarter 10 RH was collected one week before slaughter

and therefore perhaps bears little association with the pathology of the quarter.

Group K.

ACUTE MASTITIS ASSOCIATION WITH SUB-ACUTE AND
CHRONIC MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> $\times 10^6$	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
48 RF	?	13.0	80	<u>Str. agalactiae</u>	246(18c.108sa.120A.)
27 LH	10.5	15.0	92	<u>Staph. aureus</u>	168(8c. 70sa. 90A.)
6 LH	7	0.36	58	<u>Str. bovis</u>	119(3c. 8sa.108A.)
6 RF	7	0.90	96	<u>Str. uberis</u>	72(2c. 4sa. 66A.)
4 qrs.	8	7.3	82		152(8c. 48sa. 96A.)

Group L.

ACUTE MASTITIS ASSOCIATED WITH SUB-ACUTE MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> $\times 10^6$	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
48 LH	?	13.0	87	<u>Str. agalactiae</u>	237(24sa.213A.)
39 LF	1	2.16	71	NPS	49(16sa. 33A.)
2 qrs.	-	7.5	79		143(20sa.123A.)

Group M.ACUTE MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
46 LF	14	0.90 A.T.	77	Sterile	3 (3A.)
23 LF	19	2.40 A.T.	90	Micrococci	2 (2A.)
2 qrs.	17	1.65	84		3 (3A.)

Group N.ACUTE MASTITIS ASSOCIATED WITH CHRONIC MASTITIS

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
48 RH	?	0.80	70		47 (20c. 27A.)
3 LF	14	0.36	-	Micrococci	5 (2c. 3A.)
10 RF	7	0.16	31	NPS <u>Str.bovis</u>	4 (1c. 3A.)
		1 week B.T.			
3 qrs.	11	0.58 (2)	70 (1)		19 (8c. 11A.)

Group O.MASTITIS APPARENTLY NEGLIGIBLE

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Bacteria in udder</u>	<u>Score for Pathology</u>
15 LH	?	0.80	87	Sterile	NIL
18 LF	9	0.32	44	Sterile	NIL
2 qrs.	9	0.56	65	Sterile	NIL

SUMMARY OF GROUPS A - N.

TABLE 1. Table of Relationship of means of available counts to the mean pathology of groups.

<u>Group</u>	<u>Pathology</u>	<u>No. of Quarters in Group</u>	<u>Mean Cell Count</u> <u>x 10⁶</u>	<u>Mean Poly %</u>	<u>Mean Score for Pathology</u>
A.	Chronic only	11	5.7 (1)	18(1)	98c.
A.	Chronic only	3	3.7	30	11c.
B.	Chronic with sa.	6	15.0 (2)	70(2)	84(74c.10sa.)
B.	Chronic with sa.	14	0.84(9)	44(9)	17(11c. 6sa.)
C.	Chronic with sa. and A.	3	1.16(2)	69(2)	81(44c.22sa.15A.)
D.	Chronic with A. and sa.	3	5.3	62	136(85c.18sa.33A.)
E.	Chronic with acute	6	1.35(5)	72(5)	38(26c.12A.)
F.	Sub-acute with C.	5	0.60	84	52(9c.43sa.)
F.	Sub-acute with C.	8	3.0	37	38(12c.26sa.)
G.	Sub-acute only	4	0.41	67(3)	9(9sa.)
H.	Sub-acute with C. & A.	13	5.1	63(12)	57(15c.35sa.7A.)
J.	Sub-acute with A.	3	19.0	87	150(107sa.43A.)
J.	Do.	2	1.3 (1)	-(0)	14(8sa.6A.)
K.	Acute with sa. and C.	4	7.3	82	152(8c.48sa.96A.)
L.	Acute with sa.	2	7.5	79	143(20sa.123A.)
M.	Acute only	2	1.65	84	3(3A.)
N.	Acute with chronic	3	0.58(2)	70(1)	19(8c.11A.)
O.	Negligible	2	0.56	65	NIL
18 divisions		94	-	-	-

The bracketed number following a cell count is the number of quarters having available counts from which the mean was calculated.

TABLE 2. Table of Relationship of means of total and differential counts to the mean pathology of groups of quarters yielding the samples from which these counts were made.

<u>Group</u>	<u>Pathology</u>	<u>No. of Quarters in Group</u>	<u>Mean Cell Count x 10⁶</u>	<u>Mean Poly %</u>	<u>Mean Score for Pathology</u>
A.1st div.	Chronic only	1	5.7	18	103c.
A.2nd div.	Chronic only	3	3.7	30	11c.
B.1st div.	Chronic with sa.	2	15.0	70	77(61c.16sa.)
B.2nd div.	Chronic with sa.	9	0.84	44	17(11c.6sa.)
C.	Chronic with sa. and A.	2	1.16	68	63(36c.16sa.11A.)
D.	Chronic with A. and sa.	3	5.3	62	136(85c.18sa.33A.)
E.	Chronic with A.	5	1.35	72	14(10c.4A.)
F.1st div.	Sub-acute with C.	5	0.60	84	52(9c.43sa.)
F.2nd div.	Sub-acute with C.	8	3.0	37	38(12c.26sa.)
G.	Sub-acute only	3	0.46	67	9(9sa.)
H.	Sub-acute with C. & A.	12	5.5	63	61(16c.37sa.8A.)
J.1st div.	Sub-acute with A.	3	19.0	87	150(107sa.43A.)
J.2nd div.	Do.	0	-	-	-
K.	Acute with sa. and C.	4	7.3	82	152(8c.48sa.96A.)
L.	Acute with sa.	2	7.5	79	143(20sa.123A.)
M.	Acute only	2	1.65	84	3(3A.)
N.	Acute with chronic	1	0.80	70	47(20c.27A.)
O.	Negligible	2	0.56	65	NIL
18 divisions		67			

The following nine divisions which contain acute mastitis have been arranged according to their score for combined acute and sub-acute mastitis.

<u>Group</u>	<u>Pathology</u>	<u>No. of Quarters</u>	<u>Cell Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Mean Score Pathology</u>
J.1st div.	Sub-acute with A.	3	19.0	87	150(107sa.43A.)
K.	Acute with sa. and C.	4	7.3	82	152(8c.48sa.96A.)
L.	Acute with sa.	2	7.5	79	143(20sa.123A.)
D.	Chronic with A. and sa.	3	5.3	62	136(85c.18sa.33A.)
H.	Sub-acute with C. and A.	12	5.5	63	61(16c.37sa.8A.)
C.	Chronic with sa. and A.	2	1.16	68	63(36c.16sa.11A.)
N.	Acute with C.	1	0.80	70	47(20c.27A.)
E.	Chronic with A.	5	1.35	72	14(10c.4A.)
M.	Acute only	2	1.65	84	3(3A.)
		34		74	

From the above arrangement it is concluded that the total cell count in general corresponds to the extent of the pathological changes. The combined lesions of sub-acute and acute mastitis generally also appear to be related directly to total cell count.

Where the total cell count on samples collected after transport of the cow is less than 2.0 million cells per ml. this relationship becomes looser. There

are several exceptions to this general direct relationship of total cell count to pathological changes in the udder. Quarter 48 RH (Group N) produced milk with counts of 0.80 million cells per ml. and 70 per cent. differential count. The score for pathology was 47 (20 c. 27 A.). The same total count and a differential of 87 per cent. were produced by Quarter 15 LH (Group O) which contained only negligible amounts of chronic mastitis. It is considered that much mastitis might be missed by taking too few sections from a gland. In the above two quarters this was perhaps not an important point because while only two sections were cut from 48 RH, 13 sections were examined from 15 LH. A strong indication of mastitis was found in 48 RH eight days before slaughter when a sample of milk contained 1.7 million cells per ml. with 85 per cent. polymorphs.

It can be concluded that when the total cell count of a sample of milk is over 1.0 million cells per ml. there is a strong probability that lesions of mastitis will be found in the gland which produced the milk. In general quarters containing lesions of acute mastitis produced samples of milk in which the differential count varied from 51 to 96 per cent. polymorphs. In the present work there were 34 quarters which were known to

contain lesions of acute mastitis and for which differential counts were calculated. The 34 counts varied from 17 to 96 per cent. polymorphs. The mean was 74 per cent.; seven were 90 or more; nine were between 80 and 89; five were from 70 - 79; four were from 60 - 99, six from 50 - 59, while the three remaining counts were 40, 29 and 17 per cent. respectively. Twenty-one of these 34 counts were over 70 per cent. and only three were less than 51 per cent. The content of polymorpho-nuclear leucocytes in a milk sample is generally only an approximate indication of the main type of mastitis in a quarter.

The three quarters with acute mastitis with low differential cell counts were 7 LF and 7 RH (Group H), 18 RH (Group E). Cow No. 7 calved about 6.5 months before slaughter and at the time was almost dry. Two months before slaughter the daily yield from all four quarters was only eight pounds of milk. The differential counts of her LF, LH and RF and RH quarters were 40, 30, 30 and 17 per cent. polymorphs respectively. The extensive desquamation of epithelial cells would probably account for the relative depression of the polymorph count despite the presence of small acute lesions. Cow No. 18 calved nine months before slaughter and was approaching

the end of the lactation period. It is noteworthy that in all three of these quarters the acute lesions were only mild and were only about one-sixteenth of the total area of tissue examined.

Of the 67 quarters for which differential counts were available nine had counts of 90 per cent. polymorphs or more. Eight of the nine showed lesions of acute mastitis although in quarter 40 RF the acute lesions were too small to be included in the score.

The nine quarters are tabulated below for comparison:-

<u>Cow and Quarter</u>	<u>Total Cell Count</u> <u>x 10⁶</u>	<u>Poly</u> <u>%</u>	<u>Score for Pathology</u>
6 RF	0.90	96	72 (2c. 4sa. 66A.)
23 LH	1.21	95	6 (5c. 1A.)
27 LH	15.0	92	168 (8c. 70sa. 90A.)
40 RF	0.54	92	55 (4c. 62sa.)
21 RF	35.0	91	158 (6c. 116sa. 36A.)
12 LF	36.0	90	191 (98sa. 93A.)
6 LF	0.16	90	26 (3c. 22sa. 1A.)
23 LF (P.M.)	2.40	90	2 (2A.)
40 LF	1.0	90	48 (8c. 40sa.)

This table shows that a differential count of over 90 per cent. polymorphs does not necessarily indicate the presence of acute lesions nor does it indicate their extent, but the extent seems to govern the total cell count. Three of the above quarters contained apparently minimal acute lesions. On the other hand in all three quarters with a cell count of 15.0 million cells per ml.

or more and a differential count of 90 per cent. polymorphs or more there were extensive acute and sub-acute lesions.

In the lower total cell category there appeared to be little relationship between total cell count and the pathological changes observed. Quarters 23 LF and 23 LH both produced larger cell counts than quarters 6 LF, 6 RF, 40 LF and 40 RF yet they both appeared to contain comparatively very small amounts of inflamed tissue. There was extensive acute mastitis in quarter 6 RF while the other three quarters contained mainly sub-acute mastitis.

The relative states of involution of these quarters would not appear to account for these cell counts. Quarters 23 LF and LH were in a state of much more advanced involution than were the other four above quarters. Cow No. 23 was slaughtered 19 months after calving and she was yielding very little milk. It might have been expected therefore in the absence of much acute mastitis that the desquamation of epithelial cells would have accounted for most of the cells in the milk sample. That such was not the case deters any hard and fast relationship being accorded between cell count and pathology.

It is concluded from the four differential counts of Group A quarters that a low differential count of between 18 and 37 per cent. polymorphs is associated with chronic mastitis in quarters which are in process of involuting. These low differential counts can also occasionally be obtained from quarters with acute and sub-acute mastitis as has been previously shown. The counts of quarters in Group B in general support the contention that in the absence of acute lesions and in the presence of mainly chronic mastitis the differential cell count is usually below 50 per cent.

General Conclusions.

While the foregoing data provide evidence that neither the total cell count nor the differential count of cells in milk appears to bear accurate relationship to the pathological changes of the tissues which secreted the milk, a combination of these two counts can be used to assess approximately the probable pathological picture. Where the total count is over 15.0 million cells per ml. with over 90 per cent. polymorphs then extensive acute mastitis would be expected in the quarter. This opinion is based on three quarters in each of which only about one-eighth of the acinar tissue appeared to be normal and in which the entire duct system was abnormal. In these

three cases most of the mastitis was acute.

From the present work it would appear to be difficult to set reliable standards for the cell counts to be expected in milk from normal quarters from cows of the fifth or a later lactation. Only two of the 94 quarters examined appeared to have negligible pathological changes. After transport of the cow one of these apparently healthy quarters yielded milk containing 0.8 million cells per ml. Total counts were found as low as 0.03 million cells per ml. in milk from other quarters after transport; these quarters contained varying amounts of inflamed tissue. Altogether 31 quarters yielded milk containing fewer cells calculated per ml. of milk than did the milk from this apparently normal quarter.

Counts on milk samples taken within a few weeks of slaughter assist in predicting the pathology of the secreting quarter. Total and differential counts are then a guide as to the changes going on in the udder. Counts of over 2.0 million cells with about 90 per cent. polymorphs generally indicate acute mastitis in progress. Two or three days later the count may be largely composed of epithelial cells as the acute inflammation subsides and in place of polymorphs vast numbers of epithelial cells are desquamated as a result of the closing down of acini as a reaction to the inflammation.

PART SIXTHE BACTERIOLOGY OF BOVINE MAMMARY GLANDS IN
RELATION TO THEIR PATHOLOGY AND CELL COUNTS

Group A. Corynebacterium pyogenes cultured from udder
tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Clinical findings</u>	<u>Score for Pathology</u>
26 LF	8	Green pus	264 (72 c. 192 A.)
21 LH	0.75	Green pus	154 (106 c. 48 A.)
26 RF	8	Atrophy	144 (144 c.)
26 LH	8	Atrophy	133 (133 c.)
44 RF	0.5	Green pus	118 (60 c. 34 sa. 24 A.)
5 qrs.	Mean 5		163 (103 c. 7 sa. 53 A.)

None of these quarters was secreting milk at the
time of slaughter.

Group B. Streptococcus agalactiae cultured from udder
tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count(A.T.) x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
48 RF	?	4.20	56	246 (18 c. 108 sa. 120 A.)
48 LH	?	4.0	66	237 (- 24 sa. 213 A.)
12 LF	17	36.0	90	191 (- 98 sa. 93 A.)
47 LH	8	5.5	51	135 (83 c. 22 sa. 30 A.)
47 RH	8	3.5	62	131 (52 c. 28 sa. 51 A.)
12 RF	17	Atrophied	No milk	81 (79 c. 2 sa. -)
12 RH	17	4.0	80	74 (12 c. 38 sa. 24 A.)
7 qrs.	13 (5)	9.5	68	157 (35 c. 46 sa. 76 A.)

In Group B with the exclusion of the atrophied quarter the mean pathological score is 169 (27 c. 53 sa. 89 A.). With the later inclusion of quarter 6 LH the mean pathology score is 162 (23 c. 47 sa. 92 A.). The mean cell counts are then 8.2 million per ml. and 66 per cent. polymorphs respectively.

Group C. Staphylococcus aureus cultured from udder tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count (A.T.)</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
27 LH	10.5	15.0	92	168 (8 c. 70 sa. 90 A.)
27 LF	10.5	13.2	89	164 (- 152 sa. 12 A.)
21 RF	0.75	35.0	91	158 (6 c. 116 sa. 36 A.)
47 RF	8	7.0	73	142 (120 c. 4 sa. 18 A.)
39 RF	1	8.0	81	94 (- 70 sa. 24 A.)
28 RF	11	10.0	59	75 (51 c. 24 sa.)
39 RH	1	2.7	84	60 (24 c. 30 sa. 6 A.)
29 LH	20	5.31	62	35 (12 c. 20 sa. 3 A.)
28 LH	11	0.75	37	12 (12 c.)
3 LH	14	0.34 (B.T.)	-	5 (1 c. 4 sa.)
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10 qrs.	9	10.8	67	91 (23 c. 49 sa. 19 A.)

Group D. Streptococcus uberis cultured from the udder tissue in association with coagulase-negative staphylococci.

6 RF	7	0.90 (A.T.)	96	72 (2 c. 4 sa. 66 A.)
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Group E. Coagulase-negative staphylococci cultured from
the udder.

<u>Cow and</u> <u>Quarter</u>	<u>Months</u> <u>calved</u>	<u>Total</u> <u>Count (A.T.)</u> <u>x 10⁶</u>	<u>Poly</u> <u>%</u>	<u>Score for</u> <u>Pathology</u>
22 RF	?	Dry cow	92	(92 c.)
10 LF	-	Teat occluded	88	(88 c.)
18 RF		1.81	55	78 (47 c. 16 sa. 15 A.)
12 LH	17	0.60	80	56 (22 c. 34 sa.)
29 RF	20	5.4	86	52 (40 c. 12 sa.)
39 LF		2.16	71	49 (- 16 sa. 33 A.)
24 LF		5.7	53	45 (18 c. 24 sa. 3 A.)
44 LF	0.5	0.36	53	42 (15 c. 24 sa. 3 A.)
29 LF	0.5	5.31	62	35 (12 c. 20 sa. 3 A.)
34 LH		2.61	41	33 (21 c. 12 sa.)
34 RH		1.55	32	32 (16 c. 16 sa.)
44 LH	0.5	0.14	88	29 (1 c. 28 sa.)
29 RH		6.0	46	28 (12 c. 16 sa.)
18 RH		0.26	29	17 (14 c. - 3 A.)
18 LH		0.40	30	8 (4 c. 4 sa.)
46 RF	14	0.50	76	4 (- 4 sa.)
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16 qrs.		2.34	57	43 (25 c. 14 sa. 4 A.)
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Staph. aureus was recovered from the milk of quarters 39 LF and 44 LF within 48 hours before slaughter and with the exclusion of these the means of the remaining twelve quarters were 2.52 million cells per ml. and 56 per cent. polymorphs respectively and for the score 35 (17 c. 16 sa. 2 A.).

Group F. Coagulase-negative staphylococci and
Streptococcus bovis cultured from the udder
tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count (A.T.) x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
28 RH		20.8	81	78 (70 c. 8 sa.)
24 RH		13.0	52	42 (18 c. 18 sa. 6 A.)
7 RH	6.5	1.63	17	39 (4 c. 32 sa. 3 A.)
7 LF	6.5	1.42	40	37 (10 c. 24 sa. 3 A.)
7 LH	6.5	1.46	30	36 (8 c. 28 sa.)
10 RH		Teats removed		14 (- 8 sa. 6 A.)
1 LF	21	0.26 (B.T.)	-	8 (- 8 sa.)
6 RH	7	0.04	16	8 (6 c. 2 sa.)
9 LF		Dry quarter		5 (5 c.)
10 RF		Teats removed		4 (1 c. - 3 A.)
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10 qrs.		6.4 (6 qrs.)	39	27 (12 c. 13 sa. 2 A.)

Group G. Streptococcus bovis cultured from the udder tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count (A.T.) x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
6 LH	7	0.27	56	119 (3 c. 8 sa. 108 A.)
24 LH	12	1.0	52	14 (- 14 sa.)
1 RF	21	0.37 (B.T.)	-	13 (9 c. 4 sa.)
46 LH	14	2.0	86	10 (6 c. 4 sa.)
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4 qrs.	13.5	1.09 (3 qrs.)	65	39 (4 c. 8 sa. 27 A.)

Streptococcus agalactiae was recovered from a sample of milk taken from quarter 6 LH on the day before slaughter. With the exclusion of this quarter the mean total count of Group G is 1.5 million cells per ml. of which 69 per cent. are polymorphs. The mean pathology of the three quarters is 12 (5 c. 7 sa.).

Group H. Coagulase-negative staphylococci and undetermined streptococci cultured from the udder tissue.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count (B.T.)</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
1 RH	21	0.25	-	27 (19 c. 8 sa.)
3 RF	14	0.57	-	15 (4 c. 8 sa. 3 A.)
3 RH	14	1.30	-	14 (- 8 sa. 6 A.)
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3 qrs.	16	0.7	-	19 (8 c. 8 sa. 3 A.)

The cell counts of cows 1 and 3 were on samples of milk collected the day before the cows left the farm and before differential counts were used in the present work.

Group J. Miscellaneous bacteria cultured from the udder tissue.

In this group N represents coagulase-negative staphylococci, B represents Str. bovis, F Str. faecalis, M micrococci, L Str. lactis, C Bacterium coli and U represents undetermined streptococci.

<u>Cow and Quarter</u>	<u>Bacteria found</u>	<u>Total Count (B.T.)</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
22 LH	L	Dry cow		58 (58 c.)
1 LH	NBC	Teat occluded		52 (52 c.)
24 RF	BF	2.7	52	40 (8 c. 32 sa.)
9 LH	NBL	8.55	18	16 (16 c.)
10 LH	NBF	Teat removed		8 (4 c. 4 sa.)
3 LF	MU	0.36 (B.T.)	-	5 (2 c. 3 A.)
23 RF	NL	0.60	87	5 (4 c. 1 A.)
23 LF	NM	0.48	70	2 (2 A.)
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8 qrs.		3.08 (4 qrs.)	57	23 (18 c. 4 sa. 1 A.)

The mean score for pathology of the four above quarters which have differential counts is 16 (7 c. 8 sa. 1 A.).

Group K. Quarters which were apparently sterile.

<u>Cow and Quarter</u>	<u>Months calved</u>	<u>Total Count (A.T.)</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
15 RH	?	Teat occluded	136	(132 c. 4 sa.)
15 LF	?	Teat occluded	112	(112 c.)
21 RH		4.9	61	105 (39 c. 60 sa. 6 A.)
26 RH		5.7 (P.M.)	18	103 (103 c.)
47 LF		Teat occluded		85 (85 c.)
22 LF		Dry cow		82 (70 c. 12 sa.)
39 LH		3.4	33	75 (23 c. 52 sa.)
22 RH		Dry cow		69 (69 c.)
40 RF		0.54	92	66 (4 c. 62 sa.)
40 RH		0.32	77	66 (26 c. 34 sa. 6 A.)
44 RH		0.72	69	60 (10 c. 50 sa.)
40 LF		1.0	90	48 (8 c. 40 sa.)
40 LH		0.50	80	48 (26 c. 16 sa. 6 A.)
48 RH		0.80	70	47 (20 c. - 27 A.)
7 RF	6.5	1.5	30	36 (8 c. 28 sa.)
27 RH		4.26	65	35 (20 c. - 15 A.)
27 RF		0.58	42	34 (26 c. 8 sa.)
48 LF		0.12	51	31 (27 c. 4 sa.)
6 LF		0.16	90	25 (3 c. 22 sa.)
21 LF		Teat occluded		24 (20 c. 4 sa.)
34 RF	18	3.0	31	21 (7 c. 14 sa.)
28 LF		0.38	34	12 (4 c. 8 sa.)
34 LF		1.23	40	11 (3 c. 8 sa.)
15 RF	?	0.23	59	10 (6 c. 4 sa.)
46 RH		0.71	74	10 (- 10 sa.)
23 RH		0.44	83	8 (6 c. - 2 A.)
23 LH		1.21 (P.M.)	95	6 (5 c. - 1 A.)
46 LF		0.90	77	3 (- - 3 A.)
15 LH	?	0.80	87	Nil
18 LF		0.32	44	Nil
30 qrs.	-	1.40	62	46 (29 c. 15 sa. 2 A.)

Cell counts were available from 24 of the above 30 quarters. The mean score for pathology of these 24 is estimated at 36 (16 c. 17 sa. 3 A.). The mean score for pathology of the four quarters having occluded teats and two from the dry cow is 85 (82 c. 3 sa.). Only eight of the above 30 quarters had scores for acute mastitis. The mean score for pathology of these eight quarters is 40 (18 c. 14 sa. 8 A.). The total counts varied from 0.32 to 4.9 (mean 1.66) million cells per ml. The differential count varied from 61 to 95 per cent. (mean 76 per cent.) polymorphs. The only two quarters encountered having no score for pathology were both apparently sterile. After the exclusion of all four quarters of cow No. 40 from the table on the grounds that her milk contained Staphylococcus aureus the remaining 20 quarters had mean cell counts of 1.6 million per ml. and 58 per cent. polymorphs respectively and a mean score for pathology of 32 (16 c. 13 sa. 3 A.).

Summary of the means of Groups A - K.

cns represents coagulase negative staphylococci.

<u>Group and</u> <u>No. of qrs.</u>	<u>Bacteria</u> <u>found</u>	<u>Total</u> <u>Count</u> <u>x 10⁶</u>	<u>Poly</u> <u>%</u>	<u>Score for</u> <u>Pathology</u>			
A 5	<u>C. pyog.</u>	-	-	163	(103 c.	7 sa.	53 A.)
B 7	<u>Str. agal.</u>	9.5	68	157	(35 c.	46 sa.	76 A.)
C 10	<u>Staph. aur.</u>	10.8	67	91	(23 c.	49 sa.	19 A.)
D 1	<u>Str. uber.</u>	0.90	96	72	(2 c.	4 sa.	66 A.)
E 16	cns	2.34	57	43	(25 c.	14 sa.	4 A.)
F 10	cns <u>Str. bov.</u>	6.4	39	27	(12 c.	13 sa.	2 A.)
G 4	<u>Str. bov.</u>	1.09	65	39	(4 c.	8 sa.	27 A.)
H 3	cns, str.	0.7	-	19	(8 c.	8 sa.	3 A.)
J 8	Mixed	3.08	57	23	(18 c.	4 sa.	1 A.)
K 30	None	1.40	62	46	(29 c.	15 sa.	2 A.)
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	94						
<hr/>							

This summary shows that on average Corynebacterium pyogenes and Streptococcus agalactiae were associated with the most extensive pathological changes. On the average the mean score for pathology of the five quarters found to contain Corynebacterium pyogenes was 163 of which 103 represented severe chronic inflammation affecting about three quarters of the entire mammary tissue. More than half of the remaining tissue on average was affected by severe acute mastitis. The quarters 26 LH and RF contained negligible amounts of normal tissue. Almost their entire tissue was affected by severe chronic inflammation. At some period within the eight months before slaughter these

two quarters became infected by C. pyogenes. All acute reaction had subsided before slaughter.

The cells in the green pus in the other three quarters were uncountable and often unrecognisable. It is considered that if milk samples had been collected a day or two before the acute clinical mastitis, they would have contained about the largest cell counts, probably 30 to 40 million cells per ml. The quarters 21 LH and 26 LF appeared clinically to be by far the most severely affected by acute mastitis than any of the other 92 quarters examined. Cow No. 21 was killed in December and cow No. 26 killed in January. These two cases were unusual in that they occurred in mid-winter. Acute mastitis associated with C. pyogenes generally occurs during the humid weather of July and August and is commonly referred to as 'summer mastitis'. By the exclusion of the two atrophied quarters the mean score for pathology of Group A would become on average 169 (79 c. 12 sa. 88 A.). This is very similar to the average score of 169 (27 c. 53 sa. 89 A.) for six quarters in Group B which were infected by Streptococcus agalactiae.

Staph. aureus appeared to be associated with quarters showing less extensive and mainly sub-acute

mastitis in general. The mean cell counts were on average the same as those from Group B quarters. The total counts were in general larger than those of other groups. Str. uberis was recovered from only one quarter and this showed extensive severe acute mastitis. The very high differential count of 96 per cent. appears to have been an indication of the lesions found.

The pathological changes in the 23 quarters of Groups A, B, C and D were generally far more extensive than those of the remaining groups. The four bacteria C. pyogenes, Str. agalactiae, Staph. aureus and Str. uberis are commonly referred to throughout the literature as being associated generally with bovine mastitis. Bacterium coli and micrococci are considered by some workers to be associated with the condition at times (MacEwan). The other bacteria such as coagulase-negative staphylococci, Str. bovis, Str. lactis and Str. faecalis are generally considered not to be associated with mastitis and to be saprophytes.

The 30 quarters of Group K from which no bacteria were recovered had a mean pathology score similar to those of Groups E to J and almost identical to that of Group E. During the present examination of 94 quarters the four major mastitis bacteria were between them cultured from

23 quarters after slaughter and from the milk of seven others within 48 hours before slaughter. Other bacteria were cultured from 38 quarters while the remaining 26 quarters appeared to be sterile. It is assumed that the bacteria found in milk would be associated with lesions present in the tissues up to 48 hours afterwards.

All four quarters of cow No. 40 and 44 LF two days before slaughter yielded milk containing Staph. aureus. This organism was also recovered from a milk sample taken on the day of slaughter from quarter 39 LF. The latter case demonstrates the elusiveness of some udder bacteria. It may have been shortcomings of the bacteriological technique which prevented this organism from being cultured from the udder tissue. Probably too few samples of udder tissue were collected. Similarly Streptococcus agalactiae was grown from a milk sample from quarter 6 LH the day before slaughter and was not recovered from the tissues. The seven above quarters have therefore been regrouped on the assumption that the bacteria found in their milk as shown above might reasonably have been expected in the udder tissue at the time of slaughter. New means of groups have been calculated after the accommodation of the seven above mentioned quarters into their changed bacteriological categories.

Revised Summary of Pathology of Groups A - K.

<u>Group</u>	<u>No. of Quarters</u>	<u>Bacteria found</u>	<u>Mean Score for Pathology</u>
A	5	<u>C. pyogenes</u>	163 (103 c. 7 sa. 53 A.)
B	8	<u>Str. agalactiae</u>	152 (31 c. 41 sa. 80 A.)
C	16	<u>Staph. aureus</u>	77 (19 c. 43 sa. 15 A.)
D	1	<u>Str. uberis</u>	72 (2 c. 4 sa. 66 A.)
E	14	coag-neg., staph.	43 (28 c. 13 sa. 2 A.)
F	10	c.n.s. <u>Str. bovis</u>	27 (12 c. 13 sa. 2 A.)
G	3	<u>Str. bovis</u>	12 (5 c. 7 sa.)
H	3	c.n.s., str.	19 (8 c. 8 sa. 3 A.)
J	8	mixed	23 (18 c. 4 sa. 1 A.)
K	26	none	44 (31 c. 11 sa. 2 A.)

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There is great similarity of the average scores of pathology of Groups E and K, those quarters infected with the coagulase-negative staphylococci and those which were apparently sterile. The latter 26 show in general more pathological changes than 24 quarters of Groups F to J. The most probable explanation of the latter finding is that most of the lesions in quarters in Groups F to J are more recent and that the associated bacteria have not yet been killed by the defence mechanisms. Group K contains many quarters in which many lesions are chronic and resulted from past bacterial infections which were by the time of slaughter successfully counteracted. Had some of these quarters been examined histologically at the time of the major attack of disease it is probable that some bacteria would have been found.

These considerations apply especially to four quarters of Group K having occluded teats. The complete fibrosis of a teat is evidence of most severe mastitis probably occurring after infection by virulent bacteria several months before slaughter. It seems probable from the pathological changes observed that Corynebacterium pyogenes would be the organism most likely involved in quarters 15 RH and LF, 21 RH and 26 RH, the four most pathological quarters of Group K. C. pyogenes was recovered from the other three quarters of cow No. 26 and from 21 LH. All four of the sterile quarters show that about three-quarters of the tissues were affected by severe chronic mastitis which is similar to the extent of chronic lesions of Group A quarters. When only data of quarters having available differential counts is recorded the following table results.

<u>Group</u>	<u>No. of Quarters</u>	<u>Mean Total Cell Count</u> <u>x 10⁶</u>	<u>Mean % Poly.</u>	<u>Mean Score for Pathology</u>
A	None has differential count			
B	7	8.2	66	162 (23 c. 47 sa. 92 A.)
C	15	6.8	71	82 (21 c. 45 sa. 16 A.)
D	1	0.90	96	(2 c. 4 sa. 66 A.)
E	12	2.52	57	35 (17 c. 16 sa. 2 A.)
F	6	6.4	39	40 (19 c. 19 sa. 2 A.)
G	2	1.5	69	(3 c. 9 sa.)
H	None has differential count			
J	4	3.08	57	16 (7 c. 8 sa. 1 A.)
K	20	1.6	58	32 (16 c. 13 sa. 3 A.)
	<u>67</u>			

The expectation would be that after any bacterial infection of the mammary tissues was sterilised, the pathological changes would rapidly resolve. It is unexpected that acute lesions would be found in apparently sterile quarters. The existence of small areas of acute mastitis in six of the 26 apparently sterile quarters can be accounted for partly by using too few samples of tissue, shortcomings of bacteriological technique, to the effects of trauma due to transport of cows in lorries or to combinations of such factors. There appears to be no symbiosis between udder bacteria and the cow and it is concluded that all the bacteria recovered from udder tissues were parasites and associated with lesions of inflammation.

Streptococcus agalactiae and C. pyogenes appeared from the present studies to be by far the most virulent in general in that they were found in association with greater tissue damage than the other bacteria recovered. Staphylococcus aureus and Streptococcus uberis were in general associated with only about half the tissue damage as compared with the preceding two bacteria. The tissue damage was about double compared with that of quarters infected by the coagulase-negative staphylococci and of quarters found to be sterile. The remaining groups

showed a mean pathology which was roughly half that of the apparently sterile quarters. The proportions of pathological changes shown by Groups A and B; C and D; E and K; F, G, H and J; are approximately in the ratio of 8 ; 4 ; 2 ; 1.

The Relationship of Total Cell Count to the Bacteria of the Udder.

The mean cell counts of those seven quarters infected by Str. agalactiae were larger than those of any other group. Five of these seven counts were between 3.5 and 5.5 million cells per ml. while quarter 12 LF was producing milk with the unusually high cellular content estimated at 36.0 million cells per ml. Milk of quarter 6 LH had a count of only 0.27 million. Group C contained 15 quarters having a mean cell count of 6.8 million per ml., the second highest figure. Six quarters had counts between 5.3 and 15.0 million cells per ml. and that of 21 RF was 35.0 million cells per ml. The mean differential count of 71 per cent. polymorphs was second highest only to the unusually high figure of 96 per cent. polymorphs from the single Str. uberis quarter.

Four counts from quarters of Group E were between 5.0 and 6.0 million cells per ml. Two counts from

Group F were 13.0 and 20.8 million cells per ml. respectively. One quarter of Group J had a count of 8.55 million cells. Five of the 30 apparently sterile quarters produced milk having counts of from 3.0 to 6.0 million cells per ml. From these facts it is concluded that while most of the bacteria involved can be associated with quarters producing cell counts of over 3.0 million per ml. it does appear that Streptococcus agalactiae tends to be more generally associated with these high counts than do other bacteria studied. No milk was obtained from quarters infected with C. pyogenes. The following table shows the relationship found between bacteria and total cell counts of samples taken after transport. Figures in brackets represent a percentage of total quarters in group.

Total Cell Count in Millions per ml.

<u>Bacteria</u>	<u>Plus 3.0</u>	<u>1.0-2.9</u>	<u>.5-.99</u>	<u>0-.49</u>	<u>Total Quarters</u>
<u>Str. agalactiae</u>	6 (84)	-	-	1 (16)	7
<u>Staph. aureus</u>	7 (47)	3 (20)	3 (20)	2 (13)	15
<u>Str. uberis</u>	-	-	1 (100)	-	1
coag-neg. staph.	4 (33)	3 (25)	2 (17)	3 (25)	12
c.n.s. <u>Str. bovis</u>	2 (33)	3 (50)	-	1 (17)	6
<u>Str. bovis</u>	-	2 (100)	-	-	2
Mixed	1 (25)	1 (25)	1 (25)	1 (25)	4
None	5 (25)	4 (20)	8 (40)	3 (25)	20
<u>Total</u>	<u>25 (37)</u>	<u>16 (24)</u>	<u>15 (22)</u>	<u>11 (17)</u>	<u>67</u>

This table shows that during the present work Streptococcus agalactiae and Staphylococcus aureus were associated with counts of over 3.0 million cells per ml. more often than other bacteria. Associated with these two bacteria the total quarters in each cell count group above are 13 : 3 : 3 : 3 while those with the remaining bacteria occur in roughly equal proportions in each cell count category 12 : 13 : 12 : 8. In other words these two fore-mentioned organisms have about four times the likelihood of being associated with total counts of over 3.0 million cells per ml. than have the remaining bacteria.

The Relationship of the Differential Count to the Bacteria found in the tissues.

Means of the differential counts of quarters have been tabulated above in groups. In order further to investigate any relationship the following table of distribution of differential counts is recorded.

<u>Bacteria found</u>	<u>Total qrs.</u>	<u>Polymorph count expressed as a percentage</u>								
		10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
<u>Str. agal.</u>	7	-	-	-	-	3	2	-	1	1
<u>Staph. aur.</u>	15	-	-	1	-	2	1	3	4	4
<u>Str. uberis</u>	1	-	-	-	-	-	-	-	-	1
coag-neg. staph.	12	-	1	2	2	2	1	1	3	1
c.n.s. <u>Str. bov.</u>	6	2	-	1	1	1	-	-	1	-
<u>Str. bovis</u>	2	-	-	-	-	1	-	-	1	-
Mixed	4	1	-	-	-	1	-	1	1	-
None	20	1	-	4	3	2	3	3	2	2
	67	4	1	8	6	12	7	8	13	8

From the above table it is found that of the nine quarters having a differential count of over 90 per cent. six were infected with one of the three more virulent bacteria, two were sterile and one contained micrococci and coagulase-negative staphylococci. Details of the nine quarters are collected below:-

<u>Cow and Quarter</u>	<u>Bacteria</u>	<u>Total Count</u> <u>x 10⁶</u>	<u>Poly %</u>	<u>Score for Pathology</u>
12 LF	<u>Str.agal.</u>	36.0	90	191 (- 98 sa. 93 A.)
27 LH	<u>Staph.aur.</u>	15.0	92	168 (8 c. 70 sa. 90 A.)
21 RF	Do.	35.0	91	158 (6 c. 116 sa. 36 A.)
40 LF	Do.	1.0	90	48 (8 c. 40 sa.)
40 RF	Do.	0.54	92	66 (4 c. 62 sa.)
6 RF	<u>Str.uber.</u>	0.90	96	72 (2 c. 4 sa. 66 A.)
6 LF	None	0.16	90	25 (3 c. 22 sa.)
23 LH	None	1.21	95	6 (5 c. - 1 A.)
23 LF	m.c., cns.	2.40	90	2 (2 A.)

From this short table it is seen that remarkably high differential counts of over 90 per cent. can be associated with very high or very low total cell counts; with various bacteria and sterile quarters; and with varying pathological states including three quarters in which acute lesions appeared to be negligible. It appears that when very high cell counts are found together with high differential counts they form an indication of extensive acute and sub-acute mastitis. In the nine quarters shown above chronic lesions are negligible.

In conclusion it can be said that while all differential counts except one from quarters having Str. agalactiae, Str. uberis and Staph. aureus in their tissues were over 50 per cent., those of other quarters appeared to have differential counts distributed fairly evenly from about 16 to 89 per cent. These differential figures reflect the main pathological tendencies for those quarters in the first three groups to contain extensive acute lesions while those of other groups contained very small acute lesions and relatively more plentiful sub-acute lesions.

Conclusions.

Corynebacterium pyogenes appeared to be associated with the greatest extent of pathological changes including severe chronic mastitis, which eventually wholly destroys the capacity for lactation. Streptococcus agalactiae showed in the present studies more severe acute and sub-acute lesions. The total cell counts from quarters affected by it were on average larger than counts from other quarters. Next in importance affecting mammary tissue appeared to be Staphylococcus aureus and Streptococcus uberis. The above four bacteria were associated with a total of 28

quarters and the differential counts of 22 of these quarters were over 50 per cent. This appeared to be a reflection of the extensive acute lesions in most of these quarters.

The remaining bacteria found appeared to be generally associated with much less extensive mastitis. Apparently sterile quarters contained in general about as much affected tissue as those of quarters containing bacteria such as coagulase-negative staphylococci, Str. bovis, Str. faecalis, Str. lactis and micrococci. Of 26 apparently sterile quarters, six were found to contain small acute lesions. High cell counts (over 3.0 million per ml.) appeared to be associated with Streptococcus agalactiae and Staphylococcus aureus rather than with other bacteria.

PART SEVENTEAT MEASUREMENTS

It was considered that useful data would be provided by the recording of certain physical features of the teats from the cows available. In particular measurements of the teat canal were recorded to investigate any relationship which might exist between physical features of the canal and the liability to infection of the udder by bacteria causing mastitis. In the present studies the teat sinus means the potential space enclosed by the lining of the teat. The gland sinus means the potential space dorsal to the teat sinus and surrounded by the openings of the ducts.

Historical.

The following historical survey on the subject was extracted from work published by Turner (1939). Sisson (1914), Ellenberger and Baum (1915) and Plumb all recorded lengths of bovine teats varying from 8.0 - 10.0 cm. Emmerson (1928) found fore teats were on average 6.6 cm. long and 2.9 cm. in diameter and hind teats 5.2 cm. long and 2.6 cm. in diameter. Other workers recorded lengths 6.0 - 8.0 cm.

Fürstenberg (1868) first described the rosette at the proximal end of the teat canal. He recorded eight ridges in the lining of the canal. Mankowski (1903) recorded the length of the teat canal to be up to 1.4 cm. He considered that each main ridge of the canal was divided into about ten subsidiary ridges. He found the lumen of the canal to be closed effectively by the apposition of the longitudinal ridges. Kamm (1925) found 7 - 8 ridges in the canal. Turner (1939) called the teat canal the streak canal and found the length to vary from 8.0 - 12.0 mm.

Wirz (1913) found that a constriction between the gland sinus and the teat sinus was inconstant. Zietchmann (1915) found that the size of the constricting fold was due to the size of the underlying vein. Rubeli (1916) considered that the teat sinus was generally separated from the gland sinus by a constricting fold of dense connective tissue 2.0 - 6.0 mm. thick. Käppeli (1918) found the constriction only occasionally. Hammond (1927) using plaster casts found the volume of the gland sinus was about 400 ml. varying greatly in different cows and in different quarters of the same cow. Turner (1939) recorded a volume of 10 ml. in the gland sinus. The two most capacious gland sinuses found in

the present work were about 110 and 65 ml. in volume and were both from cow 15 whose other two gland sinuses were occluded by fibrosis. The majority of gland sinuses of the 24 udders examined were from 10 - 25 ml. in volume. These udders were frozen and the volumes were calculated from the amounts of frozen milk recovered from the sinuses.

Materials and Methods.

Facilities were available to study the pathology of the quarters of cows in their fifth or later lactations. Only macroscopic examination was carried out on quarters of younger cows. It was found difficult to determine the proximal extremity of the teat as the udder generally gradually tapers towards the teat. In order to standardise this measurement the arc of hair follicles nearest to the teat on the lateral surface was used. The teat was measured along the midline from the distal tip to the arc of hair follicles. The hair follicles were not on a uniform arc so that this measurement was estimated to the nearest $\frac{1}{2}$ cm. generally. The external diameter was measured at a point half way along the length of the teat. The teat was laid as flat as possible and was not stretched nor compressed during measurement.

Details of the pathology and bacteriology were correlated to the teat measurements in 17 of the 24 Ayrshire cows in the fifth or later lactations, in three of the four British Friesian cows and in two of the three Shorthorn cows available.

Measurements.

The cows were classified in nine groups according to age and breed and their teat measurements are shown below in tables 1 - 10. In calculating the mean measurements in each group the fibrosed and grossly abnormal teats were omitted. Measurements of such teats are indicated by letter A. Group No. 1 contained one Ayrshire heifer No. 81 having three erupted permanent incisor teeth and two Aberdeen-Angus heifers each having two such teeth. The ages of these three animals were probably 2 - $2\frac{1}{4}$ years. The teats in this group were 3 - 4 cm. long and 1.2 - 1.5 cm. in diameter. The canals were 0.4 - 0.8 cm. long and 0.4 - 0.7 cm. in circumference at both the rosette of Fürstenberg and orifice. All measurements for the Ayrshire heifer were slightly below the mean of the group. The three Shorthorn heifers in Group 2 showed 4 - 6 broad teeth and so were probably about six months older than those in Group 1. The teat lengths in Group 2 were

3.5 - 5.5 cm. and the diameters 1.5 - 2.0 cm. Canal lengths were 0.4 - 0.9 cm. while the circumferences at both rosette and orifice were 0.3 - 0.8 cm.

The number of lactations of cows Nos. 1 - 48 were obtained from the owners of these animals. Those of other cows were assessed from the body size and from the number of rings on the horns and from the teeth. In the 17 cows in Group 3 the teat lengths were 4 - 7 cm. and the diameters 2 - 3 cm. Canal lengths were 0.5 - 1.2 cm. while the circumferences at both the rosette and orifice were 0.5 - 1.2 cm. In Group 4 the teat lengths were 5 - 8 cm. and the diameters 2.5 - 3.5 cm., canal lengths were 0.6 - 1.2 cm. while circumferences at the rosette were 0.6 - 1.4 cm. and those at the orifice were 0.6 - 1.1 cm.

In Group 5 the teat lengths were 5.0 - 9.0 cm. and the diameters 2.3 - 3.5 cm.; canal lengths were 0.8 - 1.5 cm. while circumferences at the rosette were 0.8 - 1.7 cm. and those at the orifice 0.6 - 1.1 cm. In Group 6 the teat lengths were 5.0 - 10.0 cm. and the diameters 2.5 - 4.0 cm.; canal lengths were 0.6 - 1.6 while circumferences at the rosette were 0.6 - 1.5 and those at the orifice 0.4 - 1.1 cm.

Nine of the ten teats available from three Shorthorn

cows in Group 7 were 6.0 mm. long, the remaining one was 7.0 cm. The diameter of all ten was 2.5 cm. Canal lengths were 0.7 - 1.3 cm. while circumferences at the rosette were 0.6 - 0.8 and those at the orifice 0.5 - 0.8 cm.

The teat lengths of the five British Friesian cows in Group 8 were 5.0 - 8.0 cm. and the diameters 2.0 - 4.0 cm. Canal lengths were 0.8 - 1.3 cm. while circumferences at the rosette were 0.8 - 1.3 cm. and those at the orifice 0.6 - 0.9 cm.

There was only one cow in Group 9. She was of the Guernsey breed. All four of her teats were 6.0 cm. long and 2.5 cm. in diameter. The teat canals were 1.1 - 1.2 cm. long, the circumferences at the rosettes of all four were 1.0 cm. while those at the orifices were 0.8 - 0.9 cm.

Tables Nos. 10 - 10d show various measurements of teats of cows of various age groups. Measurements from cows of Groups 6, 7 and 8 have been combined and means calculated. In the tables below the following abbreviations are used: Ayr represents Ayrshire; A.A. Aberdeen-Angus; LF left fore quarter; LH left hind; RF right fore; RH right hind; CR circumference at the rosette and CO represents circumference at the orifice.

Table 1. Measurements of the Teats Available from three
Non-pregnant Heifers aged about two years old
(Group No. 1).

<u>No. of Heifer</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
81 (Ayr)	3.5	3.5	3.5	3.0	1.2	1.2	1.2	1.2
82 (A.A)	4.0	3.5	3.5	3.0	1.5	1.5	1.5	1.5
83 (A.A)	4.0	4.0	4.0	4.0	1.5	1.5	1.5	1.5
Mean	3.8	3.7	3.7	3.3	1.4	1.4	1.4	1.4

Table 1a. Measurements of Teat Canals (Left Quarters).

<u>No. of Heifer</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
81	0.5	0.5	0.5	0.4	0.4	0.4
82	0.5	0.6	0.6	0.4	0.4	0.4
83	0.6	0.6	0.6	0.7	0.7	0.7
Mean	0.53	0.57	0.57	0.50	0.50	0.50

Table 1b. Measurements of Teat Canals (Right Quarters).

<u>No. of Heifer</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
81	0.5	0.5	0.5	0.5	0.4	0.4
82	0.4	0.5	0.5	0.4	0.5	0.5
83	0.7	0.6	0.6	0.8	0.6	0.6
Mean	0.53	0.53	0.53	0.57	0.50	0.50

Table 2. Teat Measurements from three Virgin Shorthorn Heifers aged 2 - 3 years (Group No. 2).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
77	5.0	4.0	5.5	4.0	1.8	1.8	2.0	1.8
78	4.0	4.0	4.5	4.0	1.8	1.8	1.8	1.8
79	4.5	3.5	4.0	4.0	1.5	1.5	1.5	1.5
Mean	4.5	3.8	4.7	4.0	1.7	1.7	1.8	1.7

Table 2a. Measurements of Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
77	0.8	0.7	0.7	0.7	0.5	0.5
78	0.8	0.6	0.6	0.8	0.6	0.6
79	0.4	0.3	0.3	0.4	0.3	0.3
Mean	0.67	0.53	0.53	0.63	0.47	0.47

Table 2b. Measurements of Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
77	0.8	0.8	0.8	0.8	0.6	0.6
78	0.9	0.7	0.6	0.7	0.6	0.6
79	0.5	0.3	0.3	0.4	0.3	0.3
Mean	0.73	0.60	0.57	0.70	0.50	0.50

Table 3. Teat Measurements of 17 Ayrshire Cows in their
First Lactation (Group No. 3).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
4	6.0	4.5	6.0	6.0	2.5	2.5	2.5	2.5
13	4.5	4.5	4.5	4.5	2.5	2.5	2.0	2.0
14	4.0	4.0	4.0	4.0	2.0	2.0	2.0	2.0
19	7.0	6.0	7.0	6.0	2.5	2.5	2.5	2.5
20	6.0	6.0	6.0	6.0	2.5	2.5	2.5	2.5
30	6.0	4.5	6.0	5.0	2.5	2.5	2.5	3.0
31	7.0	7.0	7.0	7.0	2.5	2.5	2.5	2.5
32	7.0	6.5	7.0	7.0	2.5	3.0	2.5	3.0
33	6.0	5.5	6.5	5.5	2.5	2.5	2.5	2.5
35	7.0	5.5	5.0A	6.5	2.2	2.5	2.0A	2.5
36	6.5	6.0	6.5	6.0	2.5	2.5	3.0	3.0
37	7.0	6.0	7.0	7.0	2.5	2.5	2.5	2.5
51	5.0	5.0	5.0	4.5A	2.0	2.2	2.0	2.0A
52	5.0	5.0	5.0	5.0	2.0	2.5	2.2	2.5
53	6.5	6.5	6.5	6.5	2.7	3.0	2.5	3.0
54	6.0	6.0	5.0A	5.0	2.2	2.2	2.0A	2.2
55	6.0	6.0	5.5	5.0	2.5	2.5	2.5	2.5
Mean	6.0	5.5	6.0	5.75	2.4	2.5	2.4	2.5

Table 3a. Measurements of Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
4	1.0	0.8	0.8	0.9	0.5	0.8
13	0.7	0.9	0.7	0.8	1.1	0.8
14	0.5	0.6	0.6	0.6	0.6	0.6
19	0.6	0.5	0.5	0.6	0.5	0.5
20	0.8	0.8	0.8	0.8	0.8	0.8
30	0.9	1.0	0.8	1.0	1.0	1.0
31	0.7	0.7	0.7	0.6	0.7	0.7
32	0.8	1.2	0.8	0.9	1.1	0.6
33	1.2	1.0	0.9	1.1	0.8	0.8
35	0.8	0.8	0.8	0.7	0.7	0.7
36	0.8	1.0	0.7	0.9	0.8	0.8
37	0.7	1.0	0.6	Tramped Teat		
51	1.0	1.2	1.5	0.9	1.0	1.1
52	0.6	0.7	0.6	0.7	0.7	0.5
53	0.8	1.1	1.0	0.7	1.0	1.0
54	0.8	0.8	0.8	0.7	0.8	0.8
55	0.6	1.0	0.5	0.6	0.9	0.7
Mean	0.78	0.89	0.76	0.78	0.81	0.76

Table 3b. Measurements of Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
4	1.0	0.9	0.8	0.9	0.9	0.9
13	0.7	0.9	0.7	0.8	1.0	0.8
14	0.5	0.5	0.5	0.6	0.6	0.6
19	0.6	0.5	0.5	0.6	0.5	0.5
20	0.8	0.7	0.7	1.0	0.9	0.9
30	0.8	0.8	0.7	0.7	0.7	0.6
31	0.7	0.7	0.7	1.0A	0.8A	0.7A
32	0.7	1.2	0.7	0.9	1.0	0.8
33	1.1	1.0	0.8	1.0	0.8	0.8
35	Fibrosed			1.0	0.6	0.6
36	0.9	0.9	1.0	0.8	0.8	0.8
37	0.7	0.8	0.8	0.7	0.9	0.7
51	0.9	1.2	1.2	Fibrosed		
52	0.5	0.7	0.5	0.5	0.5	0.5
53	0.8	1.1	1.0	0.7	1.0	0.9
54	0.8	0.6	0.6	0.7	0.9	0.9
55	0.6	1.0	0.6	0.7	1.0	0.5
Mean	0.76	0.84	0.74	0.84	0.80	0.72

Table 4. Teat Measurements of six Ayrshire Cows in their Second Lactation (Group No. 4).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
2	5.5	5.5	3.5A	5.0	2.5	2.5	2.5	2.7
5	6.0	5.0	1.5A	5.5	2.5	2.5	1.5A	2.5
56	6.0	6.0	6.0	6.0	2.5	2.5	2.5	2.5
57	6.0	6.0	6.0	6.0	2.5	2.5	2.5	2.5
58	8.0	7.0	8.0	7.0	2.7	2.7	2.7	2.7
59	8.0	6.5	7.5	6.5	3.0	2.5	3.5	2.5
Mean	6.6	6.0	6.9	6.0	2.6	2.5	2.7	2.6

Table 4a. Measurements of Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
2	0.6	0.7	0.7	0.7	0.7	0.7
5	1.0	1.0	1.0	0.8	0.9	1.1
56	0.7	0.8	0.6	0.8	0.9	0.8
57	1.0	1.0	0.8	1.0	1.0	0.8
58	0.8	0.6	0.9	1.0	0.7	0.7
59	0.9	1.4	0.9	0.9	1.2	0.8
Mean	0.83	0.92	0.82	0.86	0.90	0.82

Table 4b. Measurements of Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
2	Fibrosed			0.6	0.7	0.7
5	Very Abnormal			0.9	1.0	0.9
56	0.7	0.7	0.7	0.7	0.9	0.9
57	0.9	0.9	0.8	1.0	1.0	0.8
58	1.0	0.6	0.8	1.0	0.7	0.7
59	0.9	1.3	0.8	1.2	1.0	0.9
Mean	0.87	0.88	0.78	0.90	0.88	0.82

Table 5. Teat Measurements of ten Ayrshire Cows in their Third or Fourth Lactation (Group No. 5).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
8	7.0	6.0	7.0	6.0	2.5	2.5	2.5	2.5
60	7.5	6.0	7.5	7.0	2.7	2.7	2.7	2.7
61	7.5	6.0	7.0	6.5	2.7	2.3	2.3	2.3
62	7.0	6.0	7.0	6.0	3.0	2.5	3.0	2.8
63	8.0	7.0	8.0	7.0	3.0	3.0	2.5	2.7
64	8.0	9.0	9.0	9.0	3.5	3.0	3.5	3.5
65	7.0	6.0	7.0	6.0	2.5	2.7	2.7	2.7
66	6.0	5.0	6.0	5.5	2.5	2.3	2.5	2.5
67	8.5	8.5	8.5	7.5	2.8	3.0	3.0	3.0
68	6.5	6.5	6.0	6.5	3.0	3.0	3.0	3.0
Mean	7.3	6.6	7.3	6.7	2.8	2.7	2.8	2.8

Table 5a. Measurements of Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
8	1.2	0.8	0.7	1.2	0.8	0.8
60	0.8	0.9	0.8	0.8	0.8	0.6
61	1.4	1.0	0.7	1.5	1.1	0.7
62	0.9	1.4	0.8	1.0	1.4	0.8
63	1.0	0.8	0.8	0.9	0.9	0.6
64	0.9	1.0	1.0	1.0	1.1	1.1
65	0.9	1.1	0.7	0.9	1.1	0.6
66	1.2	1.2	0.9	Fibrosed		
67	1.0	0.8	0.8	1.0	1.0	1.0
68	0.9	1.0	0.7	0.8	1.0	0.8
Mean	1.02	1.0	0.79	1.01	1.02	0.78

Table 5b. Measurements of Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
8	1.2	0.9	0.7	1.2	0.8	0.7
60	0.8	1.0	0.8	0.9	1.0	0.8
61	1.5	1.0	0.9	1.3	1.0	0.7
62	1.0	1.4	0.8	1.0	1.7	1.0
63	0.8	0.8	0.6	0.8	1.0	0.6
64	1.1	1.0	1.0	1.0	1.1	0.9
65	0.8	1.1	0.6	0.8	1.2	0.8
66	1.2	1.0	0.7	1.2	1.1	0.7
67	0.9	0.9	0.9	1.2	1.0	0.9
68	1.2	1.3	0.7	1.0	1.0	0.8
Mean	1.05	1.04	0.77	1.04	1.09	0.79

Table 6. Teat Measurements of 24 Ayrshire Cows in the Fifth or a later Lactation (Group No. 6).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
1	7.0	3.5A	6.0	6.0	3.5	2.5A	3.5	3.5
3	7.0	6.0	8.0	6.5	2.5	2.7	3.5	2.7
6	9.5	9.0	9.0	9.0	3.5	4.0	3.5	3.5
7	7.0	7.0	7.0	6.0	3.0	3.5	3.0	3.0
12	7.0	6.5	6.0	7.0	3.0	3.5	2.5	3.0
15	-	9.0	10.0	-	-	3.0	4.0	-
18	8.0	8.0	7.0	8.0	3.0	3.0	3.0	3.0
21	5.0A	-	7.0	7.0	2.5A	-	2.5	2.5
24	7.0	8.0	8.0	8.0	3.0	3.0	3.0	3.0
27	7.0	6.0	7.0	6.0	3.0	2.5	3.0	3.5
28	7.0	7.0	6.0	6.0	3.0	3.0	2.5	2.6
29	7.0	7.0	6.0	8.0	3.0	3.0	2.5	3.0
34	6.5	6.0	6.0	6.0	3.0	2.5	3.0	2.5
39	6.0	5.0	6.0	6.5	2.5	2.5	2.5	2.5
46	7.0	6.0	7.0	7.0	3.0	3.0	3.0	3.0
47	7.0A	7.0	8.0	7.0	2.5A	3.0	3.0	3.0
48	7.0	6.0	7.0	6.0	3.0	2.5	3.0	3.0
69	7.0	6.5	7.0	6.5	3.0	2.8	3.0	3.0
70	7.0	7.0	8.0	7.0	2.5	2.7	3.0	2.5
71	7.0	6.5	7.0	6.5	3.0	3.0	3.5	3.3
72	9.0	7.5	8.0	5.5	2.8	2.6	2.8	2.6
73	9.0	7.0	8.0	7.0	3.5	2.5	3.0	2.5
74	6.0	5.0	6.0	5.0	2.5	2.5	2.5	2.5
75	7.0	7.0	7.0	7.0	2.5	3.0	3.0	3.0
Mean	7.2	6.8	7.2	6.7	3.0	2.9	3.0	2.9

Table 6a. Measurements of the Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
1	1.0	1.2	0.6	Fibrosed		
3	1.5	0.6	0.6	1.6	0.6	0.6
6	1.2	1.0	1.0	1.1	1.5	0.8
7	0.8	0.8	0.6	0.8	0.9	0.7
12	0.8	1.8	0.7	0.9	1.5	0.8
15	Fibrosed			1.3	0.5	0.5
18	0.8	1.0	0.7	0.8	1.0	0.7
24	0.8	1.2	0.7	0.8	1.1	0.6
27	1.1	1.2	0.6	0.9	1.2	0.6
28	1.1	0.9	0.8	1.2	1.2	0.9
29	1.2	1.0	1.0	1.2	1.1	0.9
34	1.2	1.0	1.0	1.2	1.2	0.8
39	0.9	1.2	0.6	0.9	1.0	0.7
46	0.8	0.8	0.6	0.9	0.8	0.6
47	0.9	0.8	0.8	1.5	1.0	0.8
48	0.7	0.9	0.4	0.6	1.0	0.5
69	0.8	0.8	1.0	0.9	1.0	0.9
70	1.0	1.0	1.1	0.9	0.9	1.1
71	1.0	0.9	0.7	1.1	1.1	1.0
72	0.7	1.3	0.6	0.8	1.0	0.6
73	1.1	0.8	0.8	1.2	0.7	0.5
74	0.9	1.0	1.0	1.0	1.0	1.0
75	0.9	1.4	0.8	1.0	1.5	0.8
Mean	0.96	1.03	0.76	1.03	1.04	0.75

Table 6b. Measurements of the Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
1	1.0	1.0	0.7	1.0	1.0	0.7
3	1.5	0.6	0.6	1.3	0.7	0.7
6	1.0	1.3	0.7	1.1	1.5	0.9
7	0.8	0.9	0.7	0.9	1.0	0.8
12	0.9	1.2	0.8	0.9	1.8	0.9
15	1.3	1.3	0.6	Fibrosed		
18	0.9	0.9	0.7	0.8	1.0	0.8
21	1.5	0.8	0.6	1.3	1.0	0.7
24	0.9	1.5	0.4	1.1	1.5	0.5
27	1.0	1.2	0.6	1.1	1.2	0.7
28	1.0	0.7	1.0	1.1	0.9	0.9
29	0.9	1.1	0.9	1.4	1.2	0.9
34	1.0	1.2	0.8	1.2	1.1	0.8
39	0.8	0.9	0.7	1.0	0.9	0.8
46	0.9	0.8	0.6	1.1	0.8	0.8
47	1.3	1.1	0.9	1.2	1.2	0.8
48	0.7	0.9	0.4	0.7	0.8	0.5
69	0.9	1.0	0.9	0.9	0.9	0.8
70	1.0	1.0	1.0	0.9	0.9	0.9
71	1.0	1.0	0.8	1.2	1.2	0.8
72	0.8	1.0	0.5	0.9	1.0	0.5
73	1.3	0.7	0.9	1.1	0.7	0.5
74	1.1	1.2	1.0	1.1	1.2	1.0
75	1.0	1.4	0.7	1.0	1.4	0.7
Mean	1.02	1.04	0.73	1.05	1.13	0.76

Table 7. Teat Measurements of three Shorthorn Cows in the Fifth or a later Lactation (Group No. 7).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
9	7.0	6.0	-	-	2.5	2.5	-	-
22	6.0	6.0	6.0	6.0	2.5	2.5	2.5	2.5
80	6.0	6.0	6.0	6.0	2.5	2.5	2.5	2.5
Mean	6.3	6.0	6.0	6.0	2.5	2.5	2.5	2.5

Table 7a. Measurements of Teat Canals (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
9	1.0	0.8	0.8	0.8	0.7	0.6
22	0.7	0.7	0.7	0.8	0.7	0.7
80	1.1	0.6	0.5	1.3	0.8	0.6
Mean	0.93	0.70	0.67	0.97	0.73	0.63

Table 7b. Measurements of Teat Canals (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
9	Not available			Not available		
22	0.7	0.7	0.7	0.7	0.7	0.7
80	1.0	0.8	0.5	1.2	0.8	0.5
Mean	0.85	0.75	0.60	0.95	0.75	0.60

Table 8. Teat Measurements of four British Friesian
Cows in the Fifth or a later Lactation
(Group No. 8).

<u>No. of Cow</u>	<u>Length of Teat</u>				<u>External Diameter</u>			
	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>	<u>LF</u>	<u>LH</u>	<u>RF</u>	<u>RH</u>
23	7.0	6.5	8.0	7.0	3.0	3.5	3.0	3.0
26	10.0A	7.0A	7.0A	7.0	4.0A	3.0A	3.0A	2.5
44	6.0	5.0	6.0A	6.0	4.0	3.5	4.0A	3.5
76	7.0	6.0	6.5	5.0	2.7	2.7	2.7	2.0
Mean	6.7	5.8	7.3	6.2	3.2	3.2	2.9	2.7

Table 8a. Measurements of Teat Canal (Left Quarters).

<u>No. of Cow</u>	<u>Left Fore</u>			<u>Left Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
23	1.3	1.0	0.8	1.3	1.3	0.9
26	0.6A	0.7A	0.7A	1.2A	0.7A	0.7A
44	0.8	0.8	0.6	0.8	0.8	0.6
76	0.9	1.0	0.8	1.0	1.0	0.8
Mean	1.00	0.93	0.73	1.03	1.03	0.77

Table 8b. Measurements of Teat Canal (Right Quarters).

<u>No. of Cow</u>	<u>Right Fore</u>			<u>Right Hind</u>		
	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>
23	1.1	1.0	0.8	1.2	1.2	0.9
26	1.1A	0.5A	0.5A	1.3	1.3	0.7
44	1.0A	1.0A	0.7A	0.8	0.8	0.6
76	0.8	1.0	0.8	1.0	0.8	0.6
Mean	0.95	1.00	0.8	1.08	1.03	0.70

Table 9. The Number of Cows in each Group.

<u>Group No.</u>	<u>Type of Cow</u>	<u>No. in Group</u>	<u>Age in Years</u>
1	Ayrshire and Aberdeen Angus Heifers	3	2
2	Shorthorn Heifers	3	2 $\frac{1}{2}$
3	Ayrshire 1st Lactation	17	3
4	Ayrshire 2nd Do.	6	4
5	Ayrshire 3rd Do.	10	5 - 6
6	Ayrshire 5th or later Lactation	24	7 +
7	Shorthorn 5th or later Do.	3	7 +
8	British Friesian 5th or later Lactation	4	7 +
9	Guernsey Cow 4th Lactation	1	6
Total of Cows		71	-

Table 10. Mean Bovine Teat Length in Relation to Age.

<u>Group No.</u>	<u>Age in Years</u>	<u>Length of Teat</u>		<u>Diameter of Teat</u>	
		<u>Fore</u>	<u>Hind</u>	<u>Fore</u>	<u>Hind</u>
1	2	3.75	3.5	1.4	1.4
2	2½	4.6	3.9	1.8	1.7
3	3	6.0	5.65	2.4	2.5
4	4	6.75	6.0	2.6	2.6
5 & 9	5 - 6	7.2	6.55	2.8	2.8
6, 7 & 8	7 +	7.1	6.55	3.0	2.9

Table 10a. Mean Measurements of Teat Canal in Relation to Age.

<u>Group No.</u>	<u>Age in</u>		<u>Fore</u>			<u>Hind</u>		
	<u>Years</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>	<u>Length</u>	<u>CR</u>	<u>CO</u>	
1	2	0.53	0.55	0.55	0.53	0.50	0.50	
2	2½	0.70	0.57	0.55	0.67	0.49	0.49	
3	3	0.77	0.86	0.75	0.81	0.81	0.74	
4	4	0.85	0.90	0.80	0.88	0.89	0.82	
5 & 9	5 - 6	1.04	1.02	0.79	1.04	1.05	0.79	
6, 7 & 8	7 +	0.99	1.00	0.74	1.03	1.03	0.74	

The figures of table No. 10 are shown in Graph No. 1. The mean teat length increased almost uniformly with age in the first five Groups. From the measurements of the teats of the 71 cows included in this work it would appear that there was no appreciable change in length after the 3rd and 4th lactations. The means of the lengths of the hind teats were generally about 0.5 cm. shorter than those of the fore teats. The external diameter of the bovine teat appeared to increase about

0.2 mm. with each lactation. The diameters of teats in lactation were about twice those of teats of non-pregnant heifers 2 - 3 years old.

Graph No. 2 shows that the mean length of the bovine teat canal increased almost uniformly from 5 - 6 mm. in the two year old bovine to 10.5 mm. in Group No. 5 in the third and fourth lactations. Those of Groups 6, 7 and 8 were slightly less. It was found that the lengths of the four teat canals of a cow were generally similar to within 1 mm. The same general finding held to within 2 mm. for the circumferences at the rosettes and orifices. The teat canals of a cow were, unless pathological, generally similar in macroscopic appearance. Graphs 2 and 3 showed that the circumference at the rosette was very similar to the length of the canal in any age group. In Groups 1 and 2 the mean circumference both at the rosette and at the orifice were generally 5.0 - 6.0 mm. In Groups 3 - 9 inclusive, containing all the cows which had calved, the circumference at the orifice was mostly 7.5 - 8.0 mm. The circumference at the rosette after the first calving in Group 3 was 8 - 9 mm. After the third lactation it was 10 - 10 $\frac{1}{2}$ mm.

Of the 71 bovines whose teats were measured, 58 were Ayrshire, six dual-purpose Shorthorn, four British

Friesian, two Aberdeen-Angus and one was Guernsey. While it is probable that teat measurements vary according to the breed of cow there were insufficient bovines of breeds other than Ayrshire to enable any breed variations to be disclosed conclusively.

The pathology was studied histologically of 68 quarters from 17 of the 24 cows of Group 6. In order to determine whether there appeared to be any relationship between teat structure and liability to infection by mastitis organisms the teats of the ten quarters estimated to have the highest scores for pathology were compared with those of ten sterile quarters having the lowest scores.

Table 11 showing teat measurements of ten most affected quarters of 68 studied.

<u>Cow and Quarter</u>	<u>Teat Length</u>	<u>Teat Diam.</u>	<u>Canal Length</u>	<u>CR</u>	<u>CO</u>	<u>Score for Pathology</u>
48 RF	7.0	3.0	0.7	0.9	0.4	246(18c. 108sa. 120A.)
48 LH	6.0	2.5	0.6	1.0	0.5	237(- 24sa. 213A.)
12 LF	7.0	3.0	0.8	1.8	0.7	191(- 98sa. 93A.)
47 LH	7.0	3.0	1.5	1.0	0.8	135(83c. 22sa. 30A.)
47 RH	7.0	3.0	1.2	1.2	0.8	131(52c. 28sa. 51A.)
12 RF	6.0	2.5	0.9	1.2	0.8	81(79c. 2sa. -)
12 RH	7.0	3.0	0.9	1.8	0.9	74(12c. 38sa. 24A.)
27 LH	6.0	2.5	0.9	1.2	0.6	168(8c. 70sa. 90A.)
27 LF	7.0	3.0	1.1	1.2	0.6	164(- 152sa. 12A.)
6 LH	9.0	4.0	1.1	1.5	0.8	119(3c. 8sa. 108A.)
10 qrs.	6.9	3.0	0.97	1.3	0.7	155(26c. 55sa. 74A.)
Group 6	7.0	3.0	1.01	1.06	0.75	-

Streptococcus agalactiae was recovered from the udder tissue post-mortem from the first seven of the above quarters and from the milk sample taken from quarter 6 LH 24 hours before slaughter. Staphylococcus aureus was cultured from the two above quarters of cow No. 27.

Table 12 showing teat measurements of the ten least affected sterile quarters of 68 studied.

<u>Cow and Quarter</u>	<u>Teat Length</u>	<u>Teat Diam.</u>	<u>Canal Length</u>	<u>CR</u>	<u>CO</u>	<u>Score for Pathology</u>
18 LF	8.0	3.0	0.8	1.0	0.7	NIL
15 LH	9.0	3.0	1.3	0.5	0.5	NIL
46 LF	7.0	3.0	0.8	0.8	0.6	3 (- - 3A.)
46 RH	7.0	3.0	1.1	0.8	0.8	10 (- 10sa.)
15 RF	10.0	4.0	1.3	1.3	0.6	10 (6c. 4sa.)
34 LF	6.5	3.0	1.2	1.0	1.0	11 (3c. 8sa.)
28 LF	7.0	3.0	1.1	0.9	0.8	12 (4c. 8sa.)
34 RF	6.0	3.0	1.0	1.2	0.8	21 (7c. 14sa.)
6 LF	9.5	3.5	1.2	1.0	1.0	25 (3c. 22sa.)
48 LF	7.0	3.0	0.7	0.9	0.4	31 (27c. 4sa.)
10 qrs.	7.7	3.1	1.05	0.94	0.7	12 (5c. 7sa.)
Group 6	7.0	3.0	1.01	1.06	0.75	-

In Table 11 there were six hind-quarters while in Table 12 there were only two. No conclusions are drawn from the distribution of fore and hind quarters in these two tables owing to the small numbers involved. It would appear from the additions of the scores of pathology of all 94 quarters examined histologically that all four

quarters were similarly affected by mastitis. The totals of scores were as follows: 24 LF quarters 1249; 24 LH quarters 1446; 23 RF quarters 1600 and 23 RH quarters 1203.

The average measurements of all 24 cows in Group 6 were as follows: teat length 7.0 cm.; diameter 3.0 cm.; canal length 1.01 cm.; circumference at the rosette 1.06 cm. and at the orifice 0.75 cm. These figures are inserted below Tables 11 and 12 for comparison. The only significant differences in the measurements appear to be in the longer length of teats in the sterile quarters and in the larger mean circumference at the rosette in the diseased quarters. It would appear that there were no relationships between the length of the teat canal or its circumference at the orifice to a liability to infection with mastitis organisms.

Discussion and Conclusions.

The measurements of the teats of 71 bovines recorded above are similar to those of previous workers. The mean length in adult cows was about 7 cm. in fore teats and about 6.5 cm. in hind teats. In general teats were about 3 cm. in diameter. The length of the teat canal and the circumference at the rosette was on average about

1 cm. while that at the orifice was about $\frac{3}{4}$ cm. The length and diameter of the teat and the length and circumference at the rosette of the teat canal increased steadily with age, as shown on the graphs, until cows were about five years old. The circumference at the orifice was fairly constant after the third year. In general the narrowest point in the teat canal appeared to be about one third of the length from the orifice. The apparent slight decrease in the circumference at the orifice in older cows may have been due to measuring the orifice nearer the narrower part owing to reflection of the distal 1 - 2 mm. of canal epithelium. Such a reflected canal lining is readily visible in several cows while in others the edge of the canal epithelium cannot be decided macroscopically. The length of a teat was measured from the tip to the arc of hair follicles on the lateral surface.

It was found that the length of the four teat canals of a cow were generally similar to within 1 mm. Only 13 bovines other than Ayrshires were used and no conclusions were drawn regarding any variations in teat measurements due to breed. When the teat measurements of the ten quarters most severely affected by mastitis were compared with those of the ten least affected quarters the only

significant differences appeared to be the greater length of teat of the least affected and the larger circumference of the canal at the rosette of affected quarters. It is concluded from these findings that, other factors being equal, teats longer than average are less likely to be associated with severe mastitis. Distension of the teat canal at the rosette of Fürstenberg appeared more likely to be associated with severe mastitis.

PART EIGHTNOTES ON TEAT STRUCTUREMacroscopic observations for the presence of pockets
and ridges in the lining of the teat sinus

Sixty-two quarters were grouped according to the pockets found in the linings of the teat sinuses. Pockets were found in 47 teats (75 per cent.) and were generally 2 - 4 mm. in diameter. In 31 (50 per cent.) the pockets were shallow and were found more generally towards the distal end of the teat sinus. In seven teats (11 per cent.) the pockets were deep, resembled short ducts and generally occurred towards the proximal end of the teat sinus. In four of these teats the pockets were 5 - 7 mm. deep while in the remaining three, which were from cow No. 46, the pockets were from 1 - 3 cm. deep. The remaining nine teats (14 per cent.) had pockets of intermediate depth. The scores for pathology of the quarters having teats (a) without pockets were 0 - 237 (mean 69) (b) with shallow pockets 0 - 168 (mean 41) (c) with intermediate pockets 5 - 246 (mean 60) and (d) with deep pockets 3 - 42 (mean 16). From these few observations it does not appear that the presence or depth of pockets in the teat sinus can be related to

liability to mastitis.

Fifty-five teats were examined for the presence of longitudinal ridges. Ten teats had four ridges, 21 had three, eight had two and 16 had none. The scores for pathology of the quarters having teats (a) with four ridges were 8 - 191 (mean 65) (b) with three ridges 0 - 103 (mean 36) (c) with two ridges 12 - 246 (mean 82) and (d) without ridges 0 - 237 (mean 72). It does not appear therefore that the presence or number of longitudinal ridges in the teat sinus can be related to liability to mastitis.

The teat canal

The attached three diagrams show the structure of the teat canal from the gland of a first lactation cow which had always secreted milk of low cell count. When this apparently normal teat canal was opened along its length and the caseous plug washed off gently about 25 longitudinal ridges were distinguished by the naked eye. These were described by Mankowski (1903). It was found that these ridges were formed in relation to the capillary blood supply of the dermal papillae. These papillae ran perpendicularly to the surface of the canal and about half way through the epidermis they appeared to

become sinuous so that in transverse section towards the lumen the papillae appeared as lighter stained round areas. There were alternate large and small papillae. In the troughs between ridges the epidermal cells were degenerating and appeared hazy. Deeper to them was a zone of cells with pyknotic nuclei. Columns of living cells were seen being thrust towards the ridges from the tips of the dermal papillae, many of which were oval lighter areas contracted during wax embedding from the surrounding epidermal cells to form crescentic spaces up to $20\ \mu$ wide.

In longitudinal section through the epithelium of the teat canal the ridges were seen as alternating layers of keratin and epidermal cells. There were no glands in the epithelium of the teat canal; the epithelium was about $400\ \mu$ thick, and tapered abruptly into the two layered $25\ \mu$ thick epithelium of the teat sinus at the rosette of Fürstenberg.

The skin of the teat

No glands nor hair follicles were found in the skin of the bovine teat. The epidermis was about $350 - 400\ \mu$ thick. The dermal papillae were triangular unlike those of the teat canal. The surface of the epidermis was

smooth. The skin of the teat was less intricate and regular in detail than the epithelium of the canal, the ridged structure of which probably assisted in more effective closure by the plug of keratin and caseous material.

Junction of the epithelia at the teat orifice

There was a definite point of junction of the two epithelia. The epidermis at the orifice was about 900μ thick and there the dermal papillae were $300 - 700\mu$ long, in contrast to those of the canal proper where they were only 200μ . The change of structure occurred about 1 mm. from the orifice and was seen macroscopically as the zone of longer papillae was paler in colour than the surrounding external skin. The point of junction varied slightly in different cows.

As in the teat canal the papillae at the orifice showed their tips to have been cut in transverse section with similar crescent-shaped spaces. Ridges in the surface of the epidermis were seen above the papillae. Some of the dermal papillae were $30 - 40\mu$ from the keratin layer which was thicker in the canal than on the external skin. Two diagrams show that the canal epithelium appeared in three zones owing to the line of

section after fixation of the opened teat.

Pathological changes in teats

Several of the teat sinuses of mastitic quarters from cows in the fifth or a later lactation showed macroscopic pathological changes attributable to mastitis. The lining of the sinus in some cases showed wart-like papillomata $\frac{1}{2}$ - 5 mm. in diameter, some of which were sessile and others pedunculated. In most of the more severely affected teats these papillomata were thickly keratinised and grated harshly when scraped by a scalpel. Two quarters 1 RH and 47 RH showed numerous small papillomata covering the distal half of the teat sinus separated from the apparently normal proximal half along a horizontal line of junction. In these two cases it would appear therefore that gravity influenced whatever factors were responsible for the lesions. The twelve quarters which showed keratinised papillomata in the teat sinuses had scores for pathology 10 - 164 (mean 57, 29c. 21 sa. 6 A.). Taking into account the age of the cows it is probable that most of the teat lesions were long-standing chronic lesions. In some cases the teat sinuses showed fibrous scar tissue, some in the form of well-defined puckered areas and others in the form of

linear scars.

The lining of the teat sinus of quarter 6 LH, which had a score for pathology of 119 (3 c. 8 sa. 108 A.), showed many papillomata around the rosette of Fürstenberg. On microscopic examination many of these papillomata were found to be villus-like and up to $200\ \mu$ long. Others were round, sessile and up to $500\ \mu$ in diameter. Most showed squamous metaplasia in that they were thickly keratinised and some contained oval masses of keratin near their centres. The normal two-layered sinus epithelium was converted into a thick irregular epidermis. Streptococcus agalactiae was recovered from milk taken from this quarter the day before slaughter.

Several microscopic lesions were found in the skin near the tip of this teat. The epidermis in the lesions was at least twice as thick as normal and contained excessive keratin; the dermal papillae were very irregular and distorted and there was marked cellularity in the dermis below the lesions.

Tramped Teat

A teat which had been severely tramped a few weeks prior to the slaughter of a first-laction cow showed three large papillomata in the epithelium of the canal and

another in that of the sinus near the rosette. All four papillomata contained a central round mass of keratin 200 - 500 μ in diameter surrounded by a zona pellucida of poorly stained dying cells. Although the papilloma in the sinus was surrounded by two-layered normal sinus epithelium the thick metaplastic epidermis covering the papilloma resembled that found in the teat canal. From examination of 55 serial sections it was calculated that the largest mass of keratin was 600 μ long and 500 μ in diameter. The wall of the teat showed marked cellularity under the two layered epithelium. At the distal end of the canal the epidermis was very irregularly shaped and thicker than normal. Isolated parts of epidermis were found in the dermis. In the skin of the teat distorted dermal papillae were associated with thickened keratin layers and with increased cellularity in the area.

Teat lesions of cow No. 46

Microscopic examination of the teat-sinus pockets, which were deeper in this cow than those of others, showed that they were lined by duct epithelium with an underlying elastic membrane which was absent from the lining of the teat sinus. Occasional lobules were found at the tips of these pockets. In the distal end of the

teat sinus of quarter 46 LH an area of squamous metaplasia 2 cm. in diameter was seen macroscopically. Although the teat canal of this quarter appeared normal to the named eye it was found on microscopic examination that the dermal papillae in the distal 6 mm. of the teat canal were heavily infiltrated by polymorphs. The skin over the tip of this teat showed acute inflammation. Many polymorphs infiltrated into the epidermis, some of the cells of which were vacuolated while some were necrotic. Several cells of the dermal papillae were swollen and vacuolated. The score for pathology of quarter 46 LH was 10 (6 c. 4 sa.) and no mastitis organisms were recovered from numerous samples since Staphylococcus aureus was found in milk collected seven months before slaughter.

Other lesions

In the teat canal of an old cow the epidermis was double normal thickness, very irregular in shape and the keratin layer was replaced by a smooth unstained layer of vacuolated dying cells. In the teat canal from a quarter suffering severely from purulent mastitis resembling that caused by Corynebacterium pyogenes the epithelium was very irregular. The normal ridged lining was smooth in places and in others the ridges were

distorted and larger than normal. The dermal papillae were of various abnormal shapes.

A round papilloma, 2 mm. in diameter, on the skin of a teat was found to consist of a layer of keratin 1 mm. thick. The dermis underneath was raised slightly and was very cellular, containing many fibroblasts. The epidermis under the mass of keratin showed ten mitotic figures along the base of the stratum germinativum. In a similar length of apparently normal tissue only three mitotic figures were found. Dermal papillae were absent under the lesions where the epidermis was only 100 μ thick in contrast to the 300 μ thickness of adjacent normal tissue. In another similar lesion on the skin five dermal papillae larger and wider than normal were found under the keratin mass and the epidermis was ridged opposite the tips of these papillae in a manner similar to that found in the epidermis of the teat canal.

An ulcer 400 - 500 μ in diameter was seen external to the keratin layer over the skin of the teat of a first-lactation heifer. The ulcer was haemorrhagic and many polymorph cells were present. In the vicinity of the ulcer the epidermal cells below the keratin were paler and the dermal papillae thicker and less regular than normal. Although the ulcer was traced through 40 serial

sections the capillary connection to the dermis was not found.

Foetal mammary glands

Two foetuses removed from the uteri of two slaughtered cows measured 60 and 75 cm. from the poll to the anus and were considered to be in the eighth month of uterine development. Measured from the tip of the teat to the first hair follicle on the lateral aspect of the gland the four front teats were 7 - 8 mm. long and the hind teats 4 - 6 mm. The epidermis over the foetal teat was uniformly 70μ thick without glands or follicles. There were no dermal papillae. Over the udder the epidermis was only 30μ thick while the hair follicle zone was 200μ thick. The gland sinuses were relatively capacious, one being 2 mm. in diameter and the other 3 x 1 mm. Both sinuses tapered towards the teats and were almost cell-free. Half-way up the teats the sinuses showed secondary branches clearly seen in transverse sections with five longitudinal ridges projecting into the sinuses. These ridges probably correspond to those of the adult.

The epithelium of the duct system consisted of an upper layer of dense cells with round or oval nuclei and

a lower layer of fewer, less distinct cells with paler staining nuclei. Under the epithelium of one sinus was a group of 20 polymorphs, occasional groups of three were found and isolated polymorphs were seen more often than in normal adult gland tissue. Capillaries were filled with blood as, unlike adult cattle, the foetuses were not bled and this probably accounts for the apparent frequency of polymorphs in the foetal glands. Six polymorphs and six epithelial cells were found in one sinus. The culture of bacteria from foetal udders was not attempted. Sections stained by Gram's method failed to reveal bacteria.

PART NINETHE EFFECT ON THE MILKING COW OF TRANSPORT BY LORRY
AS SHOWN BY THE TOTAL AND DIFFERENTIAL CELL COUNTS
OF THE MILK

According to the work of various investigators the cell content of milk is abnormally high where there is an inflammatory condition of the bovine udder (Cherrington et al., 1933; Hopkirk, 1933; Malcolm et al., 1942; Malcolm and Campbell, 1946, and McFarlane et al., 1949). However it had been observed by McFarlane et al. (1949) that milk drawn from a cow after she had been transported by lorry to an abattoir showed a marked increase in cell count as compared with milk taken the previous day at the farm. As this increase in cell count may have been due to pathological changes in the mammary gland as a result of the traumatic effect of the transportation, it was decided to determine whether such changes in the milk under these conditions were of common occurrence.

Methods

Milk samples were drawn from 30 quarters of nine cows before and after transport of the animals by lorry to abattoirs. No specimens were drawn from the remaining six quarters as they were blind, atrophied or

affected by purulent mastitis. The cows were taken from different farms situated from 10 - 20 miles from the abattoirs. Seven of the cows were Ayrshires, two were Friesians and all were in the fifth or a later lactation. Milk smears were prepared and stained as described in Part 3. The system of scoring for pathological lesions was described in Part 4.

Results

In the 30 quarters examined the cell counts of samples taken at the abattoir were on the average 4.6 times those of samples taken at the farm. In two cases the counts were slightly decreased, but in five instances they were doubled, in nine they were increased up to three or four times, and in 14 cases from 6 - 10 times. The quarters were arranged in five groups, according to the total cell counts of milk samples collected at the farms. The following table shows the average cell counts per ml. of samples of milk taken before and after transport of the cows to the abattoirs.

Table No. I. Average Increases of Total Cell Counts.

<u>Group No.</u>	<u>Range of Counts</u>	<u>No. of Qrs.</u>	<u>Average Count Before Transport</u>	<u>Average Count After Transport</u>	<u>Average Times Increased</u>
1	0- 99,000	7	54,000	380,000	6.6
2	100,000-249,000	4	165,000	780,000	4.7
3	250,000-499,000	4	310,000	2,050,000	6.7
4	500,000-999,000	6	610,000	1,920,000	3.1
5	1,000,000 or more	9	3,660,000	10,600,000	3.7
		<u>30</u>			

The table shows that the effect of the transport on the cows, as indicated by the relative increase in the total cell count of its milk, was almost twice as great in the first three groups, i.e. in the 15 quarters with milk having less than 500,000 cells per ml., as in the remaining 15 quarters with milk having more than 500,000 cells per ml.

The Proportion of Polymorphs.

As the differential cell count was carried out as well as the total cell count, it was possible to determine the extent to which the above increase in cell count was due to polymorphs. Of the 30 quarters examined, only two were apparently normal. Milk from these at the farms contained 50,000 and 80,000 cells per ml. Polymorphs constituted 40 and 58 per cent. of the respective totals of these cells. After transport, samples

contained 320,000 and 800,000 cells per ml. of which 44 and 87 per cent. respectively were polymorphs.

Of 13 quarters with acute lesions eleven secreted milk taken at the farm in which from 58 to 88 per cent. of cells were polymorphs. It appeared from these 13 cases that increased proportions of polymorphs in the cells of milk drawn after transport were associated with the more extensive acute lesions, because seven of these quarters with an average score of 26 for acute mastitis secreted milk in which the average proportion of polymorphs increased from 64 to 80 per cent. as a result of transport; the remaining six quarters with an average score of only twelve for acute mastitis secreted milk in which the average proportion of polymorphs fell from 70 to 62 per cent. after transport. The percentages of polymorphs for each of the five groups of quarters averaged respectively before transport 52, 66, 62, 55 and 66 while after transport they were 60, 69, 61, 54 and 73. In the quarter with the most extensive and most severe acute lesions the polymorph percentage increased from 58 to 92 as a result of the journey.

Pathology.

The following table shows the average scores

representing the pathological changes of the quarters in each of the foregoing five groups.

Table No. II. Pathological Findings.

<u>Group No.</u>	<u>Range of Cell Counts</u>	<u>No. of Qrs.</u>	<u>Average Scores representing Lesions</u>			
			<u>Total</u>	<u>Chronic</u>	<u>Sub-acute</u>	<u>Acute</u>
1	0-99,000	7	16	7	8	1
2	100,000-249,000	4	42	8	33	1
3	250,000-499,000	4	55	21	20	14
4	500,000-999,000	6	42	18	20	4
5	1,000,000 or more	9	130	37	64	29
		30	285	91	145	49

The table shows that there is in general a positive relationship between the total cell count of milk and the pathological state of the mammary gland. This finding is in agreement with those of Cherrington et al. (1933), Hopkirk (1933), Malcolm et al. (1942) and McFarlane et al. (1949). The counts of over 1,000,000 cells per ml. were found in milk from nine quarters which all showed extensive mastitis. Eight of the nine quarters showed acute mastitis.

The relative increases in cell count after the journey appeared to be greater in the normal udder and in quarters with little mastitis than in quarters having milk in which the cell count was already high and which showed more mastitis. An outstanding exception was the

quarter most affected by mastitis, having a total score of 168 of which 90 represented acute mastitis. Both of these scores are higher than corresponding scores of other quarters. The cell count of milk from this quarter increased from 1,500,000 to 15,000,000 cells per ml. as a result of the transport.

Cell Counts in Samples collected post mortem.

In 21 of 26 cases milk taken from quarters a few minutes post mortem contained more cells than milk taken from these quarters when the cows arrived at the abattoirs. In general the increase was one and a half times; in a few cases counts were doubled. The proportions of polymorphs appeared to be little affected.

Results of Bacteriological Examinations.

Of 30 quarters examined, two were found to contain Streptococcus agalactiae and yielded milk at the farms having 2,000,000 cells per ml.; six contained coagulase-positive Staphylococcus aureus and of their counts one was 35,000, four were from 1,000,000 to 3,000,000, and one was 15,400,000 cells per ml. Eight quarters contained coagulase-negative staphylococci and produced milk having from 50,000 to 550,000 cells per ml.

Fourteen quarters contained no mastitis organisms; milk from seven of these had between 30,000 and 200,000 cells per ml.; milk from five had between 530,000 and 730,000; and milk from the last two had 1,500,000 and 3,480,000 cells per ml.

Conclusions.

Quarters which were only slightly affected by mastitis, produced milk of which the total cell count after transport of the cows by lorry increased on an average about six or seven times. On the other hand, quarters with extensive mastitis showed an average increase in total cell count of about three or four times after transport of the cows. In general the quarters with more extensive acute mastitis show greater increases in the proportion of polymorphs in the milk. The reasons for the increased cell counts of the milk samples taken after transport of the cows are obscure. It is possible that the higher counts may reflect increased pathological changes in the glands caused by the traumatic effects of the transport of the cows. However, in the case of the two apparently normal quarters, the increases in cell counts were of from six to ten times despite the finding of no pathological tissue in the

sections. It must be borne in mind that only a small fraction of the entire bovine gland was examined and it might be that lesions were missed.

It may be that the jolting of even normal udders during the journeys caused desquamation of epithelial cells and diapedesis of polymorphs at rates much faster than normal. In acute lesions it might be expected that the passage of polymorphs into the luminae would be further increased and this is borne out by the greater increases in the proportions of polymorphs in the milk of those quarters containing greater amounts of acute mastitis. When it is considered that a delicate elastic fabrication such as the udder of the milking cow may contain several gallons of milk under pressure it is reasonable to suppose that alveolar damage will ensue from the constant violent agitation of the udder during transport of the cow by lorry.

Summary.

(1) Study of cell counts of milk samples and the pathology of 30 quarters confirms the findings of past workers that in general high cell counts in milk are associated with marked pathological changes.

(2) As a result of the transport by lorry of nine cows

increases in cell count occurred in the milk of 28 of 30 quarters examined. On average the counts increased about fivefold.

(3) Mastitis lesions were present in twelve of 14 quarters in which no mastitis organisms could be found, and also in eight affected with coagulase-negative staphylococci. In general the lesions in these 20 quarters were not nearly so extensive as those in eight quarters affected with Streptococcus agalactiae and coagulase-positive Staphylococcus aureus.

PART TENSUMMARY AND CONCLUSIONS

The author prepared and stained 2,500 milk smears and counted the cells present. The addition of 1 - 2 drops of formalin to each 10 ml. of milk sample preserved cells and increased adherence of the smear to the slide. The Sudan Black, Leishman method of staining facilitated cell-identification. The cell counting method of Prescott and Breed was adopted. Malcolm's standard loop was found to lift a mean of 0.0074 ml. of milk. It appeared that a platinum loop of 5.25 mm. internal diameter lifted volumes generally nearest 0.01 ml.

It is concluded from the centrifuging of ten samples at 2,000 revolutions per minute for ten minutes that about half of the cells were sedimented, about one fifth were suspended in the intermediate layer, about one seventh rose with the cream while about one sixth were unaccounted. About 70 per cent. of polymorphs, 85 per cent. of lymphocytes and 57 per cent. of epithelial cells were sedimented. It is concluded that centrifugalisation does not sediment all the cells in milk owing to so many cells rising with the cream.

All cells, other than mammary epithelial cells,

found in milk appear to be identical to corresponding cells of the blood. Almost all samples examined contained polymorphs, epithelial cells and lymphocytes. The author agrees with Bourgeois (1927) that in normal milk the ratio of multinucleate to mononucleate cells is approximately 1:1.

It was found that in many cases there was great variation in the type and in the severity of lesions in different parts of the same quarter. To enable comparisons to be made of the various pathological lesions found in different quarters an arbitrary system of scoring was introduced which was based on the severity and extent of the lesions in each quarter. Studies of cell counts appeared to be less valuable as a guide to the existence of chronic mastitis than to that of acute and sub-acute mastitis.

It is concluded that the total cell count in general is directly related to the extent of the pathological changes and to the combined lesions of acute and sub-acute mastitis. Lesions of mastitis will probably be found in quarters producing milk containing over 1,000,000 cells per ml. A mean polymorph proportion of 74 per cent. of cells was found in samples from 34 quarters containing lesions of acute mastitis. A polymorph proportion of

90 per cent. of cells was found in the milk produced by nine quarters, eight of which showed acute mastitis, although in four quarters it was minimal in extent. Such high polymorph proportions do not, therefore, necessarily indicate the presence of acute lesions nor do they indicate their extent, but the extent seems to govern the total cell count. There appears to be no infallible relationship between cell count and pathology. Quarters showing mainly chronic mastitis in which many lobules are in process of involuting produce milk in which generally less than 40 per cent. of cells are polymorphs. While the total and differential cell counts of the milk do not appear to bear accurate relationship to the pathology of the secreting quarter combinations of these two counts on samples collected regularly from a quarter can be used to assess the probable pathology. It appears to be difficult to set reliable standards for the cell counts to be expected in milk from normal quarters from cows of the fifth or a later lactation.

During the bacteriological examinations of 94 quarters the four major mastitis bacteria, Streptococcus agalactiae, Corynebacterium pyogenes, Str. uberis and coagulase-positive Staph. aureus, were between them cultured from 23 quarters post mortem and from the milk

of seven others within 48 hours before slaughter. Other bacteria were cultured from 38 quarters while the remaining 26 quarters appeared to be sterile.

Corynebacterium pyogenes appeared to be associated with the greatest extent of pathological changes including severe chronic mastitis, which eventually wholly destroys the capacity for lactation. Cell counts of 3,000,000 per ml. and over appeared to be associated more with Str. agalactiae and coagulase-positive Staph. aureus than with other bacteria. C. pyogenes and Str. agalactiae were, on average, associated with twice the tissue damage as compared with Str. uberis and coagulase-positive Staph. aureus, which in turn were associated with twice the pathological changes as compared with coagulase-negative staphylococci and sterile quarters. Other bacteria were associated with pathological changes only half those found, on average, in sterile quarters.

From the measurements of the teats of 71 cows it appeared that the lengths of the teat and teat canal increased with age until the third lactation after which there was little change. Hind teats were, in most cows, about $\frac{1}{2}$ cm. shorter than fore teats. The mean length of fore teats in mature cows was 7 cm. The four teat canals of a cow were, unless pathological, generally

similar in size, shape and structure. The circumference at the rosette of Furstenberg was, in most teats, similar to the length of the canal, which was generally about 1 cm. after the third lactation. The ten most diseased quarters showed, on average, shorter length of teat and greater circumference of canal at the rosette than the ten least diseased quarters.

The presence, number and size of pockets and longitudinal ridges in the teat sinus apparently do not affect liability to mastitis. The most frequent pathological changes in teats were squamous metaplasia with keratinisation and papillomata formation. In several teats the regular structure of the canal epithelium became distorted.

As a result of the transport by lorry of nine cows increases in cell count occurred in the milk of 28 of 30 quarters examined. On average the counts increased about fivefold. In general the quarters with more extensive acute mastitis showed greater increases in the proportion of polymorphs in the milk as a result of the transport. The reasons for the increased cell counts of the milk samples taken after transport of the cows are obscure. It is possible that the higher counts may reflect increased pathological changes in the glands caused by the traumatic effects of the transport of the

cows. However, in the case of the two apparently normal quarters, the increases in cell counts were of from six to ten times despite the finding of no pathological tissue in the sections. It may be that the jolting of even normal udders during the journeys caused desquamation of epithelial cells and diapedesis of polymorphs at rates much faster than normal.

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A P P E N D I XDATA OF TWENTY-FOUR UDDERS

Udders of 24 cows were available for histological study in the present work and data on them are presented below. The quarters of each udder are arranged in the order left fore, left hind, right fore and right hind. To facilitate setting of the tables cell counts are recorded in millions. Under "Cultures from Frozen Udder Tissue" cns represents coagulase-negative staphylococci, PS coagulase-positive staphylococci of which Staphylococcus pyogenes aureus was the main representative, str. streptococci, Cp Corynebacterium pyogenes, mc micrococci and S represents sterile tissue. Under "Details of Teat" e.d. represents external diameter, c.r. circumference at the rosette and c.o. circumference at the orifice. Under "Microscopic Description" c represents chronic, sa sub-acute, A acute, m mild, mod. moderate, Sev. severe, N normal and L1-5 represents the state of lactation. L1 shows that the acini were in maximal lactation with flattened mammary epithelial cells and minimal interacinar tissue, while L5 shows complete involution and L2, L3 and L4 show stages between these two extremes. Most cows were in advanced lactation and

very little tissue was found to be in the first two stages of lactation. Many lobules were classed as L3 or L4 and were in process of involution.

COW NO. 1. Breed - Ayrshire. 10th lactation. Last calving dates 10-2-46 and 7-2-47. Slaughtered 2-11-48.

NO. 1 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u> (x 10 ⁶)	<u>Mastitis Organisms</u>
8- 4-47	2	0.01	None found
5- 5-47	3	0.02	<u>Staph. aureus</u> (3 cols.)
12-10-48	20	0.01	None found
1-11-48 (B.T.)	21	0.26	None found

Macroscopic Description.

This quarter showed a fairly high state of lactation with peripheral involution in levels 1 and 2, in areas C, D and E, and focal involution in streaks in level 3. No abnormalities were seen.

Details of Teat.

Length 7 cm. e.d. 3.5 cm. Teat Canal. Length 10 mm. c.r. 12 mm. c.o. 6 mm. Teat Sinus. There were four vertical ridges and shallow pockets in the distal half of the sinus. The epithelium was smooth and there were no lobules in the teat.

Cultures from Frozen Udder Tissue.

Levels 2 and 3. Sterile; Level 1. S-cns-cns-cns-Str. bovis.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4msa 12N	4L5msa 12L5N
1A	2msa 14N	2L5msa 14L3-4N
1C	16N	2L5msa 14L5N
1D	2msa 14N	1L4msa 12L3-4N 3L5N
1E	4msa 12N	2L4msa 4L4N 2L5mc 8L5N
Level 1	2msa 14N	2L4-5msa 6L3-4N 8L5N
2A	2msa 14N	1L5mc 15L3-4N
2C	16N	1L5mc 7L5N 8L4N
2D	16N	8L5N 8L4N
2E	8msa 8N	4L5N 12L4N
Level 2	2msa 14N	1L5mc 10L3-4N 5L5N
3A	4msa 12N	1L4msa 1L4N 1L5mc 3L5N
3C	16N	16L4N
3D	2msa 14N	1L4msa 15L4N
3E	2msa 14N	1L4msa 15L4N
Level 3	2msa 14N	1L4msa 15L4N
<u>Quarter Summary</u>	2msa 14N	1L4-5msa 10L3-4N 5L5N
<u>Score</u>	<u>8 (8sa) 4D. 4L.</u>	

NO. 1 LEFT HIND QUARTER.

The owner stated that no milk had ever been obtained from this quarter.

Macroscopic Description.

This quarter was almost entirely involuted. The ducts contained watery fluid. There were a few lactating lobules around the larger ducts in the lower half of the gland.

Details of Teat.

Length 3.5 cm. e.d. 2.5 cm. Teat Canal. The proximal end was fibrosed and occluded. It was patent

for the distal 7 mm. of its length. c.o. 7 mm. Teat Sinus. This was completely occluded by fibrous tissue along its entire length.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland S-S-cns. Level 3. S-S-cns.
Level 2. Bacilli-S-B. coli - Str. bovis. Level 1. S-cns-
cns-Str. bovis.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mc	16L5mc
1A	16mc	12L5mc 4L4msa
1C	16mc	16L5mc
1D	16mc	16L5mc
1E	16mod c	16L5mod c Atrophy
Level 1	3mod c 13mc	3L5mod c 13L5mc
2A	16mc	15L5mod c 1L4msa
2C	16mc	16L5mc
2D	16mc	16L5mc Evolution
2E	16N	16L5mc Evolution
Level 2	12mc 4N	4L5mod c 12L5mc
3A	16mc	16L5mc Evolution
3C	16mc	16L5mc
3D	16mc	16L5mc Evolution
3E	16mc	16L5mc Evolution
Level 3	16mc	16L5mc Evolution
<u>Quarter Summary</u>	1mod c 14mc	2L5mod c 14L5mc 1N

Score 52 (52c) 16D. 36L.

NO. 1 RIGHT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
		(x 10 ⁶)	
8- 4-47	2	0.32	<u>Str. agalactiae</u>
5- 5-47	3	0.02	<u>Staph. aureus</u>
7- 7-47	5	0.04	None found
12-10-48	8	0.10	None found
1-11-48 (B.T.)	21	0.37	None found

Penicillin treatment after 8-4-47.

Macroscopic Description.

This quarter showed a fairly high state of lactation with peripheral involution in lower levels. In higher levels involution was focal.

Details of Teat.

Length 6 cm. e.d. 3.5 cm. Teat Canal: The distal 2 mm. of this were extruded and the edges formed a circle 3 mm. in diameter around the orifice. Length 10 mm. c.r. 10 mm. c.o. 7 mm. Teat Sinus: There were four longitudinal ridges. Pockets occurred only in the distal 2 cm.; they were very shallow.

Cultures from Frozen Udder Tissue.

Level 3. S - S - Str. bovis; Levels 1 and 2. Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mc	16L5mc
1A	16N	16L4N
1C	4mc 12N	12L5mc 4L4N
1D	8mc 8N	8L5mc 8L4-5N
1E	4mc 12N	2L5mc 6L4msa 8L4N
Level 1	7mc 9N	8L5mc 1L4msa 7L4N
2A	8mc 8N	14L4N 2L4msa
2C	16N	4L5N 8L4N 4L5mc
2D	16N	16L4N
2E	16N	14L4N 2L4msa
Level 2	2mc 14N	13L4N 1L4msa 1L5N 1L5mc
3A	16N	16L3-4N
3C	16N	16L3-4N
3D	16N	15L4N 1L5msa
3E	16N	15L4N 1L5msa
Level 3	16N	15L3-4N 1L5msa
<u>Quarter Summary</u>	3mc 13N	12L3-4N 3L5mc 1L4msa
<u>Score</u>	<u>13 (9c 4 sa) 3D. 1QL.</u>	

NO. 1 RIGHT HIND QUARTERCell Counts

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
8-11-47	2	0.56	<u>Staph. albus</u>
5- 5-47	3	0.08	None found
12-10-48	8	0.06	None found
1-11-48 (B.T.)	21	0.25	None found

Penicillin treatment given after 8-4-47.

Macroscopic Description.

This quarter showed a fairly high state of lactation with peripheral involution.

Details of Teat.

Length 6 cm. e.d. 3.5 cm. Teat Canal: Length 10 mm. c.r. and c.o. 7 mm. Teat Sinus: Small papillomata 1 mm. long completely covered the distal 3 cm. of the sinus. There was a sharp horizontal line of demarcation between this zone and the normal epithelium in the proximal half of the sinus. Some of the papillomata were white, others yellow; many were coalesced. There were four vertical ridges in the wall of the sinus.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Level 3. Sterile; Level 2. S - S - cns - str.; Level 1. cns - S - str.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4 mod c 12mc	16L5mc
1A	16mc	15L4N 1L5N
1C	16N	14L5mc 2L4N
1D	16N	14L4N 2L4msa
1E	16N	12L4-5N 4L4-5msa
Level 1	1mod c 3mc 12N	6L5mc 1L4msa 9L4-5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	2mod c 14N	1L4-5msa 15L4-5N
2C	4mc 12N	2L4-5msa 4L5N 10L4-5N
2D	2mc 14N	4L4-5msa 2L5N 10L4-5N
2E	16N	16L4N
Level 2	1 mod c 1mc 14N	13L4-5N 2L4-5msa 2L5N
3A	2mc 14N	4L5msa 4L4msa 8L4-5N
3C	8mc 8N	8L5mod c 4L4msa 4L4N
3D	12mc 4N	12L5mod c 2L4msa 2L4N
3E	16N	8L5mc 8L5N
Level 3	6mc 10N	5L5mod c 2L5mc 4L4-5msa 5L4-5N
<u>Quarter Summary</u>	1mod c 3mc 12N	2L5mod c 3L5mc 2L4-5msa 9L4-5N

Score 27 (19c 8sa) 5D. 22L.

COW NO. 3. Breed - Ayrshire. 5th Lactation. Born
August 1940. Last calving date 1-9-47. Slaughtered
2-11-48.

NO. 3 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
20-10-47	1.5	0.02	None found
1-11-48 (B.T.)	14	0.36	None found

Macroscopic Description.

This quarter was in a fairly high state of lactation. Involution had occurred in the medial E area in all levels and also in the B and D areas in higher levels. These were the areas farthest away from the main ducts.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length

15 mm.; c.r. and c.o. 6 mm. Teat Sinus: There were three very faint vertical ridges. The shallow pockets were more marked at the distal end.

Cultures from Frozen Udder Tissue.

Level 3. S - S - bacilli - str.; Level 2. S - S - bacilli - str.; Level 1. micrococci - S - bacilli - str.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	N	11L3-4N 4L5N 1L4ma
1C	N	12L3-4N 4L5N
1D	N	14L3-4N 2L5N
1E	N	16L5N 5 acini with severe acute inflammation
Level 1	16N	9L3-4N 7L5N
2A	N	15L3-4N 1L5N
2C	N	14L3-4N 2L5N
2D	N	12L3N 4L4ma
2E	N	8L5mc 8L5N
Level 2	16N	2L5mc 1L4mA 3L5N 1OL3-4N
3A	N	16L3N
3C	N	8L3N 4L3mA 4L5N
3D	N	16L3N
3E	N	15L3N 1L3mA
Level 3	16N	14L3N 1L3mA 1L5N
<u>Quarter Summary</u>	16N	1L5mc 1L3-4mA 4L5N 1OL3-4N
<u>Score</u>	<u>5 (2c 3A) 5L.</u>	

NO. 3 LEFT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
20-10-47	1.5	0.01	None found
1-11-48 (B.T.)	14	0.34	None found

Macroscopic Description.

This quarter was in a fairly high state of lactation. In Levels 1 and 2 there was focal involution. In Level 3 the tissue was involuted except for a narrow lateral strip in the D area. Involution seemed to begin in the areas farthest from the main ducts.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 16 mm.; c.r. and c.o. 6 mm. Teat Sinus: There were four very faint vertical ridges. Pockets were very shallow and slightly deeper towards the tip of the teat. There were no lobules in the teat.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland S - S - cns; Level 3. S - S - haem. Staph. albus; Level 2. S - S - haem. Staph. aureus - haem. Staph. albus; Level 1. S - S - cns - Str. faecalis.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	N	16L3N
1C	N	2L3N 14L5N
1D	N	8L3N 8L5N
1E	N	16L3N
Level 1	16N	11L3N 5L5N
2A	N	16L3-4N
2C	N	4L3N 12L5N
2D	N	8L3N 8L5N
2E	N	16L4N
Level 2	16N	11L3-4N 5L5N
3A	4mc12N	15L5N 1L5msa
3C	4mc12N	16L5N
3D	4mc12N	8L5msa 8L5N
3E	4mc12N	4L5msa 12L5N
Level 3	4mc12N	3L5msa 13L5N
<u>Quarter Summary</u>	1mc 15N	1L5msa 7L3-4N 8L5N
<u>Score</u>	<u>5 (1c 4sa) 1D. 4L.</u>	

NO. 3 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
20-10-47	1.5	0.02	None found
1-11-48 (B.T.)	14	0.57	None found

Macroscopic Description.

About half of the gland was still lactating while the other half was involuted. In Level 1 the D area was involuted; all of Level 2 was involuted and the C area in Level 3.

Details of Teat.

Length 8 cm.; e.d. 3.5 cm. Teat Canal: Length 15 mm.; c.r. and c.o. 6 mm. Teat Sinus: There were two very faint vertical ridges. Only in the lower half were three pockets and they were very shallow. There were no lobules.

Cultures from Frozen Udder Tissue.

Level 3. S - S - S; Level 2. S - S - cns - str.;
Level 1. S - S - cns - cns.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	N	12L4N 2L5msa 2L5mod c
1C	N	3L4N 1L4msa 12L5mod c atrophy
1D	N	16L4N
1E	N	12L5N 3L4N 1L4mA
Level 1	16N	8L4N 3L5N 4L5mod c 1L4-5msa
2A	N	6L4mA 6L5msa 4L4N
2C	N	12L5N 2L5msa 2L4mA
2D	N	12L5N 2L4N 2L4mA
2E	N	8L5N 8L4N
Level 2	16N	8L5N 3L4N 2L5msa 3L4mA

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	N	14L4N 1L4mA 1L5N
3C	N	12L4N 2L5msa 2L5N evolution
3D	N	15L4N 1L4mod A (9 acini of 1 lobule)
3E	N	16L4N
Level 3	16N	14L4N 1L5N 1L4-5mA

Quarter
Summary 16N 8L4N 4L5N 1L5mod c 2L4-5msa 1L4mA

Score 15 (4c 8 sa 3A) 15L.

NO. 3 RIGHT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Mastitis Organisms</u>
20-10-47	1.5	1.34	staphylococci
1- 3-48	6	1.54	staphylococci
1-11-48 (B.T.)	14	1.30	None found

Macroscopic Description.

In this quarter the areas of involution are those nearest to the ducts in Levels 1 and 2 and the whole of Level 3. The lactating lobules are confined to the central areas A and B of Levels 1 and 2.

Details of Teat.

Length 6.5 cm.; e.d. 2.7 cm. Teat Canal: Length 13 mm.; c.r. and c.o. 7 mm. Teat Sinus: There were four very faint vertical ridges. Shallow pockets were found near the tip of the teat. There were no lobules.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland S - S - cns - cns - str.;
 Level 3. S - S - cns - cns; Level 2. S - S - cns;
 Level 1. cns - S - cns.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16N	12L4N 3L4msa 1L5N
1C	8N 8msa	8L5msa 8L5N evolution
1D	12N 4msa	4L4N 4L4mA 4L5N 4L5msa
1E	16N	12L4N 4L5mA
Level 1	3msa 13N	8L4N 2L5N 2L4-5mA 4L4-5msa
2A	16N	16L4N
2C	16N	12L5N 4L5mA evolution
2D	16N	8L4N 4L5msa 4L4 evolution
2E	16N	8L4N 4L5msa 4L5N evolution
Level 2	16N	8L4N 2L5msa 1L5mA 5L5N evolution
3A	N	14L5N evolution 2L5mA
3C	N	8L5mA 6L5N 2L4mA
3D	N	12L4N 4L5mA
3E	N	15L5N 1L4N
Level 3	16N	9L5N 3L4N 4L4-5mA

Quarter

Summary 16N 6L4N 6L5N 2L5mA 2L4-5msa

Score 14 (8sa 6A) 14L.

COW NO. 6. Breed - Ayrshire. 5th Lactation. Last calving date September 1948. Slaughtered 22-3-49 after having been "overstocked", i.e. left unmilked, for 24 hours.

NO. 6 LEFT FORE QUARTER.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1-3-49	6	0.09	-	-	None found
14-3-49	6.5	0.04	0.06	60	None found
21-3-49	7	0.08	-	-	None found
22-3-49 (A.T.)	7	-	0.16	90	None found

Macroscopic Description.

This quarter was overstocked for 24 hours. It was milked out five minutes before slaughter. The quarter was lactating except for some slight involution in the higher levels of the gland. There was a streak of involuted tissue 1.5 cm. long in the BE area near the supposed junction of the two glands.

Details of Teat.

Length 9 cm.; e.d. 4 cm. Teat Canal: Length 11 mm.; c.r. 15 mm.; c.o. 8 mm. Teat Sinus: There were two very faint vertical ridges and a few shallow pockets.

Cultures from Frozen Udder Tissue.

All three levels - Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mc 8N	8L5mc 8L3-4msa
1A	8mc 8N	4L4msa 4L3N 4L4N 4L5N
1C	16N	8L4msa 4L5mc 2L3N 2L5N
1D	8msa 8N	12L5msa 2L3-4mA 2L3N
1E	4N 8msa 4mA	4L4msa 1L3mod A 3L5msa 8L2N
Level 1	3msa 3mc 1mA 9N	7L3-4msa 1L5msa 1L3mA 3L5mc 2L2N 2L4N 1L5N
2A	N	8L4msa 1L5mc 7L3-4N
2C	N	4L4msa 12L4N
2D	N	4L4msa 12L4N
2E	N	4L4msa 12L2-3N
Level 2	16N	5L4msa 2L2-3N 9L3-4N
3A	N	16L3N
3C	N	4L4msa 12L3N
3D	N	4L4msa 12L3-4N
3E	N	4L4msa 12L3-4N
Level 3	16N	3L4msa 13L3-4N

Quarter

Summary 1 msa lmc 14N 5L3-4msa 1L5mc 1L2N 9L3-4N

Score 26 (3c 22sa 1A) 3D. 23L.

NO. 6 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1-3-49	6	19.2	-	-	<u>Str. agalactiae</u>
8-3-49	6	-	32.0	96	<u>Str. agalactiae</u>
14-3-49	6.5	1.5	1.9	60	None found
21-3-49	7	0.42	-	-	<u>Str. agalactiae</u>
22-3-49 (A.T.)	7	-	0.36	58	Not cultured

Macroscopic Description.

The tissue of this quarter was in lactation. There was the marked abnormality of red mottling throughout all slices of this large quarter.

Details of Teat.

Length 9.5 cm.; e.d. 3.5 cm. Teat Canal: Length 12 mm.; c.r. and c.o. 10 mm. Teat Sinus: There were no vertical ridges nor pockets in the teat. Papilliform projections surrounded the entrance to the canal at the distal end. There was a haemorrhagic area in the connective tissue about this region. Clinical examination had revealed a small "pea" in the teat.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Level 2 - Sterile;
Level 3. Str. bovis - S - S; Level 1. Str. bovis - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4N 8mA 4mod c	12L5N 4L4msa
1A	2N 14mod A	8L4Sev A 2L3Sev A 3L5Sev sa 2L3N 1L5N
1C	16N	12L5N 2L4N 2L4Sev A 2L5mod c
1D	12mod A 4mod sa	4L3Sev A 4L3mA 4L3N 4L5mc
1E	4mod A 12N	8L3-4Sev A 2L2N 2L5mc 4L3-4N
Level 1	7mod A 2mA 1mod sa 6N	5L3-4Sev A 1L5Sev sa 1L4msa 5L5N 1L4mA 2L3N 1L5mod c
2A	12mod A 4N	12L3-4Sev A 2L3N 2L5mc
2C	16N	6L3Sev A 2L5msa 6L3-4N 2L3msa
2D	12mod A 4N	8L3-4Sev A 4L5msa 2L4N 2L5mc
2E	8mA 4mod A 4N	6L3Sev A 2L4msa 4L5mod A 4L5mc
Level 2	7mod A 2mA 7N	8L3-4Sev A 3L3-5msa 2L5mc 1L5mod A 2L3N
3A	16N	8L5N 8L3Sev A
3C	16N	6L3N 2L5N 8L3Sev A
3D	12N 4mc	12L5N 4L4msa
3E	16N	12L5N 4L4N
Level 3	1mc 15N	8L5N 4L3Sev A 1L4msa 3L3-4N
<u>Quarter Summary</u>	5mod A 1mA 1mc 9N	6L3-4Sev A 2L3-5msa 1L4-5mA 1L5mc 4L5N 2L3N
<u>Score</u>	<u>119 (3c 8sa 108A) 34D. 85L.</u>	

NO. 6 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1-3-49	6	0.42	-	-	haem. <u>Staph. albus</u>
14-3-49	6.5	0.19	0.52	76	haem. <u>Staph. albus</u>
22-3-49 (A.T.)	7	1.16	0.90	96	None found

Macroscopic Description.

This quarter had a reddish mottled appearance. It had been milked out five minutes before slaughter, after having been overstocked for 24 hours. The whole gland appeared to be in lactation.

Details of Teat.

Length 9.0 cm.; e.d. 3.5 cm. Teat Canal: Length 10 mm.; c.r. 13.0 mm.; c.o. 7.0 mm. Teat Sinus: There were two very faint vertical ridges. Pockets were very shallow.

Cultures from Frozen Udder Tissue.

Level 3. S - cns - S - S; Level 2. cns - S - S - cns; Level 1. S - cns - cns - Str. uberis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mc 12N	16L5mc
1A	1mc 15N	1L3Sev A 1L5Sev c 14L3N
1C	16N	8L3Sev A 4L5Sev c 4L4N
1D	16N	1L3Sev A 5L3mod A 4L3N 4L5N 2L5Sev sa
1E	2mc 14N	8L3Sev A 8L3N
Level 1	1mc 15N	4L3Sev A 1L3mod A 1L5Sev c 3L5mc 5L3N 1L5N 1L4N
2A	N	8L3Sev A 8L3N
2C	N	4L3Sev A 8L3N 4L4msa
2D	N	4L3Sev A 8L3N 4L4msa
2E	N	4L3Sev A 12L3N
Level 2	16N	5L3Sev A 9L3N 2L4msa
3A	N	8L3Sev A 8L3N
3C	N	4L3Sev A 8L3N 4L4mod sa
3D	N	4L3Sev A 4L3N 4L4Sev A 4L4N
3E	N	8L3Sev A 8L3N
Level 3	16N	6L3Sev A 1L4Sev A 1L4mod sa 7L3N 1L4N

Quarter 16N 5L3Sev A 1L3-4mod A 1L5mc 7L3N 1L4-5N
Summary 1L4-5msa

Score 72 (2c 4sa 66A) 72L.

NO. 6 RIGHT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
1- 3-49	6	0.04	-	-	None found
14- 3-49	6.5	0.01	-	-	None found
21- 3-49	7	0.01	-	-	None found
22- 3-49 (A.T.)	7	-	0.04	16	-

Macroscopic Description.

This was a fully lactating quarter with a pink elastic consistency. There was a narrow crescent of involution in the C area of all levels.

Details of Teat.

Length 9 cm.; e.d. 3.5 cm. Teat Canal: Length 11 mm.; c.r. 15 mm.; c.o. 9 mm. Teat Sinus: There were two fibrous bands running round the wall of the sinus in the distal half. These were felt on clinical examination before slaughter. They caused the formation of deep pockets in the wall of the sinus.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Level 3 - Sterile;
 Level 2. S - Str. bovis - Str. bovis; Level 1. S - S -
 cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16N	16L4N
1A	1mc 15N	14L1N 2L4N
1C	1mc 15N	16L5mc
1D	16N	12L5mc 4L3N
1E	16N	12L2N 4L5mc
Level 1	16N	3L1N 3L2N 4L3-4N 6L5mc

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	N	14L2N 2L5N
2C	N	4L2N 8L4N 2L5N 2L5mc
2D	N	16L3N
2E	N	12L1N 2L5N 2L5mc
Level 2	16N	3L1N 4L2N 4L3N 2L4N 2L5N 1L5mc
3A	4msa 12N	8L3N 6L4N 2L5mc
3C	4msa 12N	8L4N 8L5mc
3D	16N	12L4N 4L5mc
3E	16N	14L4N 2L5mc
Level 3	2msa 14N	10L4N 2L3N 4L5mc
<u>Quarter Summary</u>	1msa 15N	2L1N 2L2N 3L3N 5L4N 1L5N 3L5mc
<u>Score</u>	8 (6c 2sa) 2D. 6L.	

COW NO. 7. Breed - Ayrshire. 5th Lactation, Last three calving dates Oct. 1946, 23-12-47, and 5-2-49. Slaughtered 17-8-49.

NO. 7 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-6-49	4	0.30	0.40	50	None found
The daily yield of the cow at this time was only about 8 pounds.					
25-7-49	5.5	0.70	-	-	Not done
1-8-49	6	1.68	2.2	27	None found
8-8-49	6	3.9	2.3	34	None found
17-8-49 (A.T.)	6.5	-	1.42	40	Not done

Macroscopic Description.

This was an involuted quarter with periductal lobules still in lactation.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 8 mm.; c.o. 6 mm. Teat Sinus: There were no vertical ridges, no lobules and only shallow pockets present.

Cultures from Frozen Udder Tissue.

Level 3. S - Str. bovis - S; Level 2. S - cns - S;
Level 1. S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mod c 8mc 4N	8L5mc 8L5msa
1A	8mc 8N	8L5mc 4L5msa 4L5N
1C	8mc 8N	8L5mc 2L5msa 6L5N
1D	8mc 8N	8L5mc 4L5msa 4L5N
1E	4mc 12N	1L5mA 2L5msa 8L5mc 5L5N
Level 1	1mod c 7mc 8N	8L5mc 4L5msa 4L5N
2A	4mc 12N	4L3-4mA 8L5msa 4L5N
2C	4mc 12N	1L3Sev A 4L5msa 1L5N
2D	2mc 14N	4L5msa 12L5N
2E	16N	4L5msa 12L5N
Level 2	3mc 13N	2L3-4mA 5L5msa 9L5N
3A	16N	4L5mod sa 4L5msa 8L5N
3C	16N	4L5mod sa 12L5N
3D	16N	4L4mA 4L4msa 8L4N
3E	12N 4mc	4L4mA 4L4msa 8L4N
Level 3	1mc 15N	2L5mod sa 2L4mA 3L5msa 4L4N 5L5N
<u>Quarter Summary</u>	4mc 12N	1L3-4lMA 1L5mod sa 4L5msa 1L4N 6L5N 3L5mc
<u>Score</u>	<u>37 (10c 24sa 3A) 4D. 33L.</u>	

NO. 7 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-6-49	4	0.58	1.0	58	None found
4-7-49	4.5	1.34	1.5	62	None found
11-7-49	5	4.20	2.5	60	None found
25-7-49	5.5	1.62	1.0	51	Not done
1 -8-49	6	2.22	2.7	33	None found
8-8-49	6	1.1	1.6	25	None found
17-8-49	6.5	-	1.46	30	Not done
(A.T.)					

This quarter was treated with penicillin on 6th and 7th June 1949 when the daily yield of the cow was about 8 lbs. of milk.

Macroscopic Description.

This was an involuted quarter with a few lobules not yet fully involuted scattered in the A, D and E areas. There appeared to be fibrous thickening around the main ducts.

Details of Teat.

Length 7 cm.; e.d. 3.5 cm. Teat Canal: Length 8 mm.; c.o. and c.r. 8 mm. Teat Sinus: There was a ridge of fibrous tissue lying partly across the distal end of the sinus.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland S - S - S; Level 3. S -
cns - S; Level 2. S - Str. bovis - S; Level 1. S -
Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	12mod c 4msa	4L5msa 8L5mc 4L5N
1A	16N	4L5msa 8L5mc 4L5N
1C	4msa 12N	4L5msa 8L5mc 4L5N
1D	4msa 12N	4L5msa 8L5mc 4L5N
Level 1	3mod c 3msa 10N	4L5msa 8L5mc 4L5N
2A	16N	4L5msa 4L5mod sa 8L5N
2C	16N	8L5msa 8L5N
2D	16N	2L3-4Sev sa 6L3-4msa 8L5N
2E	4msa 12N	1L3-4Sev sa 4L5msa 4L3-4mA 7L5N
Level 2	1msa 15N	1L3-4Sev sa 1L5mod sa 4L5msa 1L3-4mA 1L3-4msa 8L5N
3A	16N	4L5msa 12L5N
3C	16N	2L5msa 14L5N
3D	16N	2L5msa 1L3-4modA 13L5N
3E	4msa 12N	4L5msa 12L5N
Level 3	1msa 15N	3L5msa 13L5N
<u>Quarter Summary</u>	1mod c 2msa 13N	1L3-5mod sa 4L5msa 3L5mc 8L5N
<u>Score</u>	<u>36 (8c 28sa) 6D. 30L.</u>	

NO. 7 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-6-49	4	0.12	-	-	None found
25-7-49	5.5	0.74	-	-	Not done
1-8-49	6	1.98	2.6	34	None found
8-8-49	6	0.84	1.6	24	None found
17-8-49	6.5	-	1.5	30	Not done
(A.T.)					

Macroscopic Description.

This quarter was involuted. There were a few lactating lobules scattered in E area.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 9 mm.; c.o. 7 mm. Teat Sinus: There were no vertical ridges, no lobules and only very slight pockets.

Cultures from Frozen Udder Tissue.

All three levels - sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mc	16L5mod sa
1A	4mc 12N	8L5msa 8L5mc
1C	16N	8L5msa 8L5mc
1D	6mc 10N	8L5msa 8L5mc
1E	16N	4L4msa 4L4mc 8L5N
Level 1	5mc 9N	3L5mod sa 5L5msa 5L5mc 1L4msa 2L5N
2A	16N	4L5msa 4L5mc 8L5N
2C	16N	4L5msa 4L5mc 8L5N
2D	16N	4L5msa 4L5mc 8L5N
2E	16N	2L5msa 14L5N
Level 2	16N	4L5msa 3L5mc 9L5N
3C	16N	4L5mc 12L5N
3D	16N	8L4msa 8L5N
3E	16N	3L5mod sa 13L5N
Level 3	16N	1L5mod sa 1L5mc 3L4msa 11L5N
<u>Quarter Summary</u>	2mc 14N	1L5mod sa 3L5msa 2L4msa 3L5mc 7L5N
<u>Score</u>	<u>36 (8c 28sa) 2D. 34L.</u>	

NO. 7 RIGHT HAND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-6-49	4	0.64	2.1	40	None
25-7-49	5.5	1.44	-	-	Not done
1-8-49	6	2.82	2.2	16	None
8-8-49	6	1.38	1.4	20	None
17-8-49 (A.T.)	6.5	-	1.63	17	Not done

Macroscopic Description.

This quarter was mostly involuted with some few lobules not yet fully involuted in A and E areas of all levels.

Details of Teat.

Length 6 cm.; e.d. 3 cm. Teat Canal: Length 9 mm.; c.r. 10 mm.; c.o. 8 mm. Teat Sinus: There were three slight ridges and a few shallow pockets in the proximal half.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland: S - cns - Str. bovis - S;
Level 3: cns - cns - S; Level 2: S - cns - cns - S;
Level 1: S - cns - Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	12mod c 4msa	4L5mod sa 8L5msa 4L5mc
1A	4msa 12N	1L5Sev sa 4L5msa 11L5N
1C	4mod c 8msa 4N	8L5msa 8L5N
1D	4msa 12N	2L4mod sa 4L4-5msa 10L5N
1E	4msa 12N	12L4-5msa 4L5N
Level 1	3mod c 5msa 8N	1L4-5mod sa 4L5msa 4L4-5msa 1L5mc 6L5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16N	3L3-4Sev A 8L3-4msa 5L5N
2C	16N	8L5msa 8L5N
2D	16N	8L4msa 4L5mc 4L5N
2E	16N	4L4mA 8L5msa 4L4N
Level 2	16N	1L3-4Sev A 1L4mA 4L3-4msa 4L5msa 1L5mc 5L5N
3C	16N	16L5N
3D	16N	4L5msa 12L5N
3E	16N	4L5msa 12L5N
Level 3	16N	3L5msa 13L5N
<u>Quarter Summary</u>	1mod c 2msa 13N	1L3-4mA 3L4-5msa 4L5msa 1L5mc 7L5N
<u>Score</u>	39 (4c 32 sa 3A) 6D. 33L.	

COW NO. 9. Breed - Shorthorn. 10th Lactation.
Calving dates 5-3-47 and 25-11-48. Slaughtered 8-9-49.

NO. 9 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15-3-48	12	0.31	-	-	None found
13-6-49	7	0.98	1.4	65	None found
4-7-49	7	1.3	1.0	50	None found
12-7-49	7½	1.1	0.76	55	None found
25-7-49	8	1.1	1.0	57	Not done
1-8-49	8	4.7	2.1	48	None found
8-8-49	8½	1.1	2.9	73	None found
16-8-49	9	-	1.8	35	<u>Staph. aureus</u>

Macroscopic Description.

This quarter was mostly involuted. There remained only very few incompletely involuted lobules in the lowest levels. The secretion was watery and almost negligible.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length 10 mm.; c.r. and c.o. 8 mm. Teat Sinus: There were three vertical ridges in the sinus. Towards the distal end there were small shallow pockets. Towards the gland sinus there were a few large shallow pockets.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - Str. bovis - S; Level 2: S - S - S; Level 1: S - cns - Str. bovis.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mc 8N	8L5mc 8L5N
1A	2mc 14N	14L4N 2L4msa
1C	16N	8L5mc 8L5N
1D	16N	2L3-4N 6L5mc 8L5N
Level 1	3mc 13N	6L5mc 6L5N 4L4N
2A	16N	16L5N
2C	2mc 14N	16L5N
2D	2mc 14N	16L5N
2E	16N	16L5N
Level 2	1mc 15N	16L5N
3A	16N	16L5N
3C	16N	16L5N
3D	16N	16L5N
Level 3	16N	16L5N
<u>Quarter Summary</u>	1mc 15N	2L5mc 1L4N 13L5N
<u>Score</u>	<u>5 (5c) 1D. 4L.</u>	

NO. 9 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15-3-48	12	0.19	-	-	None
13-6-49	7	0.94	1.8	74	staphylococci
25-7-49	8	1.0	0.92	64	staphylococci
The daily yield at this time was only about 7 lbs.					
1-8-49	8	-	2.1	43	None found
9-8-49	8½	-	5.7	72	<u>Staph. aureus</u>
16-8-49	9	-	1.44	40	<u>Staph. aureus</u>
8-9-49	9½	-	8.55	18	Not cultured
(A.T.)					

Macroscopic Description.

The quarter was almost completely involuted. The few lobules incompletely involuted were around the larger ducts in Levels 1 and 2. The secretion was watery.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: 8 mm. long; c.r. and c.o. 6 mm. Teat Sinus: There were a few shallow pockets at the proximal end. There were three vertical ridges.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland: S - Str. bovis - S;
Level 3: S - Str. lactis - S; Level 2: S - S - S;
Level 1: S - cns - Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mod c	16L5mc
1A	4mc 12N	12L3-4N 4L5N
1C	8mc 8N	8L5mc 8L5N
1D	16mc	8L5mc 8L5N
1E	16N	8L5mc 8L5N
Level 1	3mod c 6mc 7N	8L5mc 2L3-4N 6L5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	8mc 8N	16L5N
2C	12mc 4N	16L5N
2D	12mc 4N	14L5N 2L4N
2E	8mc 8N	16L5N
<hr/>		
Level 2	10mc 6N	15L5N 1L4N
<hr/>		
3A	8mc 8N	14L5N 2L3-4N
3C	8mc 8N	16L5N
3D	8mc 8N	16L5N
3E	8mc 8N	14L5N 2L3-4N
<hr/>		
Level 3	8mc 8N	15L5N 1L3-4N
<hr/>		
<u>Quarter</u>	1mod c	3L5mc 2L3-4N 1L5N
<u>Summary</u>	8mc 7N	
<u>Score</u>	<u>16 (16c) 10D. 6L.</u>	

COW NO. 10. Breed - Ayrshire. 5th Lactation.
Calving dates March 1948, April 1949. Slaughtered
16-11-49.

NO. 10 LEFT FORE QUARTER.

Cell Counts.

None were available as the teat of this quarter was closed completely by fibrosis.

Macroscopic Description.

The entire tissue of this quarter was firm, dry and brown. The gland was atrophied.

Details of Teat.

The teats were removed at slaughter and were not examined.

Cultures from Frozen Udder Tissue.

Level L: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mod c	16mod c
1C	16mc	16mod c
1D	16mod c	16mod c
1E	16mc	16mod c
Level 1	8mod c 8mc	16mod c
<u>Quarter Summary</u>	8mod c 8mc	16mod c
<u>Score</u>	<u>88 (88c) 24D. 64L.</u>	

NO. 10 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
19-5-49	1	0.01	-	-	None found
8-11-49	7	0.09	0.15	50	None found

Macroscopic Description.

This quarter was lactating except in parts of Level 3 and in the C area of all levels.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland: S - S - S; Level 3:
S - cns - Str. bovis - Str. faecalis; Level 2: S - cns
- S; Level 1: S - cns - cns - Str. faecalis.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mc 12N	7L5mc 8L4mc 1L3N
1A	16N	12L4N 4L5N
1C	16N	8L5N 8L4N
1D	16N	8L5N 6L4N 2L4msa
1E	16N	8L5N 6L4N 2L4msa
Level 1	1mc 15N	6L5N 1L5mc 1L4mc 1L4msa 7L4N
2A	16N	10L4N 4L4msa 2L5N
2C	16N	8L4N 2L4msa 6L5N
2D	16N	2L5N 14L4N
2E	16N	1L5N 14L4N 1L4msa
Level 2	16N	2L5N 12L4N 2L4msa
3A	16N	1L5N 15L4N
3C	16N	15L4N 1L4mA
3D	16N	2L5N 13L4N 1L4msa
3E	16N	16L5mc
Level 3	16N	1L5N 4L5mc 10L4N 1L4msa
<u>Quarter Summary</u>	16N	3L5N 2L5mc 10L4N 1L4msa
<u>Score</u>	<u>8 (4c 4sa) 8L.</u>	

NO. 10 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
19-5-49	1	0.01	-	-	None found
8-11-49	7	0.17	0.16	31	None found

Macroscopic Description.

This quarter showed much involuting tissue scattered focally amongst lactating lobules.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - Str. bovis; Level 2: S - cns
- S; Level 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mc 8N	14L4N 2L5N
1A	1mc 15N	14L4N 2L5N
1C	1mc 15N	14L4N 2L5N
1D	16N	6L5N 8L4N 2L3N
1E	16N	8L5N 8L4N
Level 1	2mc 14N	4L5N 12L4N
2A	1mc 15N	14L4N 2L4mA 1L3mA
2C	16N	16L5N
2D	16N	14L4N 2L4mA
2E	16N	16L4N
Level 2	16N	4L5N 11L4N 1L4mA
3A	16N	16L4N
3C	16N	14L4N 2L4mA
3D	16N	4L5N 8L4N 4L4mA
3E	16N	4L5N 8L4N 4L4mA
Level 3	16N	2L5N 11L4N 3L4mA
<u>Quarter Summary</u>	1mc 15N	3L5N 12L4N 1L4mA
<u>Score</u>	<u>4 (1c 3A) 1D. 3L.</u>	

NO. 10 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
19- 5-49	1	0.06	-	-	None found
8-11-49	7	0.04	0.09	30	None found

Macroscopic Description.

The entire gland showed involuted groups of lobules scattered amongst the lactating tissue.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Level 1: Sterile;
Level 3: S - cns - cns - Str. bovis; Level 2: S -
Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16N	16L4N
1A	16N	14L4N 1L4mA 1L5N
1C	15N 1msa	14L5 2L4N
1D	16N	14L4N 1L4mA 1L5N
1E	16N	10L4N 2L4mod A 4L5N
Level 1	16N	11L4N 1L4mA 4L5N
2A	16N	13L4N 2L5N 1L4mA
2C	16N	11L5N 4L5msa 1L4mA
2D	1mc 15N	12L4N 1L4msa 2L4 necrotic 1L5N
2E	16N	12L4N 4L4msa
Level 2	16N	9L4N 4L5N 2L4msa 1L5msa 1L4 necrotic

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>			
3A	16N	4L5N	4L5msa	6L4mA	2L3N
3C	16N	4L5N	4L5msa	4L4mA	4L4N
3D	16N	4L5N	4L5msa	4L4mA	4L4N
3E	16N	7L5N	1L5msa	1L4mA	7L4N
Level 3	16N	5L5N	3L5msa	4L4mA	4L4N

Quarter Summary 16N 4L5N 8L4N 2L4mA 2L5msa

Score 14 (8sa 6A) 14L.

COW NO. 12 - Breed - Ayrshire. 5th Lactation. Last calving date June 1948. Slaughtered November 25th 1949.

NO. 12 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1- 3-49	8	0.05	-	-	None found
12- 4-49	9	1.08	-	-	<u>Str. agalactiae</u>
21- 6-49	12	4.30	-	-	<u>Str. agalactiae</u>
2- 8-49	14	3.55	-	-	-
9- 8-49	14	0.88	-	-	<u>Str. agalactiae</u>
25-11-49	17	-	36.0	90	-

Macroscopic Description.

In the lower half of the gland the ducts showed marked fibrosis and areas C and D were involuted. The remaining parts were in lactation.

Details of Teat.

Length 7.0 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 18 mm.; c.o. 7 mm. Teat Sinus: There were four longitudinal ridges showing slightly roughened surfaces.

Cultures from Frozen Udder Tissue.

Level 3: S - Str. agalactiae - S; Level 2: S - Str. agalactiae - S; Level 1: S - cns - Str. agalactiae - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8Sev A 8Sev c	14L5Sev A 2L4Sev A
1A	16Sev A	14L5mod A 2L4Sev A
1C	8Sev A 8Sev sa	16L5Sev sa
1D	16mod sa	16L5Sev sa
1E	16Sev A	8L5Sev A 8L5Sev sa
Level 1	10Sev A 2Sev sa 2mod c 2mod sa	4L5Sev A 1L4Sev A 3L5mod A 8L5Sev sa
2C	8msa 8N	2L5Sev A 6L5mod sa 2L4mod A 6L4msa
2D	10mA 6N	4L4Sev A 8L5Sev sa 4L4mA
2E	6msa 10N	2L4mod A 6L5Sev sa 8L4N
Level 2	3mA 5msa 8N	2L4-5Sev A 1L4mod A 2L4mA 5L5Sev sa 2L5mod sa 2L4msa 2L4N
3A	4mA 8msa 4N	6L4Sev A 4L4mod A 2L5Sev c 4L4N
3C	4msa 12N	2L4Sev A 4L5Sev sa 4L4mA 6L4N
3D	4msa 12N	4L4Sev A 6L5Sev sa 6L4mA
3E	4msa 12N	8L5Sev sa 6L4N 2L4mA
Level 3	1mA 5msa 10N	3L4Sev A 3L4mA 5L5Sev sa 1L5Sev c 4L4N
<u>Quarter</u>	6N 3Sev A 2mA	3L4-5Sev A 2L4-5mod A 1L4mA 2L4N
<u>Summary</u>	1Sev sa 4msa	1L4msa 6L5Sev sa 1L5mod sa
<u>Score</u>	<u>191 (93A 98sa) 56D. 135L.</u>	

NO. 12 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1- 3-49	8	0.03	-	-	None found
12- 4-49	9	0.08	-	-	None found
21- 6-49	12	0.18	-	-	None found
2- 8-49	14	0.12	-	-	-
9- 8-49	14	n 1.62	-	-	None found
25-11-49	17	-	0.60	80	-

Macropsopic Description.

The gland was in lactation except in area C in all levels.

Details of Teat.

Length 6.5 cm.; e.d. 3.5 cm. Teat Canal: Length 8-10 mm.; c.r. 15 mm.; c.o. 8 mm. There were four vertical ridges in the canal. Teat Sinus: There were four vertical ridges in the sinus. The few pockets present were very shallow.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland: cns - S - S; all three levels: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	8L5mc 2L5msa 6L5N
1A	16N	1L5msa 3L5N 12L4N
1C	8mod c 8N	8L5mc 4L4msa 4L4N
1D	4mc 12N	8L5mc 8L4msa
1E	4mc 12N	8L5mc 8L4msa
Level 1	2mod c 2mc 3msa 9N	6L5mc 4L4msa 1L5msa 2L5N 3L4N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	4mod c 12N	8L5mod c 4L4msa 4L3-4N
2C	8mc 8N	10L5mc 6L4msa
2D	8mod c 8N	10L5mc 6L4msa
2E	16N	4L5mc 4L4msa 8L4N
Level 2	3mod c 2mc 10N	2L5mod c 6L5mc 5L4msa 3L3-4N
3A	8mc 8N	8L4mod sa 4L5mc 4L4N
3C	4mod c 8mc 4N	8L4mod sa 4L5mc 4L4N
3D	4mc 12N	4L4mod sa 12L4N
3E	8mc 8N	8L4msa 8L5mc
Level 3	1mod c 7mc 8N	5L4mod sa 2L4msa 4L5mc 5L4N
<u>Quarter</u>	2mod c 4mc	2L4mod sa 4L4msa 1L5mod c
<u>Summary</u>	1msa 9N	5L5mc 4L4N
<u>Score</u>	<u>56 (22c 34sa) 10D. 46L.</u>	

NO. 12 RIGHT FORE QUARTER.

This quarter was very atrophied and no milk was secreted by it for at least 8½ months.

Macroscopic Description.

Fibrosis was seen throughout almost the entire gland.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 9 mm.; c.r. 12 mm.; c.o. 8 mm. Teat Sinus: There were three vertical ridges. The entire epithelium lining the sinus was granular and not glistening. The sinus was patent though atrophied so that the space enclosed was about 1 cm. in diameter.

Cultures from Frozen Udder Tissue.

Level 3: S - cns; Level 2: Str. agalactiae;
Level 1: S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16N	16L5mod c
1A	2msa 14N	16L5mod c
1C	16N	15L5mod c 1L4msa
1D	16N	16L5mod c
1E	16Sev c	16L5Sev c

<u>Quarter</u>	3Sev c	3L5Sev c	13L5mod c
<u>Summary</u>	1msa 12N		

Score 81 (79c 2sa) 11D. 7OL.

NO. 12 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1- 3-49	9	0.75	-	-	Staphs.
12- 4-49	10	1.98	-	-	Staphs.
21- 6-49	12	0.86	-	-	Staphs.
The daily yield from the cow at this time was 1 gallon of milk.					
2- 8-49	14	3.30	-	-	Contaminated
9- 8-49	14	1.24	-	-	Strep.
25-11-49	17	-	4.00	80	-

Macroscopic Description.

Most of the gland substance was still in lactation being soft to touch except for firm patches of involution in Area C in all levels.

This gland was large and extended forward into the area normally occupied by the fore quarter.

Details of Teat.

Length 7 cm.; e.d. 3 cm. The epithelium showed several scars and small warts. Teat Canal: Length 8-10 mm.; c.r. 9 mm.; c.o. 18 mm. There were four longitudinal ridges in the canal. Teat Sinus: There were three slight vertical ridges; pockets were small.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland: S - S - S; All three levels: S - Str. agalactiae - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mod c	16L4-5msa
1A	8msa 8N	10L4msa 1L4mod A 4L4N 1L5mc
1C	4N 4mod c 8msa	14L5mc 2L4msa
1D	4msa 12N	6L5mc 2L4mod A 8L4msa
1E	4msa 12N	4L5mc 8L4msa 4L4N
Level 1	4mod c 5msa 7N	8L4-5msa 5L5mc 1L4mod A 2L4N
2A	4msa 12N	4L5mc 8L4msa 2L4mA 2L4N
2C	12msa 4N	8L5mc 4L4msa 2L4mA 2L4N
2D	12msa 4N	8L4mod A 4L5mc 4L4msa
2E	16msa	8L5mc 4L4mod A 4L4msa
Level 2	11msa 5N	6L5mc 5L4msa 1L4mA 3L4mod A 1L4N
3A	16N	1L4Sev A 2L4msa 12L4N 1L5mc
3C	4msa 12N	8L4mod A 4L4msa 4L5mc
3D	8msa 8N	4L4Sev A 8L4msa 4L5mc
Level 3	4msa 12N	2L4Sev A 2L4mod A 5L4msa 3L5mc 4L4N
<u>Quarter Summary</u>	7msa 1mod c 8N	6L4-5msa 5L5mc 2L4mod A 1L4Sev A 2L4N
<u>Score</u>	<u>74 (12c 38sa 24A) 16D. 58L.</u>	

COW NO. 15:- Breed - Ayrshire. 8th lactation.
Slaughtered 6-12-49.

NO. 15 LEFT FORE QUARTER.

Teat sinus occluded by fibrosis.

Macroscopic Description.

The gland was atrophied. The tissue was firm and dry.

Details of Teat.

Length 4 cm.; e.d. 2 cm. The teat canal and sinus were completely occluded by fibrosis.

Cultures from Frozen Udder Tissue.

Level 2: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16Sev c	16L5mod c
2C	16Sev c	16L5mod c
2D	16Sev c	16L5mod c
2E	16Sev c	16L5mod c

<u>Quarter</u>		
<u>Summary</u>	16Sev c	16L5mod c

Score 112 (112c) 48D. 64L.

NO. 15 LEFT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
4-12-49 (B.T.)	?	-	0.08	58	Not cultured
5-12-49 (A.T.)	?	-	0.80	87	Not cultured

Macroscopic Description.

This quarter was very large. The entire gland substance appeared to be in lactation excepting the C and D areas of Level 1.

Details of Teat.

Length 9 cm.; e.d. 3 cm. Teat Canal: Length 13 mm.; c.r. and c.o. 5 mm. and there was a circular scar half way up the canal. Teat Sinus: The lining was smooth without pockets. Gland Sinus: This was extremely capacious. It was roughly spherical and about 5 cm. in diameter. The volume was about 65 ml.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and all 3 Levels: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	2mc 14N	15L5N 1L4N
1A	16N	12L5N 4L3N
1C	16N	12L5N 4L3N
1D	16N	2L5N 14L3-4N
1E	16N	8L5N 8L3-4N
Level 1	16N	10L5N 6L3-4N
2A	16N	8L5N 8L3-4N
2C	6mc 10N	2L5N 14L3-4N
2D	16N	4L5N 12L3-4N
2E	16N	4L5N 12L3-4N
Level 2	1mc 15N	4L5N 12L3-4N
3A	16N	1L5Sev c 3L5N 12L3N
3C	16N	1L5mod c 15L3N
3D	16N	1L5mod c 15L3-4N
3E	16N	1L5mod c 7L5N 8L3-4N
Level 3	16N	1L5mod c 2L5N 7L3N 6L3-4N
<u>Quarter Summary</u>	16N	8L3-4N 6L5N 2L3N
<u>Score</u>	<u>NIL.</u>	

NO. 15 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
4-12-49 (B.T.)	?	-	0.03	38	Not cultured
5-12-49 (A.T.)	?	-	0.23	59	Not cultured

Macroscopic Description.

This quarter was very large. The entire gland tissue appeared to be in lactation except in C area around Level 1 which had involuted.

Details of Teat.

Length 10 cm.; e.d. 4 cm. This was the largest teat measured during these investigations. Teat Canal: Length 13 mm.; c.r. 13 mm.; c.o. 6 mm. The lining showed three ridges. Teat Sinus: There were no longitudinal ridges. A round membrane extended across the teat sinus near its junction to the gland sinus. This membrane was incomplete at the centre and the teat sinus was constricted and not occluded from the gland sinus. Gland Sinus: This was the most capacious gland sinus measured in the present work. It was roughly spherical and about 6 cm. in diameter. The volume was calculated to be about 110 ml.

Cultures from Frozen Udder Tissue.

All 3 levels: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	1msa 15N	1L3-4Sev A 14L3-4N 1L5mc
1C	16N	1L3-4m A 15L3-4N
1D	16N	4L5mc 12L3N
1E	4msa 12N	14L5mc 2L4N
Level 1	1msa 15N	1L3-4m A 5L5mc 10L3-4N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16N	2L4msa 14L3-4N
2C	16N	2L4msa 14L3-4N
2D	16N	16L3-4N
2E	16N	16L3-4N
Level 2	16N	1L4msa 15L3-4N
3A	16N	2L4msa 14L3-4N
3C	16N	4L5mc 12L3N
3D	16N	8L5mc 8L3N
3E	16N	8L5mc 8L2-3N
Level 3	16N	1L4msa 5L5mc 7L3N 3L3-4N

Quarter

Summary 16N 1L4msa 3L5mc 9L3-4N 3L3N

Score 10 (6c 4sa) 10L.

NO. 15 RIGHT HIND QUARTER.Cell Counts.

No milk obtainable.

Macroscopic Description.

The gland sinus and the ducts throughout the gland were occluded by fibrosis. The gland was atrophied. The glandular tissue was firm, dry and involuted.

Details of Teat.

Length 5 cm.; e.d. 2.5 cm. Teat Canal and Sinus:
Both occluded by fibrosis.

Cultures from Frozen Udder Tissue.

Levels 1 and 3: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16Sev c	12L5mod c 2L3-4msa 2L3-4N
2C	16Sev c	16L5Sev c
2D	16Sev c	16L5Sev c
2E	16Sev c	16L5Sev c

Level 2 16Sev c 12L5Sev c 3L5mod c 1L4msa

Quarter

Summary 16Sev c 12L5Sev c 3L5mod c 1L4msa

Score 136 (132c 4sa) 48D. 88L.

COW NO. 18 - Breed - Ayrshire. 7th Lactation. Last calved March 1949. Slaughtered 14-12-49.

NO. 18 LEFT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
27- 5-49	2	0.22	-		staphylococci
30- 6-49	2.5	0.01	-		None found
21-11-49	8	-	0.19	44	Not cultured
25-11-49	8	-	0.06	25	Not cultured
30-11-49	8.5	n 0.01	0.05	50	None found
9-12-49	9	0.01	-	-	None found
14-12-49	9	-	0.05	40	None found
15-12-49	9	-	0.32	44	Not cultured

(A.T.)

Macroscopic Description.

This gland appeared to be normal and still in lactation. Lobules were large, 3 mm. diameter, and salmon-pink. Involution was confined to the C area of Levels 1 and 2.

Details of Teat.

Length 8 mm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 10 mm.; c.o. 7 mm. Teat Sinus: There were three longitudinal ridges in the lining of the sinus and pockets were found in the upper half.

Cultures from Frozen Udder Tissue.

All 3 Levels: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16N	12L5N 4L3N
1D	16N	14L5N 2L4N
1E	16N	15L5N 1L4N
Level 1	16N	14L5N 2L3-4N
2A	16N	8L3N 8L4-5N
2C	16N	8L3-4N 8L5N
2D	16N	16L3-4N
2E	16N	8L3-4N 8L5N
Level 2	16N	2L3N 8L3-4N 4L5N 2L4-5N
3C	16N	14L3N 2L5N
3D	16N	14L3N 2L5N
3E	16N	16L5N
Level 3	16N	9L3N 7L5N
<u>Quarter Summary</u>	16N	4L3N 3L3-4N 9L5N

Score NIL.NO. 18 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
27- 5-49	2	0.02	-		Not cultured
30- 6-49	3	0.01	-		None found
21-11-49	8	-	0.13	29	Not cultured
25-11-49	8	-	0.15	40	Not cultured
30-11-49	8	0.01	0.07	-	None found
9-12-49	9	0.02	-	-	None found
14-12-49	9	0.09	0.05	40	None found
15-12-49	9	-	0.40	30	None found

(A.T.)

Macroscopic Description.

On section the tissue was that of a normal lactating gland. The lobules were salmon pink and large (3 mm. diam.). The milk-containing acini appeared as white dots. There was involution in C area of Level 1.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 10 mm.; c.o. 7 mm. Teat Sinus: There were three distinct longitudinal ridges. There were several pockets of the epithelium with openings 2 mm. in diameter. These pockets extended under the lining for up to 5 mm. Gland Sinus: This was large being approximately 7 cm. long, 7 cm. high and 5 cm. wide.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Level 2: Sterile.
Levels 3 and 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16N	16L5N
1D	16N	16L5N
1E	16N	16L5N
Level 1	16N	16L5N
2A	16N	16L5N
2C	16N	14L5N 2L4N
2D	16N	16L4N
2E	16N	14L4N 1L5N 1L2N
Level 2	16N	8L5N 8L4N
3C	16N	12L3N 2L2N 2L5N
3D	16N	16L5mc
3E	16N	8L4-5msa 8L4N
Level 3	16N	5L5mc 1L2N 4L3N 3L4-5msa 3L5N
<u>Quarter Summary</u>	16N	9L5N 2L5mc 1L4-5msa 2L2-3N 2L4N
<u>Score</u>		8 (4c 4sa) 8L.

NO. 18 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
27- 5-49	2	1.28	-	-	None found
30- 6-49	2	0.50	-	-	None found
21-11-49	8	-	2.06	58	Not cultured
25-11-49	8	-	1.09	43	Not cultured
30-11-49	8	1.08	0.78	57	None found
14-12-49	9	0.54	0.30	38	None found
15-12-49	9	-	1.81	55	Not cultured

(A.T.)

Macroscopic Description.

It appeared there was reduced lactation in the A and E areas of all levels. The rest of the gland was involuted and in addition showed slight fibrosis.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 8-9 mm.; c.r. 9 mm.; c.o. 7 mm. Teat Sinus: There were three longitudinal ridges in the lining of the sinus and pockets were found in the upper half.

Cultures from Frozen Udder Tissue.

Levels 3 and 2: Sterile; Level 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	3Sev A 6 mc 7N	10L5N 2L5mc 1L3mA 3L3N
1C	3Sev A 9 mc 4N	14L5mod C 2L4mA
1D	8mc 8N	8L5N 6L4N 2L4mA
1E	4mc 12N	15L5mc 1L4mA
Level 1	2Sev A 7mc 7N	1L3N 1L4N 1L3-4mA 4L5mod C 4L5mc 5L5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2C	16Sev c	16L5Sev c
2D	16Sev c	12L5N 4L4N
Level 2	16Sev c	8L5Sev c 6L5N 2L4N
3A	16N	14L3N 1L5N 1L5mc
3C	16Sev c	14L5mod sa 2L4-5m A
3D	16N	12L5N 3L4N 1L4m A
Level 3	5Sev c 11N	5L5mod sa 1L4-5m A 5L3N 1L4N 4L5N
<u>Quarter</u>	1Sev A 2mc	2L5mod sa 3L5Sev c 1L5mod c 1L5mc
<u>Summary</u>	7Sev c 6N	1L3-4m A 5L5N 2L3N 1L4N
<u>Score</u>	<u>78 (47c 16sa 15A) 35D. 43L.</u>	

NO. 18 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
27- 5-49	2	0.40	-	-	
30- 6-49	3	0.01	-	-	None found
21-11-49	8	-	0.10	47	Not cultured
25-11-49	8	-	0.01	-	Not cultured
30-11-49	8	0.01	0.01	-	None found
9-12-49	9	0.01	-	-	None found
14-12-49	9	0.01	0.05	40	None found
15-12-49	9	-	0.26	29	Not cultured
(A.T.)					

Macroscopic Description.

This gland appeared to be normal and still in lactation; the lobules were large (3 mm. diam.) and pink. The supernumerary gland, posterior to the R.H. gland, contained three small abscesses.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 10 mm.; c.o. 8 mm. The rosette was almost

absent. Teat Sinus: There were three longitudinal ridges and medium sized oval pockets especially in the proximal half. Gland Sinus: Size approximately 7 cm. long, 7 cm. deep and 5 cm. wide.

Cultures from Frozen Udder Tissue.

Supra-mammary lymph gland and Levels 2 and 3:
Sterile; Level 1: cns - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16N	8L5N 8L5mc
1A	16N	16L4-5N
1C	4mc 12N	8L5N 8L5mod c
1D	4mc 12N	8L4-5N 8L5mod c
1E	16N	8L4-5N 6L5N 2L5mc
Level 1	2mc 14N	2L5mc 3L5mod c 7L4-5N 4L5N
2A	2mc 14N	12L4-5N 4L5N
2C	4mc 12N	8L5mod c 4L4-5N 4L5N
2D	16N	2L4N 14L4-5N
2E	16N	16L4-5N
Level 2	2mc 14N	2L5mod c 12L4-5N 2L5N
3C	16N	15L5N 1L5mc
3D	16N	10L3N 4L3m A 3L4-5N 1L4m A
3E	4mc 12N	8L5mod c 4L5N 4L4N
Level 3	1mc 15N	3L5mod c 2L3-4m A 3L3N 2L4N 6L5N
<u>Quarter Summary</u>	2mc 14N	3L5mod c 1L3-4m A 1L3N 7L4-5N 4L5N
<u>Score</u>	<u>17 (14c 3A) 2D. 15L.</u>	

COW NO. 21 - Breed - Ayrshire. 5th Lactation. Calved on 3-12-48 and aborted 3-12-49. Slaughtered 28-12-49. The cow was in great pain from the severe mastitis. The left fore and left hind quarters were extremely hard.

NO. 21 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
1 7-12-48	0.5	0.62	-	-	<u>Staph. aureus</u>
All quarters were injected with penicillin on 29-12-48 and 30-12-48.					
4- 2-49	2	0.98	-	-	<u>Staph. aureus</u>
All quarters were injected with penicillin on 24-2-49 and 25-2-49.					

By 29-7-49 the left fore teat was occluded, and no sample of milk was obtainable then or afterwards.

Macroscopic Description.

The quarter was atrophied and involuting except for lactating areas in Level 1. The duct system was obliterated by fibrosis. The teat and gland sinus were solid.

Details of Teat.

Length 5 cm.; e.d. 2.5 cm. The teat canal and teat sinus were solid.

Cultures from Frozen Udder Tissue.

Levels 1 and 3: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16mc	16L2-3N
1C	16mc	16L2-3N
1D	16mc	8L3N 8L4msa
1E	16mc	8L2N 8L3-4N
Level 1	16mc	10L2N 4L3-4N 2L4msa

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3C	16N	8L3-4N 8L5mod c
3D	16N	8L3N 8L5N
3E	16N	8L4N 8L5mod c
Level 3	16N	8L3-4N 3L5N 5L5mod c
<u>Quarter Summary</u>	8mc 8N	5L2N 6L3-4N 1L4msa 1L5N 3L5mod c
<u>Score</u>	<u>24 (20 c 4sa) 8D. 16L.</u>	

NO. 21 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
17-12-48	0.5	4.8	-	-	staphylococci
Penicillin was injected into all quarters on 29-12-48 and 30-12-48.					
4- 2-49	2	1.77	-	-	staphylococci
Penicillin was injected into all quarters on 24-2-49 and 25-2-49.					
29- 7-49	8	2.76	-	-	Not cultured

The yield of milk of the cow was 15 lbs. daily at this time. After slaughter the green stinking pus within the teat was packed with bacteria and cells.

Macroscopic Description.

This was the largest quarter encountered during the work. Owing to the very severe acute inflammation the quarter was very distended and hard. There were small multiple abscesses throughout the gland tissue and the two largest abscesses had ulcerated. There were swollen lobules in Level 1. The proximal half of this gland appeared to be involuted.

Details of Teat.

Length 8 cm.; e.d. 4 cm. The teat canal and teat sinus were filled with green pus and no further details are available.

Cultures from Frozen Udder Tissue.

Level 3: Cp - cns - Cp - S; Level 1: Cp - cns - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16Sev c	6L5Sev c 5L2N 5L4msa
1C	16Sev c	4L2m A 12L4-5mc
1D	16Sev c	4L2Sev A 12L3-4Sev A
1E	16Sev c	4L2Sev A 12L3-4Sev A
Level 1	16Sev c	2L5Sev c 2L2Sev A 6L3-4Sev A 1L2N 1L4msa 1L2m A 3L4-5mc
3A	16Sev c	16L5Sev c
3D	16Sev c	16L5Sev c
3E	16Sev c	16L5Sev c
Level 3	16Sev c	16L5Sev c
<u>Quarter Summary</u>	16Sev c	9L5Sev c 1L2Sev A 3L3-4Sev A 2L4-5mc 1L2N
<u>Score</u>	<u>154 (106c 48A) 48D. 106L.</u>	

NO. 21 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
17-12-48	0.5	0.58	-	-	staphylococci
Penicillin was injected into all quarters on 29-12-48 and 30-12-48.					
4- 2-49	2	0.48	-	-	staphylococci
Penicillin was injected into all quarters on 24-2-49 and 25-2-49.					
29- 7-49	8	3.35	-	-	Not cultured
27-12-49 (B.T.)	.75	-	15.4	88	Not cultured
28-12-49 (A.T.)	.75	-	35.0	91	Not cultured
28-12-49 (P.M.)	.75	-	22.5	80	Not cultured

Macroscopic Description.

The gland on section showed raised lactating lobules scattered throughout involuted tissue especially in the lower levels.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length 15 mm. (one of the longest canals found in this work); c.r. 8 mm.; c.o. 6 mm. The epithelium was smooth. Teat Sinus: The lining showed no longitudinal ridges. There were several shallow pockets. In the distal half of the sinus the epithelium was keratinised showing chronic inflammation especially on the edges of pockets.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	8L5Sev c 8L4Sev A
1A	16Sev sa	12L4-5m A 4L2m A
1C	16Sev sa	12L4-5m A 4L2N
1D	16Sev sa	8L4-5m A 6L2-3m A 2L2N
1E	16Sev sa	2L4m A 2L2m A 10L4N 2L2N
Level 1	13Sev sa 3 Sev c	2L4Sev A 2L2m A 7L4-5m A 1L2N 2L5Sev c 2L4N
3A	16Sev sa	14L4-5m A 2L2m A
3C	16Sev sa	15L5msa 1L2m A
3D	16Sev sa	14L5mod sa 2L2m A
3E	16Sev sa	12L4-5mod sa 4L2m A
Level 3	16Sev sa	4L4-5m A 7L4-5mod sa 2L2m A 3L5msa
<u>Quarter Summary</u>	14Sev sa 2Sev c	1L4Sev A 2L2m A 6L4-5m A 3L4-5mod sa 2L5msa 1L2N 1L4N
<u>Score</u>	<u>158 (6c 116sa 36A) 90D. 68L.</u>	

NO. 21 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
17-12-48 Penicillin was injected into all quarters on 29-12-48 and 30-12-48.	0.5	0.80	-	-	<u>Staph. aureus</u>
4- 2-49 Penicillin was injected into all quarters on 24-2-49 and 25-2-49.	2	0.66	-	-	<u>Staph. aureus</u>
29- 7-49	8	3.15	-	-	Not cultured
27-12-49 (B.T.)	.75	-	3.48	68	Not cultured
28-12-49 (A.T.)	.75	-	4.9	61	Not cultured
28-12-49 (P.M.)	.75	-	5.2	56	Not cultured

M acroscopic Description.

Throughout this gland there were scattered groups of lobules still in lactation especially in Level 1. More than half of the lobules appeared to be involuted.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length 13 mm.; c.r. 10 mm.; c.o. 7 mm. The epithelium of the canal was thickened. Teat Sinus: There were no longitudinal ridges and no pockets; the epithelium was smooth.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	12L5mod c 4L4N
1A	8mod c 8mc	6L4N 6L4msa 4L5mc
1C	12mod c 4mc	4L4N 8L4-5msa 4L5mc
1D	16mod c	2L4N 14L4-5msa
1E	16mod c	1L3N 10L5mod sa 5L3-4m A
Level 1	3Sev c 11mod c 2mc	2L5mod c 2L5mc 2L5mod sa 6L4-5msa 1L3-4m A 3L4N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	16mod c	4L3m A 12L4msa
3C	16mod c	4L3m A 12L4msa
3D	16mod c	2L3m A 10L4mod sa 4L5msa
3E	16mod c	2L3m A 10L4mod sa 4L5msa
Level 3	16mod c	3L3m A 5L4mod sa 6L4msa 2L5msa

Quarter Summary 2Sev c 13mod c 1L5mod c 1L5mc 4L4-5mod sa
 lmc 2L3-4m A 7L4-5msa 1L4N

Score 105 (39c 60sa 6A) 33D. 72L.

COW NO. 22 - Breed - Dairy Shorthorn. This cow had calved several times; the exact number could not be ascertained. She was not giving any milk and no cell counts are available, for milk from this cow.

NO. 22 LEFT FORE QUARTER.

Macroscopic Description.

The gland tissue appeared normal and was completely involuted. There were several fine fibrous cords stretching across the gland sinus.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 7 mm.; c.r. and c.o. 7 mm. Teat Sinus: There were no longitudinal ridges. There were several distinct shallow oval pockets 5 mm. in length.

Cultures from Frozen Udder Tissue.

Level 2: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16mod c	8L5msa 8L5N
1D	16mod c	2L5Sev c 14L5mc
1E	16mod c	5L5Sev c 11L5mod c
Level 1	16mod c	2L5Sev c 4L5mod c 5L5mc 3L5msa 2L5N

Quarter Summary 16mod c 2L5Sev c 4L5mod c 5L5mc 3L5msa 2L5N

Score 82 (70c. 12sa.) 32D. 50L.

NO. 22 LEFT HIND QUARTER.

Macroscopic Description.

The gland tissue was completely involuted and appeared normal.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 7 mm.; c.r. and c.o. 7 mm. Teat Sinus: Longitudinal ridges not distinct.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - Streptococcus lactis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16mc	16L5mc
1D	16mc	16L5mc
1E	16mc	16L5mc
Level 1	16mc	16L5mc
3C	16mc	16L5mod c
3D	16mc	16L5mod c
3E	4mc 12N	16L5mc
Level 3	12mc 4N	11L5mod c 5L5mc
<u>Quarter Summary</u>	14mc 2N	6L5mod c 10L5mc

Score 58 (58c) 14D. 44L.

NO. 22 RIGHT FORE QUARTER.Macroscopic Description.

This gland appeared normal and was completely involuted. There were several fine fibrous cords stretching across the gland sinus.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 7 mm.; c.r. and c.o. 7 mm. The rosette was distinct. Teat Sinus: There were three longitudinal ridges and pockets were very distinct in the lining of the sinus.

Cultures from Frozen Udder Tissue.

Level 2: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16mod c	16L5mod c
1D	16mod c	16L5mod c
1E	16mod c	12L5mod c 4L5N
<u>Quarter Summary</u>	16mod c	15L5mod c 1L5N
<u>Score</u>	<u>92 (92c) 32D. 60L.</u>	

NO. 22 RIGHT HIND QUARTER.Macroscopic Description.

This gland appeared normal and was completely involuted.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 7 mm.; c.r. and c.o. 7 mm. Teat Sinus: There were no longitudinal ridges. There were several distinct shallow pockets.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	16mod c	16L5mod c
1D	16mc	16L5mc
1E	16mc	12L5mc 4L5mod c
Level 1	5mod c 11mc	7L5mod c 9L5mc
3C	16mc	16L5mod c
3D	8mc 8mod c	8L5mc 8L5mod c
3E	8mc 8mod c	16L5mc
Level 3	11mc 5mod c	5L5mc 8L5mod c

Quarter Summary 5mod c 11mc 8L5mod c 8L5mcScore 69 (69c) 21D. 48L.

COW NO. 23 - Breed - British Friesian Cross-bred. This cow was very aged and thin. Calved June 1948. Slaughtered 5-1-50.

NO. 23 LEFT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly%</u>	<u>Mastitis Organisms</u>
22- 2-49	9	1.50	-	-	<u>Staphylococcus aureus</u>
100,000 units of penicillin were injected into the teat canal during May.					
23- 9-49	15	0.10	-	-	Not cultured
15-12-49	18	-	0.03	-	Not cultured
22-12-49	18	-	0.05	80	Not cultured
5- 1-50(B.T.)	19	-	0.48	70	Not cultured
5- 1-50(P.M.)	19	-	2.40	90	Not cultured

Macroscopic Description.

The tissue of this gland appeared normal. The lobules were involuting.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 12-13 mm.; c.r. 10 mm.; c.o. 8 mm. The distal half of the canal was pigmented with melanin. Teat Sinus: There were three longitudinal ridges. There were five round shallow pockets in the lining of the sinus. A distinct fibrous scar ran round the sinus about 3 cm. from the rosette.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - S; Level 1: S - mc - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	15N lmc	16L3-4N
1C	16N	16L3-4N
1D	15N lmc	15L3-4N 1L4Sev A
1E	15N lmc	15L3-4N 1L3-4m A
Level 1	15N lmc	15L3-4N 1L3-4m A
3A	16N	16L4N
3C	16N	16L4N
3D	16N	16L4N
Level 3	16N	16L4N

Quarter Summary 16N 8L4N 8L3-4N
About 2% of lobules show
m A - Sev A.

Score 2 (2A) 2L.

NO. 23 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
22- 2-49	9	0.08	-	-	None found
23- 9-49	15	0.16	-	-	None found
15-12-49	18	-	0.01	-	Not cultured
22-12-49	18	-	0.03	-	Not cultured
5- 1-50 (B.T.)	19	-	0.12	75	Not cultured
5- 1-50 (A.T.)	19 (P.M.)	-	1.21	95	Not cultured

Macroscopic Description.

The tissue of the gland appeared normal. The lobules were involuting.

Details of Teat.

Length 6.5 cm.; e.d. 3.5 cm. Teat Canal: Length 13 mm.; c.r. 13 mm.; c.o. 9 mm. Teat Sinus: There were no longitudinal folds nor any pockets.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mc 8N	15L5N 1L5mc
1A	16N	16L4-5N
1C	16N	16L4-5N
1D	1mc 15N	15L4-5N 1L5mc
1E	1mc 15N	8L5mod c 8L4N
Level 1	2mc 14N	2L5mod c 2L4N 12L4-5N
3A	1mc 15N	16L4-5N
3C	16N	16L4-5N
3D	16N	16L4-5N
3E	16N	2L4mod A 14L4-5N
Level 3	16N	1L4mod A 15L4-5N

Quarter Summary lmc 15N 1L5mod c 15L4-5N
About 1% shows mod A.

Score 6 (5c. 1A.) 1D. 5L.

NO. 23 RIGHT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
22- 2-49	9	0.20	-	-	streptococci
23- 9-49	15	0.04	-	-	None found
15-12-49	18	-	0.05	1E 4P	Not cultured
22-12-49	18	-	0.02	-	Not cultured
5- 1-50(B.T.)	19	-	0.06	-	Not cultured
5- 1-50(A.T.)	19	-	0.60	87	Not cultured
(P.M.)					

Macroscopic Description.

The tissue of this gland appeared normal. The lobules appeared to be involuting.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 11 mm.; c.r. 10 mm.; c.o. 8 mm. Teat Sinus: There were three slight longitudinal ridges. There were six shallow oval pockets about 5 mm. long with 2 mm. overhang of epithelium in two of the pockets.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - S; Level 1: S - str. lactis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	16mod c	16L5N
1A	lmc 15N	16L4N
1C	16N	15L4N 1L4msa
1D	16N	16L4N
1E	16N	16L4-5N
Level 1	3mod c 13N	9L4N 3L5N 4L4-5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	16N	12L4-5N 4L3N 3 acini with Polys
3C	16N	16L3-4N
3E	3mc 13N	16L4N
Level 3	1mc 15N	1L3N 6L3-4N 5L4N 4L4-5N

Quarter

Summary 2mod c 14N 3L3-4N 7L4-5N 4L4-5N 2L5N

Score 5(4c 1A) 4D. 1L.

NO. 23 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
22- 2-49	9	0.08	-	-	None found
23- 9-49	15	0.08	-	-	None found
15-12-49	18	-	0.01	-	Not cultured
22-12-49	18	-	0.02	-	Not cultured
5- 1-50(B.T.)	19	-	0.01	-	Not cultured
5- 1-50(A.T.)	19	-	0.44	83	Not cultured
(P.M.)					

Macroscopic Description.

The lobules of this gland appeared to be involuting and normal.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 12 mm.; c.r. 12 mm.; c.o. 9 mm. Teat Sinus: There were three slight longitudinal ridges. There were a few small shallow pockets near the rosette.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	16L5N
1A	16N	1L4m A 15L4-5N
1C	16N	16L4N
1D	16N	16L4N
1E	16N	16L4N
Level 1	3Sev c 13N	10L4N 3L4-5N 3L5N
3A	16N	16L4N
3C	16N	15L4N 1L4m A
3D	16N	15L4N 1L4m A
3E	1mc 15N	15L4N 1L4m A
Level 3	16N	15L4N 1L4m A
<u>Quarter Summary</u>	2Sev c 14N	12L4N 2L4-5N 2L5N
<u>Score</u>	8 (6c 2A) 6D. 2L.	

COW NO. 24 - Breed - Ayrshire. 5th Lactation.
 Calved 4-1-49. Slaughtered 5-1-50.
NO. 24 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
9- 2-49	1	1.9	-	-	None found
Penicillin was injected through the teat canal on 24-2-49 and 25-2-49.					
23- 3-49	3	1.0	-	-	None found
29- 7-49	7	1.32	-	-	staphylococci
25-11-49	10.5	0.64	-	-	Non-haem.staph.
5- 1-50(B.T.)	12	-	1.90	47	Not cultured
5- 1-50(A.T.) (P.M.)	12	-	5.7	53	Not cultured

Macroscopic Description.

There were areas of involution in this quarter in which the walls of the ducts were thickened by fibrosis.

Intervening areas showed lobules still in lactation. The signs of chronic duct inflammation appeared throughout the medial half of the gland.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 12 mm.; c.o. 7 mm. Teat Sinus: There were three slight longitudinal ridges. There were many very shallow oval pockets 5-10 mm. long in the distal half of the sinus.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8msa 8N	8L5msa 8L5N
1A	16msa	4L4N 4L4msa 4L5N 4L5msa
1C	16msa	8L5mc 8L5N
1D	8msa 8N	8L5mc 4L5N 2L4m A 2L4N
1E	8msa 8N	8L5msa 8L5N Evolution
Level 1	11msa 5N	5L4-5msa 1L4m A 3L5mc 1L4N 6L5N
3A	4msa 12N	12L5mod c 4L4N
3C	16N	12L4N 4L5msa
3D	16N	14L5mc 2L4N
3E	16N	14L5mc 2L4N
Level 3	1msa 15N	3L5mod c 7L5mc 1L5msa 5L4N
<u>Quarter Summary</u>	6msa 10N	2L5mod c 5L5mc 1L4m A 3L4-5msa 3L4N 2L5N
<u>Score</u>	<u>45 (18c 24sa 3A) 12D. 33L.</u>	

NO. 24 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
9- 2-49	1	0.06	-	-	staph.
Penicillin was injected through the teat canal on 24-2-49 and 25-2-49.					
22- 3-49	3	0.01	-	-	None found
29- 7-49	7	0.14	-	-	None found
25-11-49	10.5	0.06	-	-	None found
5- 1-50(B.T.)	12	-	0.18	52	Not cultured
5- 1-50(P.M.)	12	-	1.0	52	Not cultured

Macroscopic Description.

The tissue of this gland was seen to be lactating except for small areas of involution in Level 1 and lower. These involuted areas were located near the periphery of the gland around areas C, D and E.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 8 mm.; c.r. 11 mm.; c.o. 6 mm. 2 mm. of the teat canal were visible before the teat opened. Teat Sinus: There were three slight longitudinal ridges and many very shallow oval pockets 5-10 mm. long.

Cultures from Frozen Udder Tissue.

Level 3: Str. bovis - S - S; Level 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	16L5msa
1A	16N	16L4N
1C	8msa 8N	16L4N
1D	16N	12L4N 3L5N 1L5msa
1E	16N	8L4N 6L5N 2L5msa
Level 1	5msa 11N	10L4N 2L5N 4L5msa

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	16N	14L4N 2L5N
3C	16N	14L4N 1L5N 1L5msa
3D	16N	16L4N
3E	16N	14L4N 1L5N 1L5mc
Level 3	16N	14L4N 1L5N 1L5msa
<u>Quarter Summary</u>	3msa 13N	2L5msa 12L4N 2L5N
<u>Score</u>	<u>14 (14sa) 6D. 8L.</u>	

NO. 24 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
9- 2-49	1	1.74	-	-	streptococci
Penicillin was injected through the teat canal on 24-2-49 and 25-2-49.					
22- 3-49	3	0.02	-	-	None found
29- 7-49	7	0.90	-	-	staph. and str.
25-11-49	10.5	1.71	-	-	<u>Staph. alb.</u> and str.
5- 1-50 (B.T.)	12	-	0.65	34	Not cultured
5- 1-50 (P.M.)	12	-	2.7	52	Not cultured

Macroscopic Description.

This gland appeared to be in lactation throughout except for the posterior angle, that is the C area.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 9 mm.; c.r. 15 mm.; c.o. 4 mm. The distal 2 mm. of the canal lining was visible ante-mortem. The epithelium lining showed three nodules of old scar tissue about half way along the length of the canal. It was keratinised near the rosette. Teat Sinus: There were two longitudinal ridges, and a few small pockets in the epithelium. The distal ends of the ridges showed squamous metaplasia.

Cultures from Frozen Udder Tissue.

Level 3: S - Str. bovis - S; Level 1: S - Str. faecalis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	8L4mc 8L4N
1A	8msa 8N	15L4N 1L5mc
1C	8msa 8N	8L5mc 8L4msa
1D	8msa 8N	4L4msa 10L4N 2L5mc
1E	8msa 8N	6L4N 6L4msa 4L5mc
Level 1	10msa 6N	8L4N 4L4msa 4L5mc
3A	8N 8msa	12L4N 4L4msa
3C	12N 4msa	12L4N 4L4msa
3D	12N 4msa	12L5mc 2L4N 2L4msa
3E	12N 4msa	4L5mc 6L4N 6L4msa
Level 3	11N 5msa	8L4N 4L4msa 4L5mc
<u>Quarter Summary</u>	8msa 8N	8L4N 4L4msa 4L5mc
<u>Score</u>	<u>40 (8c 32sa) 16D. 24L.</u>	

NO. 24 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
9- 2-49	1	4.62	-	-	str. and staph.
Penicillin was injected through the teat canal on 24-2-49 and 25-2-49.					
22- 3-49	3	0.38	-	-	str. and staph.
29- 7-49	7	2.1	-	-	str.
25-11-49	10.5	1.8	-	-	str.
5- 1-50	12	-	4.00	55	Not cultured
(B.T.)					
5- 1-50	12	-	13.00	52	Not cultured

Macroscopic Description.

Tissue in and below Level 1 was involuted. Higher levels contained lactating tissue except for involuted areas at the periphery of the gland.

Details of Teat.

Length 8 cm.; e.d. 3 cm. Teat Canal: Length 11 mm.; c.r. 15 mm.; c.o. 5 mm. The distal 2 mm. of the canal lining were visible ante-mortem. There was a healed scar 3 mm. long running partly around the lining of the canal about half way along its length. The entire lining of the canal was slightly thickened and showed squamous metaplasia at the rosette. Teat Sinus: There were three longitudinal ridges and many very shallow oval pockets 5-10 mm. long.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - Str. bovis - S; Level 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16msa	8L5mc 4L4msa 4L4N
1C	12msa 4N	12L5mc 4L4N
1D	12msa 4N	12L5mc 4L4N
1E	4msa 12N	14L5mc 2L4mod A
Level 1	11msa 5N	12L5mc 1L4msa 1L4mod A 2L4N
3A	4msa 12N	2L5mc 2L4mod A 12L4N
3C	2msa 14N	8L5mc 2L4msa 6L4N
3D	2msa 14N	8L5mc 4L4msa 4L4N
3E	2msa 14N	8L5mc 8L4N
Level 3	3msa 13N	6L5mc 1L4mod A 1L4msa 8L4N
<u>Quarter Summary</u>	7msa 9N	9L5mc 1L4mod A 1L4msa 5L4N
<u>Score</u>	<u>42 (18c 18sa 6A) 14D. 28L.</u>	

COW NO. 26 - Breed - British Friesian. Aged.
Slaughtered 31-1-50.

NO. 26 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
11-5-49	?	0.14	-	-	None found
31-1-50	8 months later	-	-	-	Not cultured

Macroscopic Description.

Ante-mortem this gland showed very severe acute mastitis. It was huge and abnormally distended, very tense and very painful to the cow. Post-mortem the teat, gland sinus and all ducts were found distended with thick green pus.

Details of Teat.

Length 10 cm.; e.d. 4 cm. Teat Canal: Length 6 mm.; c.r. and c.o. 7 mm. Teat Sinus: The lining was haemorrhagic and was so distended by pus that the wall of the teat was very thin and appeared liable to burst.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: C. pyogenes - Cp - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2C	16Sev c	16Sev c
<u>Quarter Summary</u> (estimated)	8Sev c 8Sev A	8L5Sev c 8L4-5Sev A

Score 264 (72c 192A) 120D. 154L.

This was the only section made from this gland. The entire gland appeared macroscopically similar to the block of tissue fixed for examination. In view of the clinical findings it has been assumed that half of this quarter was affected by severe acute mastitis in both lobules and ducts.

NO. 26 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
11-5-49	?	6.6	-	-	<u>Staph. aureus</u>
31-1-50	8 months later	-	-	-	Not cultured

Macroscopic Description.

Ante-mortem this gland was seen to be very atrophied. The teat was occluded by scar tissue. The gland sinus was roughly spherical and contained a mass of green foul-smelling pus about 10 cm. in diameter. Most of the larger ducts were occluded by fibrosis. The majority of lobules were completely involuted.

A few lobules containing milk were found round the gland sinus.

Details of Teat.

Length 7 cm.; e.d. 4 cm. Teat Canal: Length 12 mm.; c.r. and c.o. 7 mm. The epithelium showed chronic inflammation towards the rosette. Teat Sinus: The lining was severely inflamed and very distended by the mass of stinking pus contained.

Cultures from Frozen Udder Tissue.

Level 2: Corynebacterium pyogenes - Cp - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	16L5Sev c
2A	8Sev c 8mod c	16L5Sev c
2C	16mod c	16L5Sev c
2D	16mod c	16L5Sev c
2E	16mod c	16L5Sev c
<u>Quarter Summary</u>	5Sev c 11mod c	16L5Sev c

Score 133 (133c) 37D. 96L.

NO. 26 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
11-5-49	?	0.02	-	-	None found

Macroscopic Description.

All the ducts in this gland were fibrosed, and the lumen in most of them was obliterated. The gland sinus was almost obliterated. There was a narrow fibrosed channel running from Level 1 to the teat. No lobules could be seen in Level 1. In Levels 2 x 3 the lobules were about 2 mm. in diameter, firm and dry. There was an abscess lateral to the gland sinus, and the fibrosed portion.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 11 mm.; c.r. and c.o. 5 mm. Teat Sinus: This was only 1 cm. in diameter. The teat felt almost solid on clinical examination. Two drops of yellow pus extruded through the canal.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: Corynebacterium pyogenes - cns - Cp - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16Sev c	16L5Sev c
1C	16Sev c	16L5Sev c
1D	16Sev c	16L5Sev c
1E	16Sev c	16L5Sev c
Level 1	16Sev c	16L5Sev c

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	16Sev c	16L5Sev c
3C	16Sev c	16L5Sev c
3D	16Sev c	16L5Sev c
3E	16Sev c	16L5Sev c
<hr/>		
Level 3	16Sev c	16L5Sev c
<hr/>		
<u>Quarter Summary</u>	16Sev c	16L5Sev c
<u>Score</u>	<u>144 (144c) 48D. 96L.</u>	

NO. 26 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
11-5-49	?	11.1	-	-	None found
31-1-50 (P.M.)	?	-	5.7	18	Not cultured

Macroscopic Description.

This appeared to be a dry quarter. At all levels the lobules were 2 mm. in diameter, firm and dry. The gland sinus appeared normal.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length 13 mm.; c.r. 13 mm.; c.o. 7 mm. Teat Sinus: There were three vertical ridges. Near the proximal end of the teat there were a few shallow pockets.

Cultures from Frozen Udder Tissue.

Level 2: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	16L5Sev c
1A	16Sev c	16L5mod c Fibrosis Atrophy
1C	16mod c	16L5mod c
1D	16mod c	16L5mod c
1E	16mod c	16L5mod c
Level 1	6Sev c 10mod c	3L5Sev c 13L5mod c
3A	16mod c	16L5mod c
3C	16mod c	16L5mod c
3D	16mod c	16L5mod c
3E	16mod c	15L5mod c 1L4mod A
Level 3	16mod c	16L5mod c

Quarter
Summary

3Sev c 13mod c 2L5Sev c 14L5mod c

Score 103 (103c) 35D. 68L.

COW NO. 27 - Breed - Ayrshire. 9th Lactation. Last three calving dates were 2-2-47, 14-1-48 and 17-3-49. Slaughtered 2-2-50.

NO. 27 LEFT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	2	0.18	-	-	<u>Staph. aureus</u>
Penicillin was injected through the teat canal a few days later.					
18- 5-48	4	4.0	-	-	None found
17- 8-48	7	2.4	-	-	None found
13- 9-48	8	0.2	-	-	None found
13- 6-49	3	0.38	1.5	89	None found
5- 7-49	4	0.67	0.76	54	<u>Staph. aureus</u>
Penicillin was injected through the teat canal on 6 and 7-7-49.					

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
11- 7-49	4	1.74	2.1	67	<u>Staph. aureus</u>
26- 7-49	4	-	0.51	58	<u>Staph. aureus</u>
1- 8-49	4.5	0.16	0.20	58	<u>Staph. albus</u>
8- 8-49	5	0.21	0.28	53	<u>Staph. aureus</u>
15- 8-49	5	1.35	0.38	48	<u>Staph. aureus</u>
22- 8-49	5	1.12	1.19	76	Not cultured
29- 8-49	5	2.19	1.06	62	<u>Staph. aureus</u>
5- 9-49	5.5	3.2	2.1	67	None found
12- 9-49	6	1.2	-	-	None found
19- 9-49	6	0.5	0.24	36	None found
27- 9-49	6	0.26	0.36	38	Not cultured
3-10-49	6.5	1.11	1.02	70	None found
10-10-49	7	1.8	-	-	None found
24-10-49	7	1.02	-	-	None found
31-10-49	7.5	0.39	-	-	None found
7-11-49	8	0.50	-	-	None found
14-11-49	8	0.87	-	-	None found
21-11-49	8	1.28	-	-	None found
28-11-49	8.5	0.88	-	-	None found
5-12-49	8.5	1.35	-	-	None found
12-12-49	9	0.81	-	-	None found
19-12-49	9	1.04	-	-	None found
4- 1-50	9.5	3.96	-	-	None found
9- 1-50	10	16.0	-	-	<u>Staph. aureus</u>
16- 1-50	10	7.1	-	-	<u>Staph. aureus</u>
24- 1-50	10	10.8	6.7	86	<u>Staph. aureus</u>
30- 1-50	10.5	1.17	3.0	66	Not cultured
2- 2-50	10.5	-	13.2	89	Not cultured

(A.T.)

Macroscopic Description.

The tissue of the gland appeared to be involuting. Most of the lobules were about 2 mm. in diameter, firm and dry. There were foci in all levels especially near Level 3 where a few lobules were 3 mm. in diameter, soft and contained milk. About 25 per cent. of lobules were still in lactation.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 11 mm.; c.r. 12 mm.; c.o. 6 mm. There is slight

squamous metaplasia at the rosette. There was a healed scar 4 mm. long extending from the orifice along the canal. Teat Sinus: There was healed scar tissue in an area of about 1 sq. cm. half way up the sinus. At the junction with the gland sinus there were three pedunculated papillomata hanging from the mucous membrane. Each was about 3 mm. in diameter.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - Staphylococcus aureus - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mod sa	8L3-4N 4L4N 4L5mod sa
1A	16mod sa	6L3-4N 6L3-4mod A 1L2ma 3L5N
1C	16mod sa	4L5N 3L4N 8L5mod sa 1L4ma
1D	16mod sa	16L5Sev sa
1E	16mod sa	7L5mc 8L5mod sa 1L4ma
Level 1	16mod sa	3L5Sev sa 4L5mod sa 1L3-4mod A 1L3-4ma 3L3-4N 3L4-5N-1L5mc
3A	16mod sa	8L5mod sa 4L5N 4L4ma
3D	16mod sa	8L5mod sa 3L5N 3L4ma 1L4N
3E	16mod sa	16L5mod sa
3C	16mod sa	14L5mod sa 2L3mod A
Level 3	16mod sa	1L5N 12L5mod sa 3L3-4ma
<u>Quarter Summary</u>	16mod sa	2L5Sev sa 8L5mod sa 1L3-4mod A 2L3-4ma 2L5N 1L3-4N
<u>Score</u>	164 (152sa 12A) 64D. 100L.	

NO. 27 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	2	0.26	-	-	<u>Staph. aureus</u>
Penicillin was injected through the teat canal a few days later.					
18- 5-48	4	0.54	-	-	<u>Staph. aureus</u>
17- 8-48	7	0.50	-	-	None found
13- 9-48	8	0.74	-	-	None found
13- 6-49	3	1.48	2.6	83	None found
5- 7-49	4	0.90	1.1	76	<u>Staph. aureus</u>
Penicillin was injected through the teat canal on 6 and 7-7-49.					
11- 7-49	4	2.82	3.8	70	None found
26- 7-49	4	-	0.19	72	Not cultured
1- 8-49	4.5	0.03	0.08	48	None found
8- 8-49	5	0.16	0.46	70	<u>Staph. aureus</u>
15- 8-49	5	1.74	0.53	74	<u>Staph. aureus</u>
22- 8-49	5	2.07	7.45	75	Not cultured
29- 8-49	5	3.80	3.10	81	<u>Staph. aureus</u>
5- 9-49	5.5	1.66	0.88	61	None found
12- 9-49	6	2.25	1.76	55	<u>Staph. aureus</u>
19- 9-49	6	0.18	0.14	35	<u>Staph. aureus</u>
27- 9-49	6	0.25	0.22	41	Not cultured
3-10-49	6.5	0.52	1.07	81	None found
10-10-49	7	0.32	-	-	None found
24-10-49	7	0.55	-	-	None found
31-10-49	7.5	0.49	-	-	None found
7-11-49	8	2.48	-	-	None found
14-11-49	8	5.70	-	-	None found
21-11-49	8	6.10	-	-	<u>Staph. aureus</u>
28-11-49	8.5	7.70	-	-	None found
5-12-49	8.5	0.39	-	-	None found
12-12-49	9	0.80	-	-	None found
19-12-49	9	0.42	-	-	None found
4- 1-50	9.5	3.54	-	-	<u>Staph. aureus</u>
9- 1-50	10	14.40	-	-	<u>Staph. aureus</u>
16- 1-50	10	7.00	-	-	<u>Staph. aureus</u>
24- 1-50	10	10.50	5.00	85	<u>Staph. aureus</u>
30- 1-50	10.5	0.80	1.5	58	Not cultured
2- 2-50	10.5	-	15.0	92	Not cultured

(A.T.)

Macroscopic Description.

Most of the lobules appeared to be involuting. There were foci in all levels especially in areas A, B and E of Levels 2 and 3, containing soft lobules 3 mm. in diameter which contained milk. About half of the lobules were still in lactation.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length 9 mm.; c.r. 9 mm.; c.o. 6 mm. Teat Sinus: There was slight puckering due to contraction of healed scar tissue in the lining of the sinus 2 cm. above the rosette. Ridges and pockets were very slight.

Cultures from Frozen Udder Tissue.

Level 3: S - Staphylococcus aureus - S; Level 1: Staphylococcus aureus - Staph. aureus - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	16Sev sa	12L5ma 4L3-4mod A
1A	16Sev sa	15L5ma 1L4N
1C	16Sev sa	6L5mod c 8L5ma 2L4-5N
1D	16Sev sa	7L5mod c 8L5ma 1L4N
1E	16Sev sa	6L5mod c 8L5mod' A 2L4N
Level 1	16Sev sa	4L5mod c 7L5mod A 3L5ma 1L3mod A 1L4N
3A	16mod sa	8L3Sev A 4L3mod A 2L3ma 2L5N
3C	8mod sa 8msa	8L5N 8L5ma
3D	16msa	4L3Sev A 8L4Sev A 4L5Sev A
3E	16msa	8L4Sev A 8L5Sev A
Level 3	6mod sa 10msa	3L3Sev A 4L4Sev A 5L5mod A 1L3mod A 3L5N
<u>Quarter</u>	8Sev sa	6L5mod A 4L3-4Sev A 3L4-5N
<u>Summary</u>	3mod sa 5msa	1L3mod A 2L5mod c
<u>Score</u>	<u>168 (8c 70sa 90A) 70D. 98L.</u>	

NO. 27 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
15- 3-48	2	1.52	-	-	<u>Staph. aureus</u>
All quarters were treated with penicillin a few days later.					
18- 5-48	4	0.01	-	-	None found
17- 8-48	8	2.67	-	-	None found
13- 9-48	9	0.58	-	-	None found
13- 6-49	3	1.56	3.9	68	None found
5- 7-49	4	1.28	1.3	79	None found
All quarters were treated with penicillin on 6 and 7-7-49.					
11- 7-49	4	2.40	4.1	72	None found
26- 7-49	4	-	0.58	57	None found
1- 8-49	4.5	0.78	0.77	49	<u>Staph. aureus</u>
8- 8-49	5	1.56	2.3	64	diplococci
15- 8-49	5	2.34	1.05	60	diplococci
22- 8-49	5	1.04	2.26	40	Not cultured
29- 8-49	5.5	1.22	0.97	62	diplococci
5- 9-49	5.5	2.7	2.8	62	diplococci
12- 9-49	6	0.74	0.72	30	diplococci
19- 9-49	6	0.71	0.74	49	diplococci
27- 9-49	6	2.76	6.48	77	Not cultured
3-10-49	6.5	1.55	1.9	70	diplococci
10-10-49	7	1.05	3.2	70	None found
24-10-49	7	8.30	-	-	None found
31-10-49	7.5	1.32	-	-	None found
7-11-49	7.5	4.90	-	-	None found
14-11-49	8	2.25	-	-	None found
21-11-49	8	0.44	-	-	None found
28-11-49	8.5	0.28	-	-	None found
5-12-49	8.5	0.18	-	-	None found
12-12-49	9	0.58	-	-	<u>Staph. aureus</u>
19-12-49	9	0.31	-	-	None found
4- 1-50	9.5	0.56	-	-	<u>Staph. aureus</u>
9- 1-50	10	1.20	-	-	None found
16- 1-50	10	2.4	-	-	<u>Staph. aureus</u>
24- 1-50	10	1.24	0.99	25	<u>Staph. aureus</u>
30- 1-50	10.5	0.50	0.68	31	Not cultured
2- 2-50	10.5	-	0.58	42	Not cultured

(A.T.)

Macroscopic Description.

Most of the mammary tissue appeared to be involuting with lobules approximately 2 mm. in diameter, firm and dry. In higher levels there were areas where lobules were in lactation and about 3 mm. in diameter.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 10 mm.; c.r. 12 mm.; c.o. 6 mm. The distal 4 mm. of canal epithelium showed chronic inflammation. Teat Sinus: The epithelium showed severe chronic inflammation over its entire surface. The longitudinal ridges and edges of pockets were puckered by healed scar tissue and in these places the epithelium showed squamous metaplasia.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	8mc 8N	16L4N
1A	4mc 12N	4L4N 10L5mc 2L5msa
1C	8mc 8N	4L4N 12L5mc
1D	2mc 14N	2L4N 10L5mc 4L5msa
1E	1mc 15N	2L4N 4L5mc 2L5msa 8L5N
Level 1	5mc 11N	6L4N 6L5mc 2L5N 2L5msa
3A	4mc 12N	16L5mc
3C	4mc 12N	14L5mc 2L3msa
3D	8mc 8N	14L5mc 2L3N
3E	12mc 4N	14L5mc 2L3msa
Level 3	7mc 9N	15L5mc 1L3msa
<u>Quarter Summary</u>	6mc 10N	3L4N 10L5mc 1L5N 2L3-5msa
<u>Score</u>	<u>34 (26c 8sa) 6D. 28L.</u>	

NO. 27 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	2	0.03	-	-	None found
All quarters were treated with penicillin a few days later.					
18- 5-48	4	0.12	-	-	None found
17- 8-48	8	0.32	-	-	None found
13- 9-48	9	0.50	-	-	None found
13- 6-49	3	0.26	0.96	80	None found
5- 7-49	4	0.11	0.22	72	diplococci
All quarters were treated with penicillin on 6 and 7-7-49.					
11- 7-49	4	0.70	0.66	65	diplococci
26- 7-49	4	-	0.14	70	Not cultured
1- 8-49	4.5	0.01	0.03	44	None found
8- 8-49	5	0.12	0.31	65	diplococci
15- 8-49	5	0.27	0.15	62	<u>Staph. aureus</u>
22- 8-49	5	1.02	1.66	80	Not cultured
29- 8-49	5.5	0.40	0.51	73	diplococci
5- 9-49	5.5	0.31	0.68	65	diplococci
12- 9-49	6	0.78	0.52	60	diplococci
19- 9-49	6	0.09	0.07	30	diplococci
27- 9-49	6	0.12	0.14	55	Not cultured
3-10-49	6.5	0.08	0.23	50	diplococci
10-10-49	7	0.16	0.20	56	None found
24-10-49	7	0.24	-	-	None found
31-10-49	7.5	0.12	-	-	None found
7-11-49	7.5	0.38	-	-	None found
14-11-49	8	0.23	-	-	None found
21-11-49	8	0.32	-	-	None found
28-11-49	8.5	0.38	-	-	None found
5-12-49	8.5	0.07	-	-	None found
12-12-49	9	0.07	-	-	None found
19-12-49	9	0.25	-	-	None found
4- 1-50	9.5	2.31	-	-	None found
9- 1-50	10	0.22	-	-	None found
16- 1-50	10	0.90	-	-	None found
24- 1-50	10	0.39	0.52	64	None found
30- 1-50	10.5	0.56	0.65	59	Not cultured
2- 2-50	10.5	-	4.26	65	Not cultured

Macroscopic Description.

This quarter appeared to be involuting in most areas. There were small areas and foci of lobules still in lactation especially around Level 2.

Details of Teat.

Length 6 cm.; e.d. 3.5 cm. Teat Canal: Length 11 mm.; c.r. 12 mm.; c.o. 7 mm. The epithelium showed chronic inflammation. Teat Sinus: There were a few shallow pockets towards the rosette. There was an area about 5 mm. in diameter of scar tissue.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	16mc	14L5N 2L4N
1A	16mc	15L5N 1L4ma
1C	16mc	14L5N 2L4N
1D	16mc	13L5mc 2L5mod sa 1L3-4N
1E	16mc	6L5N 8L5mc 2L4ma
Level 1	16mc	10L5N 4L5mc 1L4-5ma 1L4N
3A	8mc 8N	16L3ma
3C	8mc 8N	8L5mc 4L3ma 4L3N
3D	8mc 8N	6L3ma 6L3N 4L5N
3E	8mc 8N	6L3ma 6L3N 4L5mc
Level 3	8mc 8N	9L3ma 3L5mc 3L3N 1L5N
<u>Quarter</u>		
<u>Summary</u>	12mc 4N	5L3-4ma 4L5mc 5L5N 2L3-4N
<u>Score</u>	<u>35 (20c 15A) 12D. 23L.</u>	

COW NO. 28 - Breed - Ayrshire. This cow had probably borne at least seven calves. Slaughtered 2-3-50. Last calving date 7-4-49.

NO. 28 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
27- 7-49	4	0.36	-	-	None found
30- 9-49	6	0.28	-	-	None found
12-12-49	8	0.11	0.03	-	None found
19-12-49	8	0.26	-	-	None found
27-12-49	8.5	0.06	0.05	-	None found
10- 1-50	9	0.03	0.01	-	None found
1- 3-50(A.T.)	11	-	0.38	34	Not cultured
1- 3-50(P.M.)	11	-	0.63	34	Not cultured

Macroscopic Description.

Most lobules in this quarter appeared to be in lactation. There were involuting lobules distributed throughout.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 11 mm.; c.r. 9 mm.; c.o. 8 mm. There were three ridges in the teat canal. Teat Sinus: There were two slight ridges.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4msa 12N	12L5N 4L4-5N
1A	8msa 8N	8L5N 8L4-5N
1C	8msa 8N	8L5mc 4L5N 4L4-5N
1D	4msa 12N	8L5mc 7L5N 1L4N
1E	2msa 14N	8L4N 8L4-5N
Level 1	5msa 11N	3L5mc 2L4N 7L4-5N 4L5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	2msa 14N	16L3N
3C	2msa 14N	16L3N
3D	2msa 14N	8L3N 8L5N
3E	2msa 14N	16L3N
<hr/>		
Level 3	2msa 14N	14L3N 2L5N
<hr/>		
<u>Quarter</u>		
<u>Summary</u>	4msa 12N	7L3N 1L4N 3L4-5N 3L5N 2L5mc
<u>Score</u>	<u>12 (4c 8sa) 8D. 4L.</u>	

NO. 28 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
27 -7-49	4	0.32	-	-	None found
30- 9-49	6	0.64	-	-	None found
12-12-49	8	0.05	0.05	-	None found
19-12-49	8	0.06	-	-	None found
27-12-49	8.5	0.14	0.15	36	None found
10- 1-50	9	0.03	0.01	-	None found
1- 3-50(A.T.)	11	-	0.75	37	Not cultured
1- 3-50(P.M.)	11	-	0.83	33	Not cultured

Macroscopic Description.

This was a lactating gland with large areas of involution especially in lower levels.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mc 8N	8L5mc 7L5N 1L4N
1A	8mc 8N	4L5mc 8L5N 4L4-5N
1C	8mc 8N	16L5mc
1D	16N	12L5N 4L4-5N
1E	16N	12L5mc 4L4-5N
Level 1	5mc 11N	8L5mc 3L4-5N 5L5N
3A	1mc 15N	16L4-5N
3C	4mc 12N	2L4-5N 14L5N
3D	4mc 12N	12L4-5N 4L5N
3E	16N	8L4N 8L5N
Level 3	2mc 14N	2L4N 8L4-5N 6L5N

Quarter Summary 4mc 12N 4L5mc 1L4N 6L4-5N 5L5N

Score 12 (12c) 4D. 8L.

NO. 28 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
27- 7-49	4	0.06	-	-	None found
30- 9-49	6	3.40	-	-	str.
12-12-49	8	9.20	12.0	79	str.
19-12-49	8	32.10	-	-	str.
10- 1-50	9	5.70	14.0	83	<u>Str. agalactiae</u>
1- 3-50 (A.T.)	11	-	10.0	59	Not cultured

Macroscopic Description.

This quarter was involuted.

Details of Teat.

Length 6 cm.; e.d. 2.5 cm. Teat Canal: Length
10 mm.; c.r. 7 mm.; c.o. 10 mm. The epithelium lining

the canal had lost its lustre and showed contracted scar tissue. The orifice was surrounded by four small sessile warts. One pedunculated wart lay across the orifice acting like a trap-door. Teat Sinus: There were no pockets nor longitudinal ridges. The epithelium was rough in parts.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - PS - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1 A	16mc	10L5N 6L5mc
1 C	16mod c	16L5N
1 D	16Sev c	4L5mc 11L5N 1L4msa
Level 1	5mc 6Sev c 5mod c	12L5N 4L5mc
3 A	16Sev sa	12L5Sev c 4L5N Evolution
3 C	16N	8L5Sev c 8L5N Evolution
Level 3	8Sev sa 8N	10L5Sev c 6L5N Evolution
<u>Quarter</u>	3Sev c 3mod c	5L5Sev c 2L5mc 9L5N
<u>Summary</u>	4Sev sa 2mc 4N	

Score 75 (51c 24sa) 41D. 34L.

NO. 28 RIGHT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
27- 7-49	4	0.06	-	-	None found
30- 9-49	6	1.20	-	-	str.
12-12-49	8	3.20	1.5	48	<u>Staph. aureus</u>
19-12-49	8	2.13	-	-	str.
27-12-49	8.5	15.60	20.0	93	<u>Staph. aureus</u> and str.
10- 1-50	9	4.20	2.05	67	<u>Staph. aureus</u> and <u>str.</u> <u>agalactiae</u>
1- 3-50 (A.T.)	11	-	20.8	81	Not cultured

Macroscopic Description.

This appeared to be an involuted quarter.

Details of Teat.

Length 6 cm.; e.d. 2.6 cm. There were four areas of sessile warts almost completely surrounding the orifice. They were covered with caseous epithelial debris. Teat Canal: Length of normal part 6 mm.; c.r. 9 mm.; at the constriction 5 mm. Between this constriction and the orifice the canal widened and the normal epithelium had been replaced entirely smooth scar tissue. Teat Sinus: There were no pockets nor lobules. There were three pedunculated warts 2 mm. long growing from the lining. The epithelium along the three longitudinal ridges showed keratinised squamous metaplasia. A knife grated harshly when scraped along these ridges.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - cns - Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	16Sev c	8L5mod c 2L4msa 6L4N
1A	16Sev c	14L5mod c 2L3-4msa
1C	16Sev c	14L5mod c 2L3-4msa
1E	16mod c	12L5mod c 4L3-4msa
Level 1	12Sev c 4mod c	12L5mod c 3L3-4msa 1L4N
3A	16mod c	4L5mc 12L5N Evolution
3C	16mc	16L5mc
3E	16mod c	8L5mc 8L5N Evolution
Level 3	11mod c 5mc	9L5mc 7L5N Evolution
<u>Quarter</u>	6Sev c 8mod c	6L5mod c 5L5mc 2L3-4msa
<u>Summary</u>	2mc	3L5N
<u>Score</u>	<u>78 (70c 8sa) 36D. 42L.</u>	

COW NO. 29 - Breed - Ayrshire. An aged cow. Last calved 5-7-48.

NO. 29 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-12-49	17	0.01	0.01	-	None found
12-12-49	17	0.14	0.05	-	<u>Staph. aureus</u> and str.
27-12-49	18	0.05	0.04	-	None found
10- 1-50	18	0.01	0.01	-	None found
23- 1-50	18.5	0.05	0.03	-	None found
30- 1-50	19	0.39	0.50	37	None found
1- 3-50 (A.T.)	20	-	5.31	62	Not cultured
1- 3-50 (P.M.)	20	-	3.52	72	Not cultured

Macroscopic Description.

This quarter was still in lactation in Level 3. The lacteral areas surrounding the larger ducts of lower levels were involuted.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 12 mm.; c.r. 10 mm.; c.o. 10 mm. Teat Sinus: The epithelium lacked lustre. There was slight keratinisation along the lower parts of the three slight longitudinal ridges. There were a few shallow pockets.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: cns - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mod c 12mc	16L5mc
1A	16mc	12L4-5msa 4L3-4N
1C	16mc	8L4-5msa 8L4-5N
1D	2mod c 12mc 2N	4L4ma 4L4N 4L5mc 4L5N
1E	16N	4L4ma 4L4N 4L5mc 4L5N
Level 1	1mod c 11mc 4N	2L4ma 4L4-5msa 5L5mc 2L3-4N 3L4-5N
3C	16mc	4L4-5msa 12L4-5N
3D	16N	4L4-5msa 12L4-5N
3E	16N	8L4-5msa 8L4-5N
Level 3	16N	5L4-5msa 11L4-5N
<u>Quarter Summary</u>	1mod c 6mc 9N	1L4ma 5L4-5msa 2L5mc 1L3-4N 7L4-5N
<u>Score</u>	<u>35 (12c 20sa 3A) 8D. 27L.</u>	

NO. 29 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-12-49	17	0.14	0.30	29	None found
12-12-49	17	0.15	0.04	-	None found
27-12-49	18	0.25	0.12	33	None found
10- 1-50	18	0.01	0.05	8	None found
23- 1-50	18.5	0.14	0.01	-	None found
30- 1-50	19	1.41	3.36	26	<u>Staph. aureus</u>
1- 3-50(A.T.)	20	-	4.18	40	Not cultured
1 -3-50(P.M.)	20	-	3.0	49	Not cultured

Macroscopic Description.

This quarter showed lactating lobules in the upper levels except in the caudo-lateral area where the lobules were involuted. Lower levels were involuted except for

groups of distended lobules near main ducts and gland sinus; these lobules were up to 6 mm. in diameter. About one third of the lobules were in lactation.

Details of Teat.

Length 7 cm.; e.d. 3 cm. Teat Canal: Length 12 mm.; c.r. 11 mm.; c.o. 9 mm. Half way along the canal there was a line of healed scar tissue running round the canal. Teat Sinus: This showed evidence of severe inflammation now healed. There were innumerable 0.5 mm. long nodules of squamous metaplasia especially along the three longitudinal folds and rims of the shallow pockets.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mod c 12mc	8L5Sev c 8L5N
1A	12mc 4N	6L4-5msa 10L4-5N
1C	16mc	4L4-5msa 12L5N
1D	8mc 8N	4L4-5msa 12L5N
1E	4mc 12N	4L4-5msa 12L4N
Level 1	1mod c 10mc 5N	2L5Sev c 3L4-5msa 5L4-5N 6L5N
3A	8mc 8N	6L4-5msa 10L4-5N
3C	2mc 12N	8L4-5msa 4L4N 4L5N
3E	16N	4L4msa 12L4N
3D	4mc 12N	4L4msa 8L4N 4L5N
Level 3	4mc 12N	6L4-5msa 7L4N 3L5N
<u>Quarter Summary</u>	8mc 8N	1L5Sev c 5L4-5msa 5L4N 5L5N
<u>Score</u>	<u>34 (14c 20sa) 8D. 26L.</u>	

NO. 29 RIGHT FORE QUARTER.Cell Counts.

This quarter was atrophied before 7-9-48. No milk was taken from the gland after that date. A few drops of fluid were obtained from the teat post-mortem and this contained about 5.4 million cells per ml. of which 86 per cent. were polymorphonuclear leucocytes.

Macroscopic Description.

This gland was almost entirely involuted and was atrophied.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: Length 9.0 mm.; c.r. 11.0 mm.; c.o. 9.0 mm. Teat Sinus: The entire lining was covered by nodules of squamous metaplasia less than 0.5 mm. in diameter. There was also an area of 0.5 cm. in diameter showing contracted scar tissue.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	8L5Sev c 7L5Sev sa 1L3Sev sa
1C	16N	8L5mod c 8L5N
1D	16N	8L5mod c 8L5N
1E	16N	8L5mod c 8L5N
Level 1	12N 4Sev c	2L5Sev c 6L5mod c 2L5Sev sa 6L5N
3C	16N	8L5mod c 8L5N
<u>Quarter Summary</u>	2Sev c 14N	1L5Sev c 7L5mod c 1L5Sev sa 7L5N

Score 52 (40c 12sa) 6D. 46L.

NO. 29 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-12-49	17	0.08	-	-	None found
12-12-49	17	1.33	0.86	25	(<u>Staph. aureus</u>
27-12-49	18	0.04	0.09	33	(and str.
10- 1-50	18	0.01	0.02	-	None found
23- 1-50	18.5	0.86	0.28	30	None found
30- 1-50	19	1.92	2.32	40	<u>Staph. aureus</u>
1- 3-50(A.T.)	20	-	6.00	46	Not cultured
1- 3-50(P.M.)	20	-	7.08	47	Not cultured

Macroscopic Description.

Parts of this gland were still lactating though in the caudo-lateral area in higher levels and in most areas of lower levels most lobules were involuted.

Details of Teat.

Length 8.0 cm.; e.d. 3.0 cm. Teat Canal: Length 14.0 mm.; c.r. 12.0 mm.; c.o. 7.0 mm. The epithelium of the distal half of the canal was changed to white scar tissue. Teat Sinus: There was slight keratinisation and squamous metaplasia along half of one longitudinal ridge.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16mod c	8L5mc 1L4msa 7L4-5N
1A	8mc 8N	4L3msa 4L3N 4L4msa 4L4N
1C	12mc 4N	16L5N
1D	4mc 12N	2L5mc 14L5N
1E	4mc 12N	1L4mod A 3L4msa 4L5mc 8L5N
Level 1	7N 3mod c 6mc	3L3-4msa 1L3-4N 3L5mc 9L5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3A	16N	4L4-5msa 4L4-5N 2L3msa 6L3N
3C	2mc 14N	4L5msa 12L5N
3D	6mc 10N	2L4mod A 6L4msa 8L5N
3E	16N	8L4N 8L5N
<hr/>		
Level 3	2mc 14N	5L4-5msa 1L3N 3L4N 7L5N
<hr/>		
<u>Quarter</u>		
<u>Summary</u>	2mod c 4mc 10N	4L4-5msa 1L3N 1L4N 2L5mc 8L5N
<u>Score</u>	<u>28 (12c 16sa) 8D. 20L.</u>	

COW NO. 34: Breed - Ayrshire. Fifth Lactation. Last two calvings were on 10-9-47 and 3-9-48.

NO. 34 LEFT FORE QUARTER.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-12-49	15	0.08	0.12	-	None found
20-12-49	15.5	0.04	0.21	61	Not cultured
9- 1-50	16	0.02	0.04	66	None found
17- 1-50	16.5	0.15	0.19	44	None found
26- 1-50	17	0.02	0.06	30	None found
30- 1-50	17	0.03	0.08	-	Non-haemolytic staph.
7- 2-50	17	0.17	0.11	-	None found
24- 2-50	17.5	0.01	0.01	-	Not cultured
7- 3-50	18	0.12	0.13	40	None found
14- 3-50(B.T.)	18	0.17	0.17	42	Not cultured
14- 3-50(A.T.)	18	-	1.23	40	Not cultured
14- 3-50(P.M.)	18	-	1.76	43	Not cultured

Macroscopic Description.

This gland was still in lactation. There were foci of involuted lobules in the lower half of the gland.

Details of Teat.

Length 6.5 cm.; e.d. 3.0 cm. Teat Canal: Length 12.0 mm.; c.r. and c.o. 10.0 mm. There were three longitudinal ridges. Teat Sinus: There were three

longitudinal ridges. There were a few pockets with edges overhanging. There was a row of abortive ducts extending under the gland sinus.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	12N 4mc	8L3-4N 8L5N
1A	16N	1L4-5msa 10L4N 5L5N
1C	16N	16L5N
1D	12N 4mc	2L4-5msa 14L5N
1E	16N	1L4-5msa 8L4N 7L5N
Level 1	2mc 14N	1L4-5msa 5L4N 10L5N
3A	16N	1L4-5msa 8L5N 7L4N
3C	16N	4L5mc 4L4msa 8L5N
3D	16N	2L5mc 2L4msa 2L4N 10L5N
3E	16N	1L4mod A 1L4msa 8L4N 4L5N
Level 3	16N	2L5mc 2L4-5msa 4L4N 8L5N
<u>Quarter Summary</u>	1mc 15N	2L4-5msa 1L5mc 4L4N 9L5N
<u>Score</u>	<u>11 (3c 8sa) 1D. 10L.</u>	

NO. 34 LEFT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-12-49	15	0.13	0.10	-	None found
20-12-49	15.5	0.10	0.15	38	Not cultured
9- 1-50	16	0.02	0.04	40	None found
17- 1-50	16.5	0.40	0.31	38	None found
26- 1-50	17	0.42	0.42	40	<u>Staph. aureus</u>

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
30- 1-50	17	0.29	0.57	30	Non-haem. staph.
7- 2-50	17	0.04	0.12	-	None found
24- 2-50	17.5	0.27	0.04	-	Not cultured
7- 3-50	18	0.37	0.22	37	None found
14-3 -50(B.T.)	18	0.61	0.55	37	Not cultured
14- 3-50(A.T.)	18	-	2.61	41	Not cultured
14- 3-50(P.M.)	18	-	6.25	41	Not cultured

Macroscopic Description.

Most of the lobules of this gland were in lactation. There were zones of focal involution in the lower two levels.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: Length 12.0 mm.; c.r. 12.0 mm.; c.o. 8.0 mm. There was a small scar in the epithelium near the rosette. Teat Sinus: The pockets here were shallower than in the left fore quarter.

Cultures from Frozen Udder Tissue.

Level 3: S - cns - S; Level 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mod c 8mc	4L4-5msa 8L5mc 4L5N
1A	8mod c 8mc	4L4-5msa 8L5mc 4L5N
1C	4mod c 4mc 8N	4L4-5msa 8L5mc 4L5N
1D	4mod c 12N	4L4-5msa 8L5mc 4L5mod c
1E	4mod c 12N	4L4-5msa 8L5mc 4L5mod c
Level 1	6mod c 4mc 6N	4L4-5msa 8L5mc 2L5mod c 2L5N
3A	1mc 15N	1L4-5ma 4L4-5msa 5L4N 6L5N
3C	4mc 12N	1L4-5msa 3L4N 12L5N
3D	16N	1L4-5ma 1L4-5msa 7L4N 7L5N
3E	16N	2L4-5msa 7L4N 7L5N
Level 3	1mc 15N	3L4-5msa 5L4N 8L5N

Quarter 3mod c 3mc 10N 3L4-5msa 4L5mc 1L5mod c
Summary 3L4N 5L5N

Score 33 (21c 12sa) 9D. 24L.

NO. 34 RIGHT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
13-12-49	15	0.18	0.14	-	None found
20-12-49	15.5	0.09	0.01	-	Not cultured
9- 1-50	16	0.05	0.01	-	None found
17- 1-50	16.5	0.04	0.08	-	None found
26- 1-50	17	0.07	0.12	23	None found
30- 1-50	17	0.17	0.67	27	Non-haem. staph.
7- 2-50	17	0.44	0.30	34	None found
24- 2-50	17.5	0.30	0.08	-	Not cultured
7- 3-50	18	0.94	0.64	49	None found
14- 3-50(B.T.)	18	0.94	0.73	38	Not cultured
14- 3-50(A.T.)	18	-	3.0	31	Not cultured
14- 3-50(P.M.)	18	-	4.0	36	Not cultured

Macroscopic Description.

Most of the lobules of this gland were in lactation. There were zones of focal involution in the lower two levels.

Details of Teat.

Length 6.0 cm.; e.d. 3.0 cm. Teat Canal: Length 10.0 mm.- c.r. 12.0 mm.- c.o. 8.0 mm. Teat Sinus:
 There were pockets present.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8msa 4mc 4mod c	2L5mc 12L4N 2L5N
1A	2msa 14N	2L4-5msa 4L5mc 2L4N 8L5N
1C	4msa 12N	2L4-5msa 4L5mc 10L5N
1D	4mod c 4msa 8N	2L4-5msa 14L5N
1E	8msa 8N	2L4-5msa 2L5mc 6L4N 6L5N
Level 1	2mod c 1mc 5msa	2L4-5msa 2L5mc 4L4N 8L5N
3A	16N	4L4msa 12L3-4N
3C	2msa 14N	2L4-5msa 4L5mc 10L5N
3D	16N	2L4-5msa 8L4N 6L5N
3E	16N	2L5msa 8L3-4N 6L5N
Level 3	16N	3L4-5msa 1L5mc 7L3-4N 5L5N
<u>Quarter Summary</u>	1mod c 1mc 3msa 9N	2L4-5msa 2L5mc 5L3-4N 7L5N

Score 21 (7c 14sa) 9D. 12L.

NO. 34 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
13-12-49	15	0.30	0.18	-	None found
20-12-49	15.5	0.04	0.04	27	Not cultured
9- 1-50	16	0.01	0.02	-	None found
17- 1-50	16.5	0.10	0.09	46	None found
26- 1-50	17	0.17	0.40	38	None found
30- 1-50	17	0.20	0.25	27	Non-haem. staph.
7- 2-50	17	0.31	0.20	28	None found
24- 2-50	17.5	0.08	0.12	50	Not cultured
7- 3-50	18	0.50	0.40	47	None found
14- 3-50(B.T.)	18	0.20	0.33	49	Not cultured
14- 3-50(A.T.)	18	-	1.55	32	Not cultured
14- 3-50(P.M.)	18	-	2.06	39	Not cultured

Macroscopic Description.

Most of the lobules of this gland were in lactation. There were zones of involuted lobules throughout.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: Length 12.0 mm.; c.r. 11.0 mm.; c.o. 8.0 mm. Teat Sinus: There were shallow pockets present.

Cultures from Frozen Udder Tissue.

Level 3: S - S - S; Level 1: S - cns - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
<u>Gland</u>		
sinus	8mod c 8msa	8L5mc 4L4msa 4L3-4N
1A	8mod c 8msa	8L5mc 4L4-5msa 4L5N
1C	4mod c 12N	8L5mc 2L4-5msa 6L5N
1D	4msa 12N	2L4-5msa 8L5mc 6L5N
1E	16N	3L4-5msa 4L5mc 9L5N
Level 1	4mod c 4msa 8N	7L5mc 3L4-5msa 1L4N 5L5N
3A	16N	2L4-5msa 14L4-5N
3C	16N	4L4-5msa 12L5mc
3D	16N	2L4-5msa 4L5mc 10L4-5N
3E	16N	1L4-5msa 15L4-5N
Level 3	16N	2L4-5msa 4L5mc 10L4-5N
<u>Quarter</u>		
<u>Summary</u>	2mod c 2msa 12N	6L5mc 3L4-5msa 7L4-5N
<u>Score</u>	<u>32 (16c 16sa) 8D. 24L.</u>	

COW NO. 39 - Breed - Ayrshire. 7th Lactation. Calving dates 4-3-48, 16-2-49 and 24-3-50.

NO. 39 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
18- 5-49	3	-	1.62	76	Not cultured
26- 9-49	7	0.78	-	-	None found
1- 5-50	1	0.52	0.33	80	<u>Staph. aureus</u>
3- 5-50 (B.T.)	1	0.01	0.26	78	<u>Staph. aureus</u>
4- 5-50 (A.T.)	1	1.29	2.16	71	<u>Staph. aureus</u>
4- 5-50 (P.M.)	1	-	1.66	71	Not cultured
4- 5-50 (P.M.)	1	-	2.60	70	Not cultured

Macroscopic Description.

This gland appeared to consist entirely of normal lactating tissue.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: Length 8.0 mm. on one half and 10.0 mm. on the other half; c.r. 12.0 mm.; c.o. 6.0 mm. Teat Sinus: There were no pockets. There were four slight longitudinal ridges. The distal 1.0 cm. of these showed yellow squamous metaplasia.

Cultures from Frozen Udder Tissue.

Level 2: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	8msa 8N	2L4Sev A 2L4-5ma 12L4-5N
2A	4msa 12N	1L4Sev A 15L4-5N
2C	4msa 12N	1L4-5mod A 15L4-5N
2D	8msa 8N	8L4ma 4L4Sev A 4L4N
2E	16msa	3L4Sev A 3L4ma 10L4-5N
Level 2	8msa 8N	2L4Sev A 3L4ma 11L4-5N

Quarter Summary 8msa 8N 2L4Sev A 3L4ma 11L4-5N

Score 49 (16sa 33A) 16D. 33L.

NO. 39 LEFT HIND QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
18- 5-49	3	-	0.30	54	Not cultured
26- 9-49	7	0.26	-	-	None found
1- 5-50	1	1.33	1.17	24	None found
3- 5-50 (B.T.)	1	1.02	1.50	33	None found
4- 5-50 (A.T.)	1	3.0	3.4	33	None found
4- 5-50 (P.M.)	1	-	4.6	21	Not cultured
4- 5-50 (P.M.)	1	-	7.5	40	Not cultured

Macroscopic Description.

Almost three-fourths of the lowest levels of this gland were involuted. In Levels 2 and 3 about half of the lobules were in lactation. There was a zone of fibrosis about 3 inches in diameter in the C area of these levels. The remaining lobules were involuted.

Details of Teat.

Length 5.0 cm.; e.d. 2.5 cm. Teat Canal: Length 9.0 mm.; c.r. 10.0 mm.; c.o. 7.0 mm. Teat Sinus: There were four slight longitudinal ridges and no pockets.

Cultures from Frozen Udder Tissue.

Level 2: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	12mod c 4mc	8L4N 8L5mc
2A	16msa	8L4msa 2L5mc 6L4N
2B	16msa	12L4msa 2L4mod c 2L4N
2C	16msa	8L4-5msa 8L5mod c
Level 2	3mod c 1mc 12msa	7L4-5msa 3L5mod c 2L5mc 4L4N

Quarter

Summary 3mod c 1mc 12msa 7L4-5msa 3L5mod c 2L5mc 4L4N

Score 75 (23c 52sa) 31D. 44L.

NO. 39 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
18- 5-49	3	-	0.18	33	Not cultured
26- 9-49	7	0.14	-	-	None found
1- 5-50	1	0.14	0.47	41	<u>Staph. aureus</u>
3- 5-50 (B.T.)	1	0.31	1.1	85	<u>Staph. aureus</u>
4- 5-50 (A.T.)	1	5.7	8.0	81	<u>Staph. aureus</u>
4- 5-50 (P.M.)	1	-	12.0	91	Not cultured
4- 5-50 (P.M.)	1	-	11.1	87	Not cultured

Macroscopic Description.

This gland appeared to consist of normal lactating tissue throughout.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: The proximal edge of the epithelium of the canal was indented so that the length varied from 6.0 to 10.0 mm.; c.r. 9.0 mm.; c.o. 7.0 mm. Teat Sinus: There were four small longitudinal ridges and no pockets.

Cultures from Frozen Udder Tissue.

Level 2: S - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	16Sev sa	2L4mod A 4L5msa 6L4-5N 4L5N
2A	16msa	1L4mod A 5L4-5msa 11L4-5N
2C	16msa	3L4mod A 5L4-5msa 8L4-5N
2D	5Sev A 11msa	1L4mod A 12L4-5msa 3L4-5N
2E	16msa	1L4mod A 8L4-5msa 7L4-5N

Quarter Summary 1Sev A 3Sev sa 2L4mod A 7L4-5msa 7L4-5N
12msa

Score 94 (70sa 24A) 54D. 40L.

NO. 39 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
18-5-49	3	-	2.1	80	Not cultured
26-9-49	7	0.42	-	-	<u>Staph. aureus</u>
1-5-50	1	0.24	0.28	76	<u>Staph. aureus</u>
3-5-50 (B.T.)	1	0.23	0.35	83	<u>Staph. aureus</u>
4-5-50 (A.T.)	1	2.58	2.7	84	<u>Staph. aureus</u>
4-5-50 (P.M.)	1	-	4.5	80	Not cultured
4-5-50 (P.M.)	1	-	6.0	73	Not cultured

Macroscopic Description.

This gland appeared to consist of normal lactating tissue throughout.

Details of Teat.

Length 6.5 cm.; e.d. 2.5 cm. Teat Canal: Length 10.0 mm.; c.r. 9.0 mm.; c.o. 8.0 mm. Teat Sinus: There were four slight longitudinal ridges and no pockets.

Cultures from Frozen Udder Tissue.

Level 2: S - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16msa	4L4msa 12L4-5N
2C	4mod c 12msa	4L4msa 12L4-5N
2D	16msa	2L4Sev A 6L4-5msa 8L4-5N
2E	16N	4L4-5msa 12L4-5N

Quarter 4Sev c 9msa 3N 1L4mod A 3L4-5msa
Summary 3L5mod c 9L4-5N

Score 60 (24c 30sa 6A) 30D. 30L.

COW NO. 40 - Breed - British Friesian. Aged 14 years.
 10th Lactation. Calved 7-4-49.

NO. 40 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
8-11-49	7	0.14	-	-	None found
Treated with intramammary penicillin early in 1950.					
1- 2-50	10	0.40	-	-	<u>Staph. aureus</u>
8- 2-50	10	0.50	0.20	74	Not cultured
14- 2-50	10	0.40	-	-	None found
22- 2-50	10.5	0.25	0.10	-	None found
15- 5-50	13	0.34	0.22	50	<u>Staph. aureus</u>
16- 5-50	13	-	0.50	92	Not cultured
17- 5-50(B.T.)	13	-	0.19	88	Not cultured
17- 5-50(A.T.)	13	-	1.0	90	Not cultured
17- 5-50(P.M.)	13	-	0.77	83	Not cultured

Macroscopic Description.

This gland appeared to be normally lactating throughout.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	12L5mc 4L4N
1A	16msa	4L5mod c 8L4msa 4L4-5N
1C	16msa	4L5mc 8L4msa 4L4N
1D	16msa	2L5mc 8L4msa 6L4N
1E	16msa	8L5mc 4L4msa 1L4Sev sa 3L4N
Level 1	16msa	1L5mod c 5L5mc 6L4msa 4L4N
3C	4msa 12N	16L3N
3D	2msa 14N	4L4-5msa 12L4N
3E	4msa 12N	4L4msa 4L5mc 8L4N
Level 3	3msa 13N	1L5mc 3L4msa 5L3N 7L4N
<u>Quarter Summary</u>	10msa 6N	4L5mc 5L4msa 2L3N 5L4N
<u>Score</u>	<u>48 (8c 40 sa) 20D. 28L.</u>	

NO. 40 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-11-49	7	0.18	-	-	None found
Treated with intramammary penicillin early in 1950.					
1- 2-50	10	0.08	-	-	None found
8- 2-50	10	0.26	0.12	75	Not cultured
14- 2-50	10	0.52	-	-	None found
22- 2-50	10.5	0.06	0.02	-	None found
15- 5-50	13	0.20	0.23	52	<u>Staph. aureus</u>
16- 5-50	13	-	0.41	87	Not cultured
17- 5-50 (B.T.)	13	-	0.08	54	Not cultured
17- 5-50 (A.T.)	13	-	0.50	80	Not cultured
17- 5-50 (P.M.)	13	-	0.90	78	Not cultured

Macroscopic Description.

This gland appeared to be in normal lactation except for Area C of Level 1 which was involuted, firm and dry.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mc 12N	16L5N
1C	16mc	8L5mod c 8L5mc
1D	16mc	4L4msa 6L5mod c 6L5mc
1E	4mc 12N	8L4msa 4L5mc 4L4N
Level 1	10mc 6N	3L4msa 4L5mod c 4L5mc 4L5N 1L4N
3A	16mc	2L5mod c 1L4Sev A 5L4ma 3L4N 5L4msa
3C	8mc 8N	8L5msa 8L5N
3D	8Sev c 8mc	1L4mod A 2L4msa 13L4N
3E	16mc	14mod A 4L4msa 1L5mc 10L4N
Level 3	2Sev c 12mc 2N	1L4mod A 2L4ma 1L5mod c 4L4msa 6L4N 2L5N
<u>Quarter Summary</u>	1Sev c 11mc 4N	2L4ma 2L5mod c 2L5mc 4L4msa 3L4N 3L5N
<u>Score</u>	<u>48 (26c 16sa 6A) 14D. 34L.</u>	

NO. 40 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-11-49	7	0.14	-	-	None found
Treated with intramammary penicillin early in 1950.					
1- 2-50	10	0.16	-	-	None found
8- 2-50	10	0.37	0.35	85	Not cultured

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
14- 2-50	10	0.18	-	-	None found
22- 2-50	10.5	0.27	0.19	86	<u>Staph. aureus</u>
15- 5-50	13	0.15	0.40	80	<u>Staph. aureus</u>
16- 5-50	13	-	0.65	90	Not cultured
17- 5-50(B.T.)	13	-	0.20	70	Not cultured
17- 5-50(A.T.)	13	-	0.54	92	Not cultured
17- 5-50(P.M.)	13	-	0.88	71	Not cultured

Macroscopic Description.

This gland appeared to be in normal lactation throughout.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	16mod c	4L4-5mc 4L4msa 8L4N
1C	16mod c	8L4-5mod sa 2L4msa 6L4-5N
1D	16mod c	12L4-5mod sa 4L4-5msa
1E	16mod c	6L5mod sa 10L4-5mc
Level 1	16mod c	6L4-5mod sa 4L4-5mc 3L4-5msa 3L4-5N
3C	16msa	1L4-5msa 15L4-5N
3D	8msa 8N	1L4ma 15L4-5N
3E	16msa	1L4-5msa 15L4-5N
Level 3	13msa 3N	1L4-5msa 15L4-5N
<u>Quarter Summary</u>	8mod c 7msa 1N	3L4-5mod sa 2L4-5msa 2L4-5mc 9L4-5N
<u>Score</u>	<u>66 (4c 62sa) 30D. 36L.</u>	

NO. 40 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
8-11-49	7	0.80	-	-	<u>Staph. aureus</u>
Treated with intramammary penicillin early in 1950.					
1- 2-50	10	0.12	-	-	None found
8- 2-50	10	0.16	0.14	50	Not cultured
14- 2-50	10	0.11	-	-	None found
22- 2-50	10.5	0.16	0.11	20	None found
15- 5-50	13	0.06	0.09	76	<u>Staph. aureus</u>
16- 5-50	13	-	0.37	85	Not cultured
17- 5-50(B.T.)	13	-	0.54	86	Not cultured
17- 5-50(A.T.)	13	-	0.32	77	Not cultured
17- 5-50(P.M.)	13	-	0.52	80	Not cultured

Macroscopic Description.

This gland appeared to be in normal lactation except for Area C of Level 1 which was involuted, firm and dry.

Details of Teat.

Teat not available.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	16L5N
1A	8mod c 8msa	4L5mod c 2L4-5msa 10L4-5N
1C	16mod c	14L5mod c 2L4-5N
1D	8mod c 8msa	12L5mod c 3L4-5N 1L4-5msa
1E	16msa	12L5mod c 3L4-5N 1L4-5msa
Level 1	6mod c 10msa	8L5mod c 7L4-5N 1L4-5msa

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
3C	4msa 12N	8L5mc 8L4-5msa
3D	16msa	2L5mc 8L4-5msa 6L4-5N
3E	16msa	2L4Sev A 4L4ma 10L4-5N
<hr/>		
Level 3	12msa 4N	3L5mc 5L4-5msa 1L4ma 1L4Sev A 5L4-5N
<hr/>		
<u>Quarter</u>	3mod c 11 msa	4L5mod c 2L5mc 3L4-5msa
<u>Summary</u>	2N	6L4-5N 1L4mod A
<u>Score</u>	<u>66 (26c 34sa 6A) 28D. 38L.</u>	

COW NO. 44 - Breed - British Friesian. Calved February 1948, 6-4-49 and 16-8-50. Slaughtered 30-8-50. Fifth Lactation. Total yield in Fourth Lactation: 1,500 gallons at 3.47 per cent. B.F.

NO. 44 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
18-10-49	6.5	0.26	-	-	None found
27-10-49	6.5	0.12	-	-	None found
11- 1-50	9	0.01	-	-	None found
9- 5-50	13	2.7	-	-	None found
28- 8-50	0.5	0.27	0.54	53	<u>Staph. aureus</u>
30- 8-50(B.T.)	0.5	0.08	0.10	62	None found
30- 8-50(A.T.)	0.5	-	0.36	53	Not cultured
30- 8-50(P.M.)	0.5	-	0.79	67	Not cultured

Macroscopic Description.

This quarter appeared to be in lactation except in Level 1 and parts nearer to the teat in which about half of the lobules appeared to be involuted. They were firmer and a deeper orange than the lactating tissue. There was an area of about 1 sq. cm. in which the lobules were brick-red.

Details of Teat.

Length 6.0 cm.; e.d. 4 cm.; on the medial side there were five deep cuts about 2 cm. long as though the teat had been wounded by barbed wire. Teat Canal: Length 8.0 mm.; c.r. 8 mm.; c.o. 6.0 mm. Teat Sinus: The epithelium was lustreless. There were two slight longitudinal ridges. There were four oval pockets near the gland sinus about 7 mm. long. There was squamous metaplasia in the epithelium in the proximal half of the sinus.

Cultures from Frozen Udder Tissue.

Levels 2 and 1: S - cns - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8Sev c 8mod c	4L4ma 4L5mod c 8L4msa
1A	8mod c 8msa	8L5mc 8L4-5msa
1C	4mod c 12mc	8L4-5msa 4L5Sev c 4L5mc
1D	16Sev c	4L5mc 8L4-5msa 4L4-5N
1E	16msa	4L5mod A 8L4-5msa 1L4mod A 3L4N
Level 1	5Sev c 4mod c 4msa 3mc	1L5Sev c 1L5mod c 3L5mc 8L4-5msa 2L4-5ma 1L4N
2A	16N	16L4N
2C	16N	15L4N 1L4msa
2D	4mod c 12msa	8L4-5N 8L4-5msa
2E	16N	1L4-5msa 15L4-5N
Level 2	1mod c 3msa 12N	14L4-5N 2L4msa
3A	4msa 12N	16L4N
3D	4msa 12N	4L4-5msa 12L4-5N
Level 3	4msa 12N	2L4-5msa 14L4-5N
<u>Quarter Summary</u>	2Sev c 1mod c 1mc 4msa 8N	4L4-5msa 1L4-5ma 1L5mod c 1L5mc 9L4-5N
<u>Score</u>	<u>42 (15c 24sa 3A) 17D. 25L.</u>	

NO. 44 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
18-10-49	6.5	0.78	-	-	None found
27-10-49	6.5	1.02	-	-	None found
11- 1-50	9	0.06	-	-	None found
9- 5-50	13	1.98	-	-	None found
28- 8-50	0.5	0.01	0.06	21	None found
30- 8-50(B.T.)	0.5	0.10	0.04	97	None found
30- 8-50(A.T.)	0.5	-	0.14	88	Not cultured
30- 8-50(P.M.)	0.5	-	0.66	82	Not cultured

Macroscopic Description.

This quarter appeared to be in lactation except in part of the C area which was involuted.

Details of Teat.

Length 5 cm.; e.d. 3.5 cm. Teat Canal: Length 8 mm.; c.r. 8 mm.; c.o. 6 mm. Teat Sinus: Ridges and pockets were absent. Supernumerary Gland: This was medio-caudal to the left hind quarter. The ducts of the supernumerary gland contained pus. The teat was 6 cm. behind the left hind teat. Details of Supernumerary Teat: Length 2 cm.; e.d. 1.5 cm. Teat Canal: Length 7.0 mm.; c.r. 5 mm.; c.o. 3 mm. Teat Sinus: There were three slight longitudinal ridges. Ten orange lobules 2 mm. in diameter were distributed over the sinus.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S; Level 2: cns - cns - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	12msa 2mc 2N	8L4-5N 4L4N 4L5N
1A	8mc 8N	2L4msa 14L4N
1E	16msa	1L4ma 1L4msa 14L4N
Level 1	9msa 4mc 3N	1L4msa 11L4N 4L4-5N

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	16msa	1L4msa 15L4-5N
2C	8msa 8N	8L4-5N 4L4msa 4L5N
Level 2	12msa 4N	2L5N 3L4msa 11L4-5N
3A	4msa 12N	2L4ma 2L4msa 12L4-5N
3E	16N	7L4-5msa 1L4ma 8L4-5N
Level 3	2msa 14N	2L4ma 4L4-5msa 10L4-5N
<u>Quarter</u>		
<u>Summary</u>	1mc 7N 8msa	3L4-5msa 9L4-5N 4L4N
<u>Score</u>	<u>29 (1c 28sa) 17D. 12L.</u>	

NO. 44 RIGHT FORE QUARTER.

No milk was available from this quarter.

Macroscopic Description.

All ducts of all 50 slices of this quarter contained green pus. In an area 7 cm. by 6 cm. of Level 3 there were nine abscesses, most of which were about 1 cm. in diameter. The abscesses were all filled with thick green stinking pus. All lobules in this quarter appeared to be involuted.

Details of Teat.

Length 6.0 cm.; e.d. 4.0 cm. Teat Canal: Length 10.0 mm.; c.r. 10 mm.; c.o. 7.0 mm. Teat Sinus: Ridges and pockets were absent. The entire epithelium appeared to show keratinised squamous metaplasia which grated harshly when scraped by a knife.

Cultures from Frozen Udder Tissue.

Level 3: S - Corynebacterium pyogenes - S;
 Level 2: C. pyogenes - C. pyogenes - S; Level 1: S -
 S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16Sev c	16L5N
1A	16Sev c	4L5Sev c 4L4Sev A 6L4-5msa
1D	16Sev c	4L5Sev c 4L4Sev A 8L4-5msa
1E	4msa 12N	8L5Sev c 8L4-5msa
Level 1	12Sev c 1msa 3N	4L5Sev c 2L4Sev A 6L4-5msa 4L4-5N
2A	16Sev c	6L5Sev c 10L4-5msa
2B	8Sev c 8msa	4L4Sev A 6L5Sev c 6L4-5msa
2C	4Sev c 12N	8L5Sev c 8L4-5msa
3C	16msa	8L5Sev c 8L4-5msa
Level 2	7Sev c 6msa 3N	7L5Sev c 1L4Sev A 8L4-5msa
<u>Quarter Summary</u>	10Sev c 3msa 3N	5L5Sev c 2L4Sev A 7L4-5msa 2L4-5N
<u>Score</u>	<u>118 (60c 34sa 24A) 36D. 82L.</u>	

NO. 44 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
18-10-49	6.5	0.18	-	-	None found
27-10-49	6.5	0.66	-	-	None found
11- 1-50	9	0.01	-	-	None found
9- 5-50	13	2.50	-	-	None found
28- 8-50	0.5	0.14	0.25	67	None found
30- 8-50(B.T.)	0.5	0.20	0.53	80	None found
30- 8-50(A.T.)	0.5	-	0.72	69	Not cultured
30- 8-50(P.M.)	0.5	-	1.60	79	Not cultured

Macroscopic Description.

Almost half of the lobules of Levels 2 and 3 and all lobules of Level 1 appeared to be involuted. The

other lobules appeared still to be lactating to a small extent.

Details of Teat.

Length 6.0 cm.; e.d. 3.5 cm. Teat Canal: Length 8 mm.; c.r. 8.0 mm.; c.o. 6.0 mm. There were three longitudinal ridges in the canal lining. Teat Sinus: There were three slight longitudinal ridges. The lining was smooth and pockets were absent.

Cultures from Frozen Udder Tissue.

All three levels: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16msa	8L4-5msa 4L5mc 4L4-5N
1A	4mod c 12msa	1L4m A 15L4msa
1E	4mod c 12msa	8L5mc 8L4-5msa
Level 1	3mod c 13msa	4L5mc 11L4-5msa 1L4-5N
2A	4msa 12N	1L4-5msa 15L4-5N
2C	16msa	8L4-5msa 8L5mc
2E	16msa	4L5mc 4L5N 8L4N
Level 2	12msa 4N	3L4-5msa 4L5mc 9L4-5N
3E	8msa 8N	4L4-5msa 10L4-5N 2L4mc
3C	4msa 12N	12L4-5msa 4L4-5N
3D	12msa 4N	8L4-5msa 4L5mc 4L4-5N
Level 3	8msa 8N	8L4-5msa 2L5mc 6L4-5N
<u>Quarter Summary</u>	11msa 1 mod c 4N	7L4-5msa 4L5mc 5L4-5N
<u>Score</u>	<u>60 (10c 50sa) 24D. 36L.</u>	

COW NO. 46 - Breed - Ayrshire. Lactation: 7th (at least). Last three calving dates 9-4-47, 11-7-48 and 7-8-49.

NO. 46 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	11	0.13	-	-	None found
13- 3-50	7	0.22	0.45	84	Do.
21- 3-50	7.5	-	0.83	90	Do.
27- 3-50	7.5	0.52	0.21	72	Do.
29- 3-50	8	-	0.42	85	Do.
3- 4-50	8	0.51	1.36	65	Do.
12- 4-50	8	-	0.71	86	Do.
27- 4-50	8.5	-	0.02	-	Do.
2- 5-50	9	-	0.60	84	Do.
8- 5-50	9	0.17	0.18	48	Do.
15- 5-50	9	0.25	0.52	53	Do.
23- 5-50	9.5	-	0.34	61	Do.
29- 5-50	9.5	0.13	0.32	48	Do.
5- 6-50	10	0.28	0.17	34	Do.
12- 6-50	10	0.27	0.12	16	Do.
19- 6-50	10.5	0.16	-	-	Do.
26- 6-50	10.5	0.26	-	-	Do.
3- 7-50	11	0.41	-	-	Do.
10- 7-50	11	0.04	-	-	Do.
18- 7-50	11.5	0.31	-	-	Do.
24- 7-50	11.5	0.14	-	-	Do.
30- 7-50	12	0.16	-	-	Do.
7- 8-50	12	0.16	-	-	Do.
14- 8-50	12	0.66	-	-	Do.
21- 8-50	12.5	1.1	-	-	Do.
28- 8-50	12.5	0.49	-	-	Do.
4- 9-50	13	0.44	-	-	Do.
26- 9-50	13.5	3.54	-	-	Do.
2-10-50	14	1.2	-	-	Do.
9-10-50	14	0.46	-	-	Do.
12-10-50(A.T.)	14	-	0.90	77	Not cultured
12-10-50(P.M.)	14	-	2.20	61	Do.

Macroscopic Description.

This quarter was secreting only half the amount of

milk secreted by each of the other three quarters. Most of the lobules were involuted. In Level 3 half the lobules were still in lactation; in Level 2 only a third and in Level 1 only one sixth were in lactation.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 c.m. Teat Canal: Length 8.0 mm.; c.r. 8.0 mm.; c.o. 6.0 mm. The epithelium at the ends of the canal was very indefinite and merged gradually into the adjacent epithelia. Teat Sinus: About 4 cm. above the rosette there was a horizontal thickened fold of the epithelium. Towards the gland sinus there were three 1.0 cm. deep pockets which appeared to be abortive ducts. Cow No. 46 was the only animal in which such pockets were found.

Cultures from Frozen Udder Tissue.

All three levels: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	16N	1L4mod A 15L4-5N
1A	16N	1L4m A 15L5N
1C	16N	1L4m A 15L5N
1E	16N	1L4m A 15L5N
Level 1	16N	4L4-5N 11L5N 1L4m A
2A	16N	16L5N
2C	16N	16L5N
3A	16N	8L4-5N 8L5N
Levels 2 & 3	16N	3L4-5N 13L5N
<u>Quarter Summary</u>	16N	3L4-5N 1L4m A 12L5N
<u>Score</u>	<u>3 (3A) 3L.</u>	

NO. 46 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	11	0.01	-	-	None found
13- 3-50	7	0.21	0.25	90	<u>Staph. aureus</u>
21- 3-50	7.5	-	0.60	88	None found
27- 3-50	7.5	0.35	0.14	-	<u>Staph. aureus</u>
29- 3-50	8	-	0.21	90	<u>Staph. aureus</u>
3- 4-50	8	-	0.16	-	None found
12- 4-50	8	-	0.17	90	Do.
27- 4-50	8.5	-	0.26	66	Do.
2- 5-50	9	-	0.35	81	Do.
8- 5-50	9	0.14	0.10	80	Do.
15- 5-50	9	0.66	1.22	80	Do.
23- 5-50	9.5	-	0.84	83	Do.
29- 5-50	9.5	0.29	0.40	68	Do.
5- 6-50	10	0.47	0.35	69	Do.
12- 6-50	10	0.43	0.20	40	Do.
19- 6-50	10.5	0.13	-	-	Do.
26- 6-50	10.5	0.51	-	-	Do.
3- 7-50	11	0.86	-	-	Do.
10- 7-50	11	0.30	-	-	Do.
18- 7-50	11.5	0.42	-	-	Do.
24- 7-50	11.5	0.20	-	-	Do.
30- 7-50	12	0.24	-	-	Do.
7- 8-50	12	0.21	-	-	Do.
14- 8-50	12	0.58	-	-	Do.
21- 8-50	12.5	1.02	-	-	Do.
28- 8-50	12.5	0.62	-	-	Do.
4- 9-50	13	1.16	-	-	Do.
26- 9-50	13.5	1.83	-	-	Do.
2-10-50	14	1.16	-	-	Do.
9-10-50	14	0.38	-	-	Do.
12-10-50(A.T.)	14	-	2.00	86	Not cultured
12-10-50(P.M.)	14	-	2.72	80	Do.

Macroscopic Description.

This gland appeared to be normal and in lactation except in C area of all levels in which most lobules were involuted.

Details of Teat.

Length 6.0 cm.; e.d. 3.0 cm. Teat Canal: Length 9.0 mm.; c.r. 8.0 mm.; c.o. 6.0 mm. Teat Sinus: There were six large pockets from 1-2 cm. deep in the proximal half. There was an area of squamous metaplasia about 2 cm. in diameter near the distal end of the sinus.

Cultures from Frozen Udder Tissue.

Levels 3 and 1: S - S - S; Level 2: S - Str. bovis - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8mod c 8N	6L4-5msa 10L5N
1A	16N	16L5N
2A	16N	1L4-5msa 7L4-5N 8L5N
2C	16N	8L5N 8L5mc
3A	16N	10L5N 6L4-5N
3C	16N	8L5N 8L5mc
3E	16N	16L4-5N
<u>Quarter Summary</u>	1mod c 15N	4L4-5N 9L5N 2L5mc 1L4-5msa
<u>Score</u>	<u>10 (6c 4sa) 2D. 8L.</u>	

NO. 46 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
15- 3-48	11	0.24	-	-	<u>Staph. aureus</u>
13- 3-50	7	0.25	0.28	82	None found
21- 3-50	7.5	-	0.62	84	Do.
27- 3-50	7.5	0.30	0.03	-	Do.
29- 3-50	8	-	0.40	92	Do.
3- 4-50	8	0.09	0.27	66	Do.
12- 4-50	8	-	0.21	77	Do.
27- 4-50	8.5	-	0.10	-	Do.
2- 5-50	9	-	0.23	78	Do.
8- 5-50	9	0.12	0.09	66	Do.
15- 5-50	9	0.23	0.19	62	Do.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
23- 5-50	9.5	-	0.07	-	None found
29- 5-50	9.5	0.03	0.23	46	Do.
5- 6-50	10	0.14	0.11	60	Do.
12- 6-50	10	0.12	0.04	-	Do.
19- 6-50	10.5	0.10	-	-	Do.
26- 6-50	10.5	0.38	-	-	Do.
3- 7-50	11	0.55	-	-	Do.
10- 7-50	11	0.14	-	-	Do.
18- 7-50	11.5	0.05	-	-	Do.
24- 7-50	11.5	0.04	-	-	Do.
30- 7-50	12	0.07	-	-	Do.
7- 8-50	12	0.01	-	-	Do.
14- 8-50	12	0.10	-	-	Do.
21- 8-50	12.5	0.47	-	-	Do.
28- 8-50	12.5	0.21	-	-	Do.
4- 9-50	13	0.14	-	-	Do.
26- 9-50	13.5	1.65	-	-	Do.
2-10-50	14	0.90	-	-	Do.
9-10-50	14	0.25	-	-	Do.
12-10-50(A.T.)	14	-	0.50	76	Not cultured
12-10-50(P.M.)	14	-	1.20	62	Do.

Macroscopic Description.

In Level 1 all lobules were involuted. In Levels 2 and 3 respectively three quarters and one quarter of all lobules were involuted. The remainder appeared to be secreting small quantities of milk.

Details of Teat.

Length 7.0 cm.; e.d. 3 cm. Teat Canal: Length 9.0 mm.; c.r. 8.0 mm.; c.o. 6.0 mm. Teat Sinus: There were two horizontal ridges under the epithelium lining this sinus. Longitudinal ridges were absent. Although there were depressions in the epithelium the deep pockets found in the other three teats of this cow were absent.

Cultures from Frozen Udder Tissue.

Levels 3 and 2: S - S - S; Level 1: cns - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	2mod c 14N	16L5N
1A	16N	16L5N
1C	16N	16L5N
2A	1msa 15N	12L5N 4L4N
2D	16N	15L4-5N 1L4msa
3A	16N	2L4m A 1L4msa 13L4-5N
3E	16N	16L4-5N

Quarter Summary 16N 1L4msa 6L4-5N 9L5N

Score 4 (4sa) 4L.

NO. 46 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
15- 3-48	11	0.07	-	-	None found
13- 3-50	7	0.09	0.16	90	Do.
21- 3-50	7.5	-	0.30	85	Do.
27- 3-50	7.5	0.35	0.16	-	Do.
29- 3-50	8	-	0.30	88	<u>Staph. aureus</u>
3- 4-50	8	0.06	-	-	None found
12- 4-50	8	-	0.08	-	Do.
27- 4-50	8.5	-	0.09	-	Do.
2- 5-50	9	-	0.37	76	Do.
8- 5-50	9	0.10	0.11	48	Do.
15- 5-50	9	0.26	0.10	60	Do.
23- 5-50	9.5	-	0.03	-	Do.
29- 5-50	9.5	0.04	0.18	48	Do.
5- 6-50	10	0.12	0.14	72	Do.
12- 6-50	10	0.14	0.13	40	Do.
19- 6-50	10.5	0.04	-	-	Do.
26- 6-50	10.5	0.02	-	-	Do.
3- 7-50	11	0.34	-	-	Do.
10- 7-50	11	0.12	-	-	Do.
18- 7-50	11.5	0.07	-	-	Do.
24- 7-50	11.5	0.10	-	-	Do.
30- 7-50	12	0.02	-	-	Do.
7- 8-50	12	0.01	-	-	Do.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
14- 8-50	12	0.12	-	-	None found
21- 8-50	12.5	0.17	-	-	Do.
28- 8-50	12.5	0.19	-	-	Do.
4- 9-50	13	0.33	-	-	Do.
26- 9-50	13.5	1.18	-	-	Do.
2-10-50	14	0.60	-	-	Do.
9-10-50	14	0.39	-	-	Do.
12-10-50(A.T.)	14	-	0.71	74	Not cultured
12-10-50(P.M.)	14	-	0.97	70	Not cultured

Macroscopic Description.

All lobules in Level 3 and one sixth of those of Level 2 were still in lactation. The remainder were involuted.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 cm. Teat Canal: Length 11.0 mm.; c.r. 8.0 mm.; c.o. 8.0 mm. Teat Sinus: There were six deep pockets in this teat. The openings of three were situated about 15 mm. from the canal. These openings were about 3.0 mm. in diameter. The longest pocket was 3.0 cm.

Cultures from Frozen Udder Tissue.

All three levels: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	8msa 8N	8L4-5N 8L4-5msa
2A	16N	16L4-5N
2B	16N	16L4-5N
2C	16N	12L4-5N 4L4-5msa
3A	16N	16L4-5N
3C	16N	16L4-5N
3E	16N	16L4-5N

Quarter Summary 1msa 15N 14L4-5N 2L4-5msa

Score 10 (10sa) 2D. 8L.

COW NO. 47 - Breed - Ayrshire. Lactation: Fifth at least; an aged cow. Calved 9-2-50.

NO. 47 LEFT FORE QUARTER.

No milk obtainable from this quarter.

Macroscopic Description.

This quarter was atrophied and appeared to be involuted except for scattered periductal lobules in all levels. The gland was about only one sixth the volume of the left hind quarter.

Details of Teat.

Length 7 cm.; e.d. 2.5 cm. Teat Canal: Length 9.0 mm.; c.r. 8.0 mm.; c.o. 8.0 mm. Teat Sinus: This was fibrosed and surrounded an abscess containing thick yellow odourless pus. The abscess was 6.0 cm. long and about 1.0 cm. in diameter.

Cultures from Frozen Udder Tissue.

Level 2: S - S - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	8mc 8N	15L5mod c 1L4-5N
1C	2mc 14N	16L5Sev c
<u>Quarter Summary</u>	5mc 11N	8L5Sev c 8L5mod c
<u>Score</u>	<u>85 (85c) 5D. 80L.</u>	

NO. 47 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
20- 3-50	1.5	0.5	-	-	None found
12- 6-50	4	2.04	-	-	<u>Staph. aureus</u>
21- 6-50	4.5	1.44	-	-	<u>Staph. aureus</u> and str.
26- 6-50	4.5	1.53	-	-	None found
6- 7-50	5	0.96	-	-	<u>Staph. aureus</u> and str.
10- 7-50	5	0.64	-	-	None found
25- 7-50	5.5	1.68	-	-	Not cultured
31- 7-50	6	1.38	-	-	<u>Staph. aureus</u>
16-10-50	8	1.95	-	-	<u>Staph. aureus</u>
18-10-50(A.T.)	8	-	5.5	51	Not cultured
19-10-50(P.M.)	8	-	7.5	78	Not cultured

Macroscopic Description.

About half of the lobules of Levels 1 and 3 appeared to be still lactating. Almost seven eighths of Level 2 were in lactation.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 cm. Teat Canal: Length 15 mm.; c.r. 10 mm.; c.o. 8 mm. Teat Sinus: Almost the entire lining of the sinus consisted of healed scar tissue. This is evidence of past severe mastitis.

Cultures from Frozen Udder Tissue.

Levels 3 and 2: S - S - S; Level 1: S - Str. agalactiae - Str. agalactiae.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	8Sev c 8msa	12L5Sev c 4L4m A
1C	16Sev c	16L5Sev c
1D	16Sev c	15L5Sev c 1L4m A
1E	16Sev c	14L5Sev c 2L4mod A
Level 1	14Sev c 2msa	14L5Sev c 1L4mod ALL4m A

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
2A	8Sev c 8mc	8L5Sev c 2L4Sev A 6L4msa
2C	16Sev c	16L5Sev c
2D	16Sev c	14L5Sev c 2L4Sev A
2E	12Sev c 4mc	8L5Sev c 2L4Sev A 6L4mod sa
Level 2	13Sev c 3mc	11L5Sev c 2L4Sev A 2L4mod sa 1L4msa
3A	16msa	4L5mc 4L4Sev A 4L4m A 4L3-4N
3C	8Sev c 8msa	8L5mc 4L4Sev A 4L4msa
Level 3	4Sev c 12msa	6L5mc 4L4Sev A 2L4m A 2L3-4N 2L4msa
<u>Quarter</u> <u>Summary</u>	10Sev c 1mc 5msa	8L5Sev c 2L5mc 2L4Sev A 2L4m A 1L4mod sa 1L4msa
<u>Score</u>	<u>135 (83c 22sa 30A) 41D. 94L.</u>	

NO. 47 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
20- 3-50	1.5	1.47	-	-	<u>Staph. aureus</u>
12- 6-50	4	6.50	8.0	64	None found
21- 6-50	4.5	1.0	-	-	<u>Staph. aureus</u>
26- 6-50	4.5	2.25	-	-	<u>Staph. aureus</u>
6- 7-50	5	10.2	-	-	<u>Staph. aureus</u>
10- 7-50	5	3.21	-	-	<u>Staph. aureus</u>
25- 7-50	5.5	0.65	-	-	Not cultured
31- 7-50	6	1.04	-	-	<u>Staph. aureus</u>
16-10-50	8	2.94	-	-	<u>Staph. aureus</u>
18-10-50(A.T.)	8	-	7.0	73	Not cultured
19-10-50(P.M.)	8	-	10.2	66	Not cultured

Macroscopic Description.

About half of the lobules of this gland were still in lactation. There was more involution in lower levels.

Details of Teat.

Length 8.0 cm.; e.d. 3.0 cm. Teat Canal: Length 13 mm.; c.r. 11 mm.; c.o. 9 mm. Teat Sinus: Almost the entire lining of the sinus consisted of healed scar tissue. This is evidence of past severe mastitis.

Cultures from Frozen Udder Tissue.

Levels 3 and 2: S - PS - S; Level 1: PS - PS - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1C	12Sev c 4msa	16L5Sev c
2D	16Sev c	12L5Sev c 4L3-4mod A
2E	16Sev c	15L5Sev c 1L3-4mod A
3A	16Sev c	8L5Sev c 8L3-4mod A
3C	8Sev c 8msa	14L5Sev c 2L4mod A
<u>Quarter Summary</u>	14Sev c 2msa	13L5Sev c 3L3-4mod A
<u>Score</u>	<u>142 (12Oc 4sa 18A) 46D. 96L.</u>	

NO. 47 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months Calved</u>	<u>Lab. 1 Count</u>	<u>Lab. 2 Count</u>	<u>Poly %</u>	<u>Mastitis Organisms</u>
20- 3-50	1.5	8.0	-	-	<u>Staph. aureus</u> and str.
12- 6-50	4	1.14	0.80	58	<u>Staph. aureus</u>
21- 6-50	4.5	1.06	-	-	<u>Staph. aureus</u>
26- 6-50	4.5	0.49	-	-	<u>Staph. aureus</u> and str.
6- 7-50	5	1.80	-	-	None found
10- 7-50	5	1.06	-	-	<u>Staph. aureus</u>
25- 7-50	5.5	0.83	-	-	Not cultured
31- 7-50	6	1.20	-	-	<u>Staph. aureus</u>
16-10-50	8	2.07	-	-	<u>Staph. aureus</u>
18-10-50	8	-	3.5	62	Not cultured
(A.T.)					
19-10-50	8	-	4.8	68	Not cultured
(P.M.)					

Macroscopic Description.

About half of the lobules of this gland appeared to be still in lactation.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 cm. Teat Canal: Length 12 mm.; c.r. 12 mm.; c.o. 8 mm. The canal lining failed to close normally and there was a permanent opening 1.0 mm. in diameter through the canal. Teat Sinus: The lining of the distal half of the sinus consisted of fibrous tissue and squamous metaplasia and was keratinised in parts. There was a remarkable fibrous band constricting the sinus about 1.2 cm. above the rosette. The proximal half of the sinus appeared to be normal. The junction of the pathological and apparently normal halves of the sinus was an almost straight line.

Cultures from Frozen Udder Tissue.

Level 3: PS - PS - Str. agalactiae - S; Level 2: S - cns - str. - S; Level 1: S - PS - str. - S.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
1A	14Sev c 2msa	12L5Sev c 4L4mod A
2A	8mod sa 4msa 4N	2L4Sev A 8L4ma 4L4-5msa 2L5mc
2C	16mod c	15L5mod c 1L4mod A
2D	16mod c	14L5mod c 2L4mod A
2E	16mod c	2L4Sev A 3L4ma 8L4msa 3L5mod c
Level 1-2	10mod c 3Sev c 2mod sa 1māa	3L5Sev c 6L5mod c 1L4Sev A 2L4mod A 2L4ma 2L4-5msa
3A	16msa	2L4Sev A 5L4ma 6L4-5msa 3L5mod c
3C	16mod c	8L4Sev A 4L4-5mod sa 4L5mod c
3D	8mod c 8msa	6L4Sev A 3L4ma 4L4-5msa 3L5mod c
Level 3	8mod c 8msa	5L4Sev A 3L4ma 2L4-5mod sa 3L4-5msa 3L5mod c

Quarter 2Sev c 9mod c 3L4Sev A 1L4mod A 3L4ma
Summary 1mod sa 4msa 1L4-5mod sa 2L4-5msa 2L5Sev c
 4L5mod c

Score 131 (52c 28sa 51A) 36D. 95L.

COW NO. 48 - Breed - Ayrshire. An aged cow.

NO. 48 LEFT FORE QUARTER.

Cell Counts.

<u>Date</u>	<u>Months</u> <u>Calved</u>	<u>Lab. 1</u> <u>Count</u>	<u>Lab. 2</u> <u>Count</u>	<u>Poly %</u>	<u>Mastitis</u> <u>Organisms</u>
10- 3-50	?	-	0.01	-	Not cultured
3- 5-50	?	-	0.02	-	None found
2- 6-50	?	-	0.10	-	Not cultured
23-10-50	?	-	0.01	-	Not cultured
25-10-50	?	-	0.02	-	Not cultured
28-10-50	?	-	0.02	-	Not cultured
1-11-50(A.T.)	?	-	0.12	51	Not cultured
2-11-50(A.M.)	?	-	0.03	-	Not cultured

Macroscopic Description.

About half of the lobules appeared to be involuted and the remainder were involuting.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 cm. Teat Canal: Length 7.0 mm.; c.r. 9.0 mm.; c.o. 4.0 mm. Teat Sinus: About 4.0 cm. above the rosette there was a horizontal fibrous band about 2.0 cm. long, beside which there was a vein. There was a mass of scar tissue about 2 cm. above the rosette. There were two 5.0 mm. deep pockets which were pointing horizontally.

Cultures from Frozen Udder Tissue.

Level 2: Sterile.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus	4mod c 12mc	16L5mc
1A	16N	1L5mc 1L4-5msa 14L4N
1D	2mod c 8mc 6N	8L5mc 8L5N
<u>Quarter Summary</u>	2mod c 7mc 7N	8L5mc 1L4-5msa 4L4N 3L5N
<u>Score</u>	<u>31 (27c 4sa) 11D. 20L.</u>	

NO. 48 LEFT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
10-3-50	?	-	0.01	-	Not cultured
3-5-50	?	-	2.84	74	<u>Staph. aureus</u>
2-6-50	?	-	10.80	76	Not cultured
23-10-50	?	-	0.80	70	Not cultured
25-10-50	?	-	3.2	80	Not cultured
28-10-50	?	-	7.2	75	Not cultured
1-11-50 (A.T.)	?	-	4.0	66	Not cultured
2-11-50 (A.M.)	?	-	13.0	87	Not cultured

Macroscopic Description.

About half of the lobules of this gland appeared to have involuted. The remainder were involuting.

Details of Teat.

Length 6.0 cm.; e.d. 2.5 cm. Teat Canal: Length 6.0 mm.; c.r. 10.0 mm.; c.o. 5.0 mm. Teat Sinus:
There were no ridges nor pockets.

Cultures from Frozen Udder Tissue.

Level 2: Str. agalactiae.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland sinus 1A	8Sev A 8m A 16m A	12L4-5Sev A 4L5mod sa 8L4Sev A 7L4m A 1L5mod sa
<u>Quarter Summary</u>	4Sev A 12m A	10L4-5Sev A 3L4m A 3L5mod sa
<u>Score</u>	237 (24sa 213A) 84D. 153L.	

NO. 48 RIGHT FORE QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
10- 3-50	?	-	1.56	73	Not cultured
4- 4-50	?	-	0.45	58	str.
3- 5-50	?	-	2.76	49	str.
2- 6-50	?	-	1.06	51	str.
25-10-50	?	-	1.7	75	str.
28-10-50	?	-	1.73	66	Not cultured
1-11-50(A.T.)	?	-	4.20	56	Not cultured
2-11-50(A.M.)	?	-	13.0	80	Not cultured

Macroscopic Description.

It appeared that only about one quarter of the lobules were still in lactation.

Details of Teat.

Length 7.0 cm.; e.d. 3.0 cm. Teat Canal: Length 7 mm.; c.r. 9 mm.; c.o. 4 mm. Teat Sinus: There were two longitudinal ridges. There was one pocket about 1 cm. above the rosette.

Cultures from Frozen Udder Tissue.

Level 2: Str. agalactiae.

Microscopic Description.

<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	8Sev A 8Sev sa	4L4Sev A 8L5Sev sa 4L5Sev c
1A	8Sev A 8msa	4L4Sev A 8L5Sev sa 4L5mod c
1D	8Sev A 8msa	4L4Sev A 8L5Sev sa 4L5mod c
2A	8msa 8N	4L4Sev A 4L5Sev sa 4L5mod c 4L4N
<u>Quarter</u>	6Sev A 2Sev sa	4L4Sev A 7L5Sev sa 1L5Sev c
<u>Summary</u>	6msa 2N	3L5mod c 1L4N
<u>Score</u>	<u>246 (18c 108sa 120A) 96D. 150L.</u>	

NO. 48 RIGHT HIND QUARTER.Cell Counts.

<u>Date</u>	<u>Months</u>	<u>Lab. 1</u>	<u>Lab. 2</u>	<u>Poly %</u>	<u>Mastitis</u>
	<u>Calved</u>	<u>Count</u>	<u>Count</u>		<u>Organisms</u>
10- 3-50	?	-	0.11	54	Not cultured
4- 4-50	?	-	0.03	-	None found
3- 5-50	?	-	0.08	24	<u>Staph. aureus</u>
2- 6-50	?	-	0.36	28	Not cultured
23-10-50	?	-	0.60	80	Not cultured
25-10-50	?	-	1.7	85	Not cultured
28-10-50	?	-	0.70	60	Not cultured
1-11-50(A.T.)	?	-	0.80	70	Not cultured
2-11-50(A.M.)	?	-	0.24	32	Not cultured

Macroscopic Description.

About half of the lobules of this gland appeared to be involuted; the remainder were involuting.

Details of Teat.

Length 6.0 cm.; e.d. 3.0 cm.; there was a bleeding wound on the external surface of the teat. This was 1.0 cm. long and was about 1.0 cm. from the orifice. It resembled a cut from barbed wire. Teat Canal: Length 7 mm.; c.r. 8 mm.; c.o. 5 mm. Teat Sinus: There were two slight longitudinal ridges, and a few very shallow pockets.

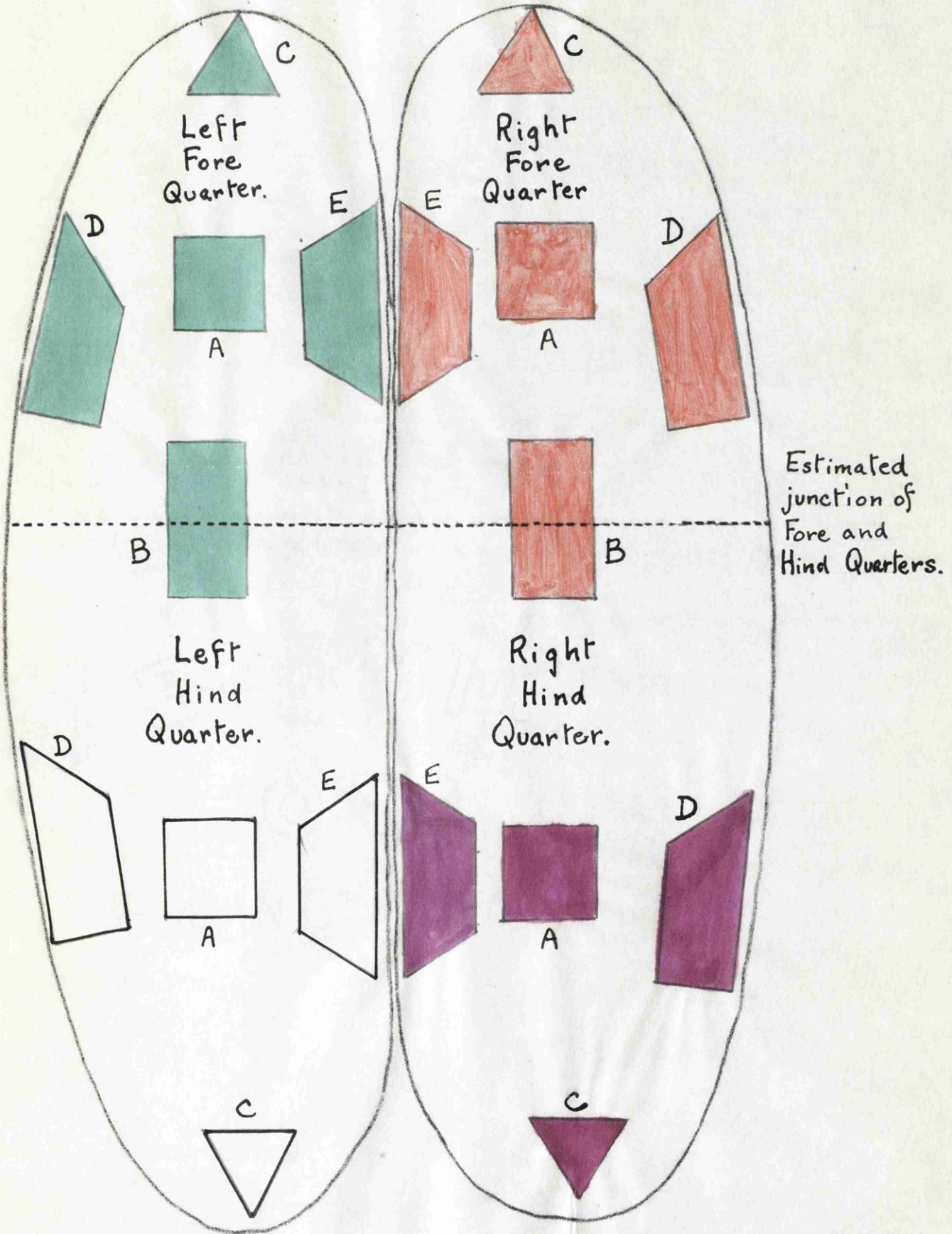
Cultures from Frozen Udder Tissue.

Level 2: Sterile.

Microscopic Description.

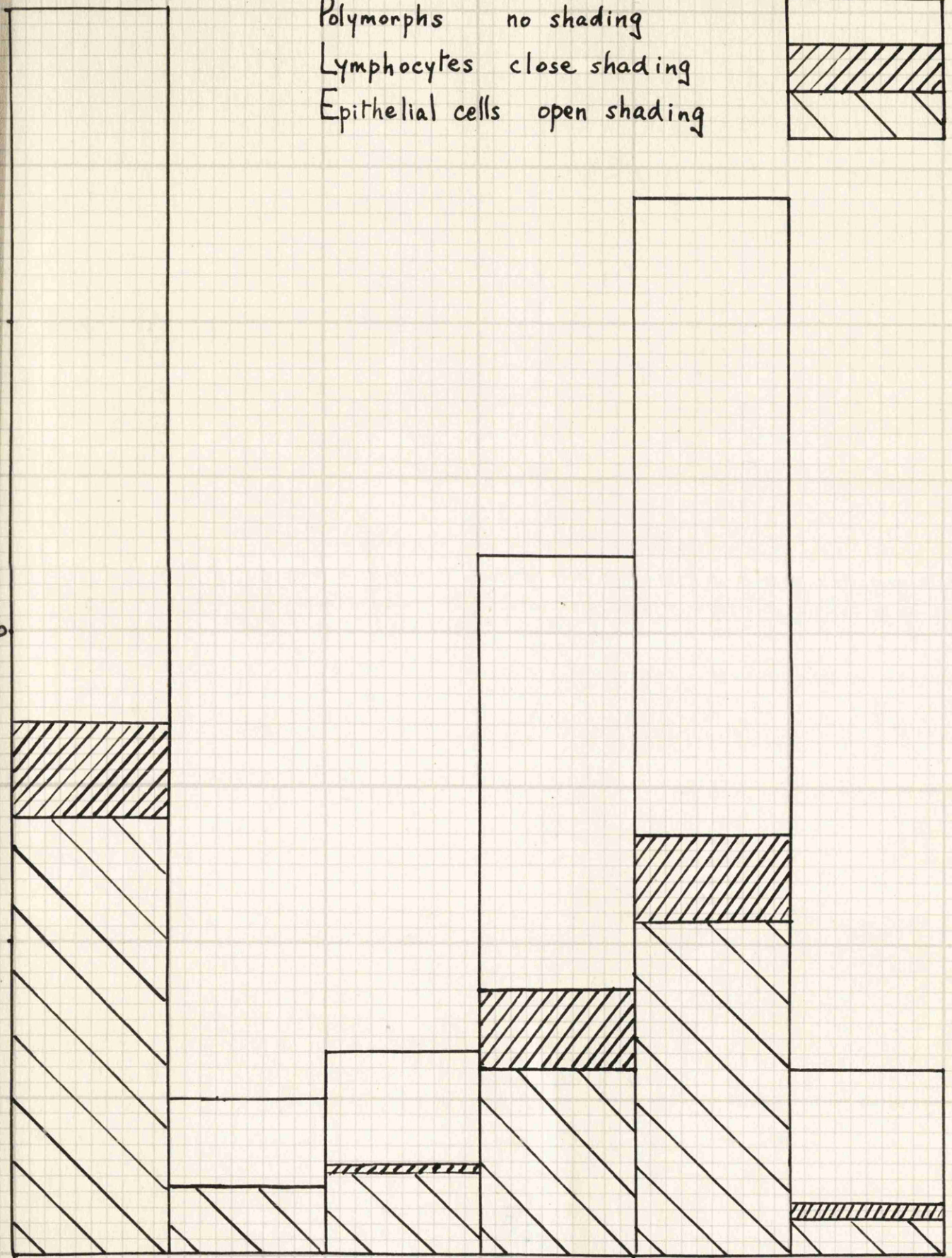
<u>Section</u>	<u>Ducts</u>	<u>Lobules</u>
Gland		
sinus	2m A 14N	16L5mc
1A	8m A 8N	4L5mc 4L4mod A 8L4N
<hr/>		
<u>Quarter</u>		
<u>Summary</u>	5m A 11N	10L5mc 2L4mod A 4L4N
<u>Score</u>	<u>47 (20c 27A) 15D. 32L.</u>	

Diagram of Dorsal View of Horizontal Longitudinal Section of Bovine Udder Showing Shapes and Colours of Blocks and the Areas from which they were cut.



Histogram of the mean distribution and proportions of types of cell found before and after centrifuging ten ml. amounts of ten samples of milk at 2,000 r.p.m. for ten minutes.

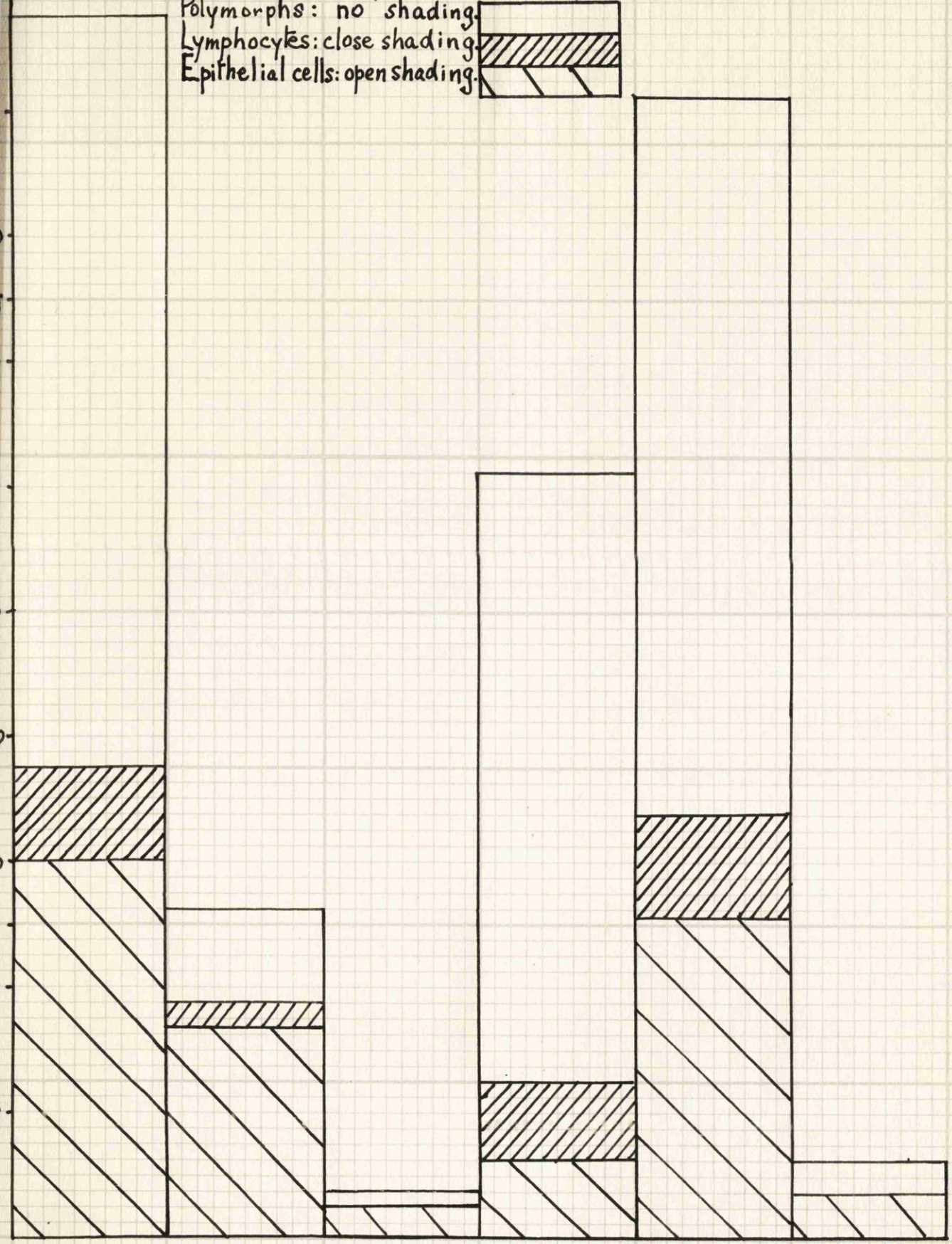
Polymorphs no shading
 Lymphocytes close shading
 Epithelial cells open shading



Whole Milk. Cream. Intermediate Layer. Deposit. Total after centrifuging. Apparent Loss.

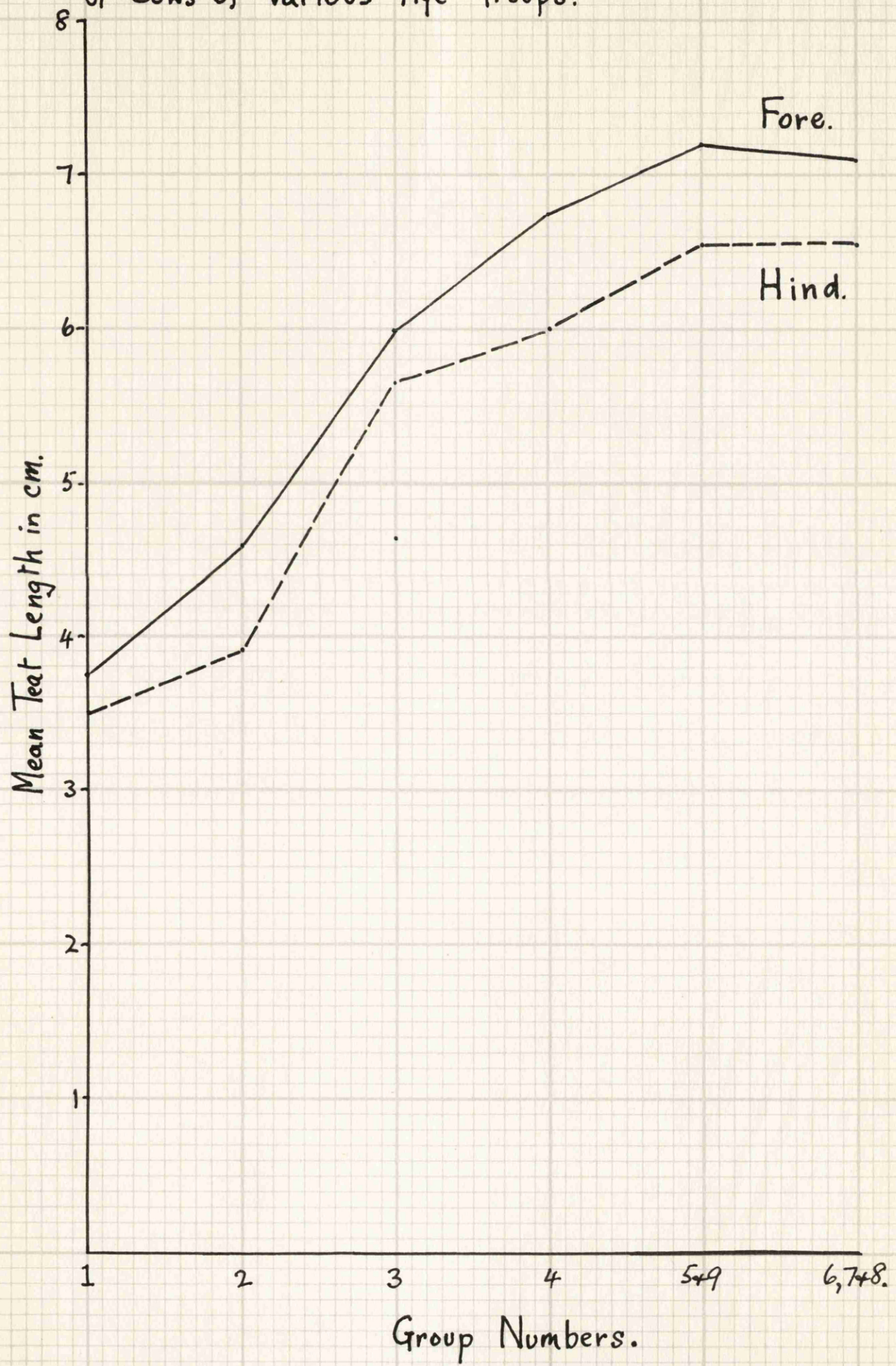
Histogram of the Mean Distribution and Proportions of Types of Cell Found before and after Centrifuging Three ten ml. amounts of one Milk Sample at 7,000 r.p.m. for one hour.

Polymorphs: no shading
 Lymphocytes: close shading
 Epithelial cells: open shading

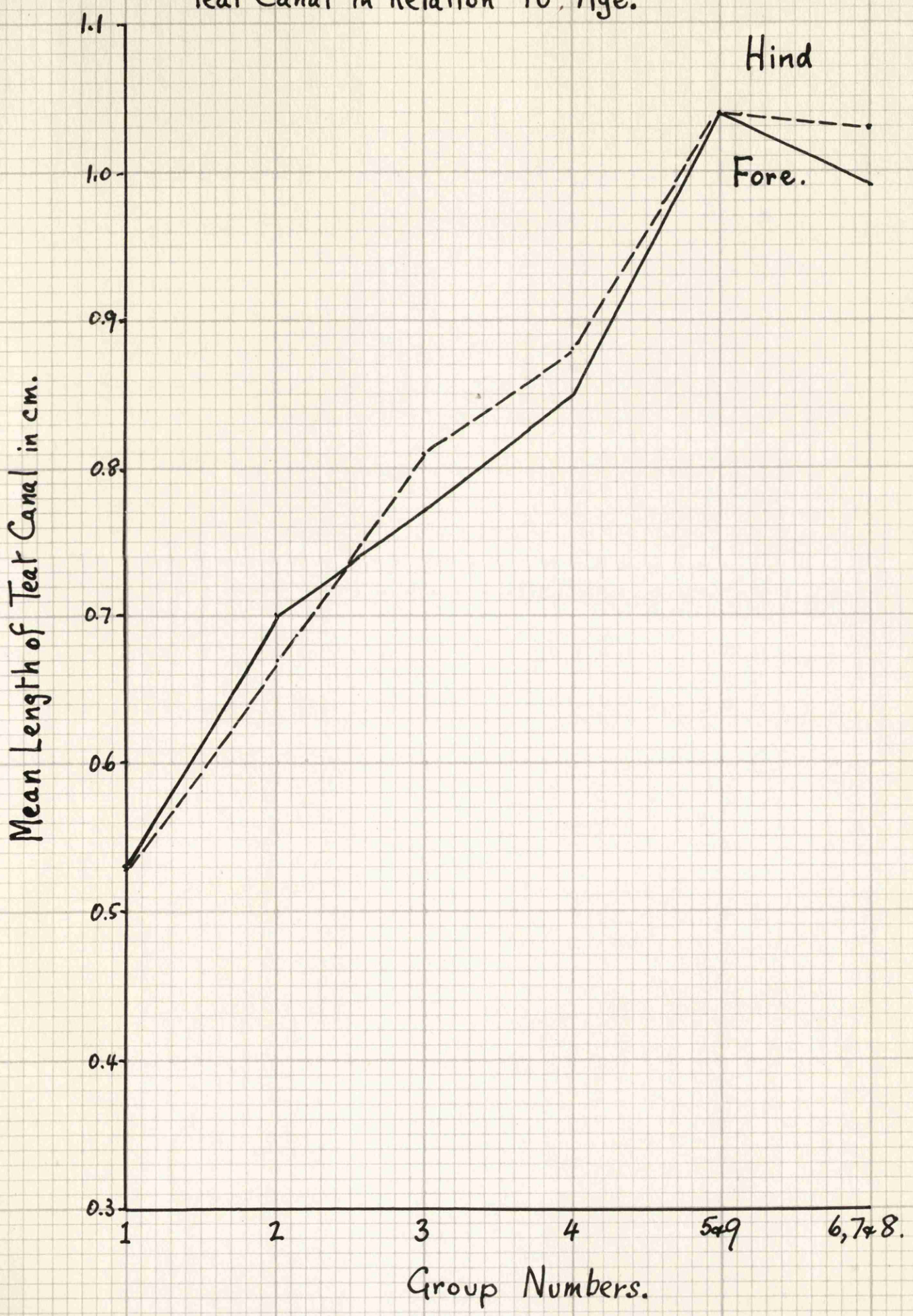


Whole Milk. Cream Intermediate Layer. Deposit. Total after centrifuging. Apparent Loss.

Graph 1. Graphs of the Means of Teat Lengths of Cows of Various Age Groups.



Graph 2. Graph of the Mean Length of the Bovine Teat Canal in Relation to Age.



Graph 3. Graph of the Mean Circumference at the Rosette and at the Orifice of the Bovine Teat Canal in Relation to Age.

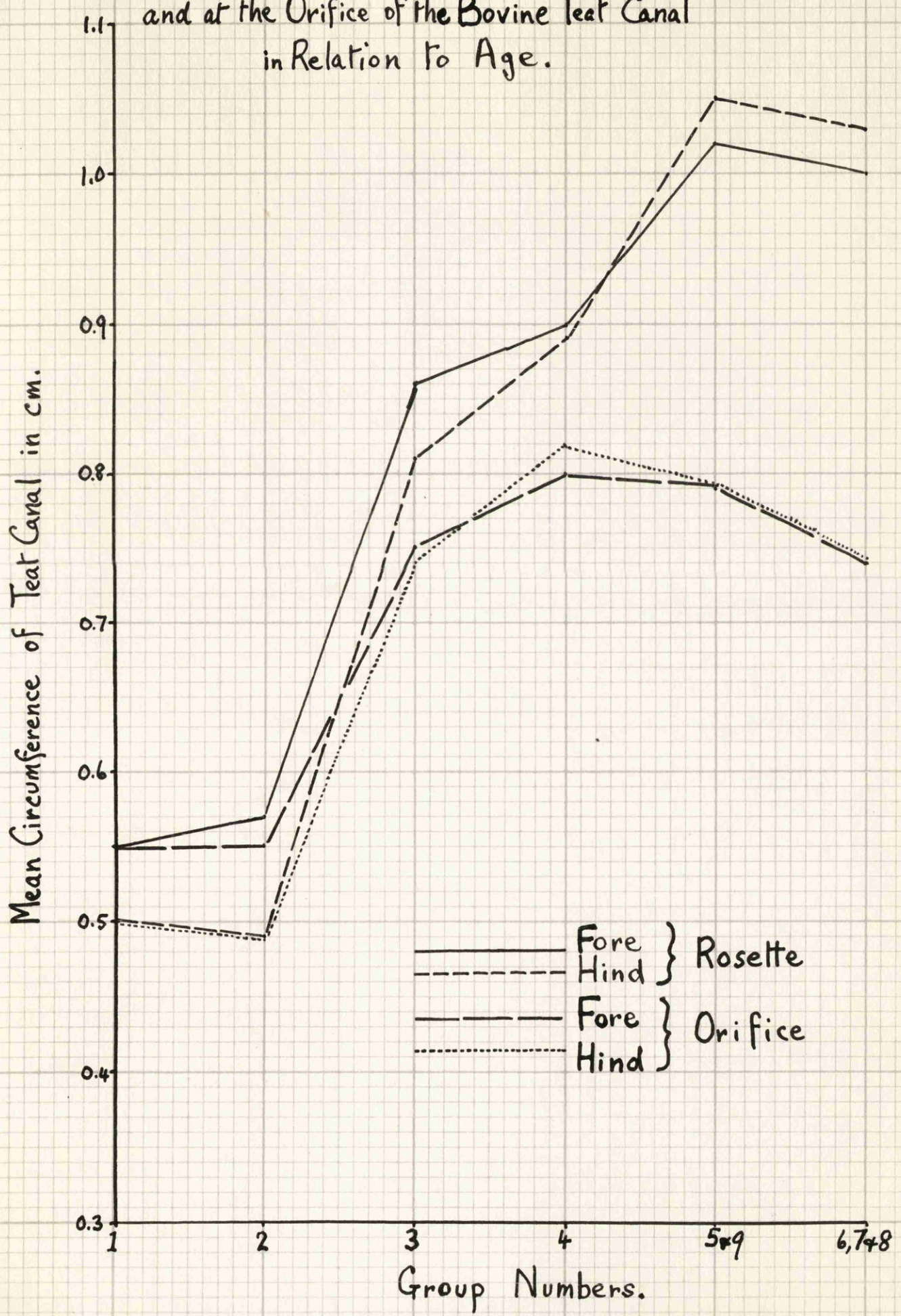


Diagram of the Longitudinal Section of the Teat

Orifice showing the Junction of the Canal

Epithelium with the skin.

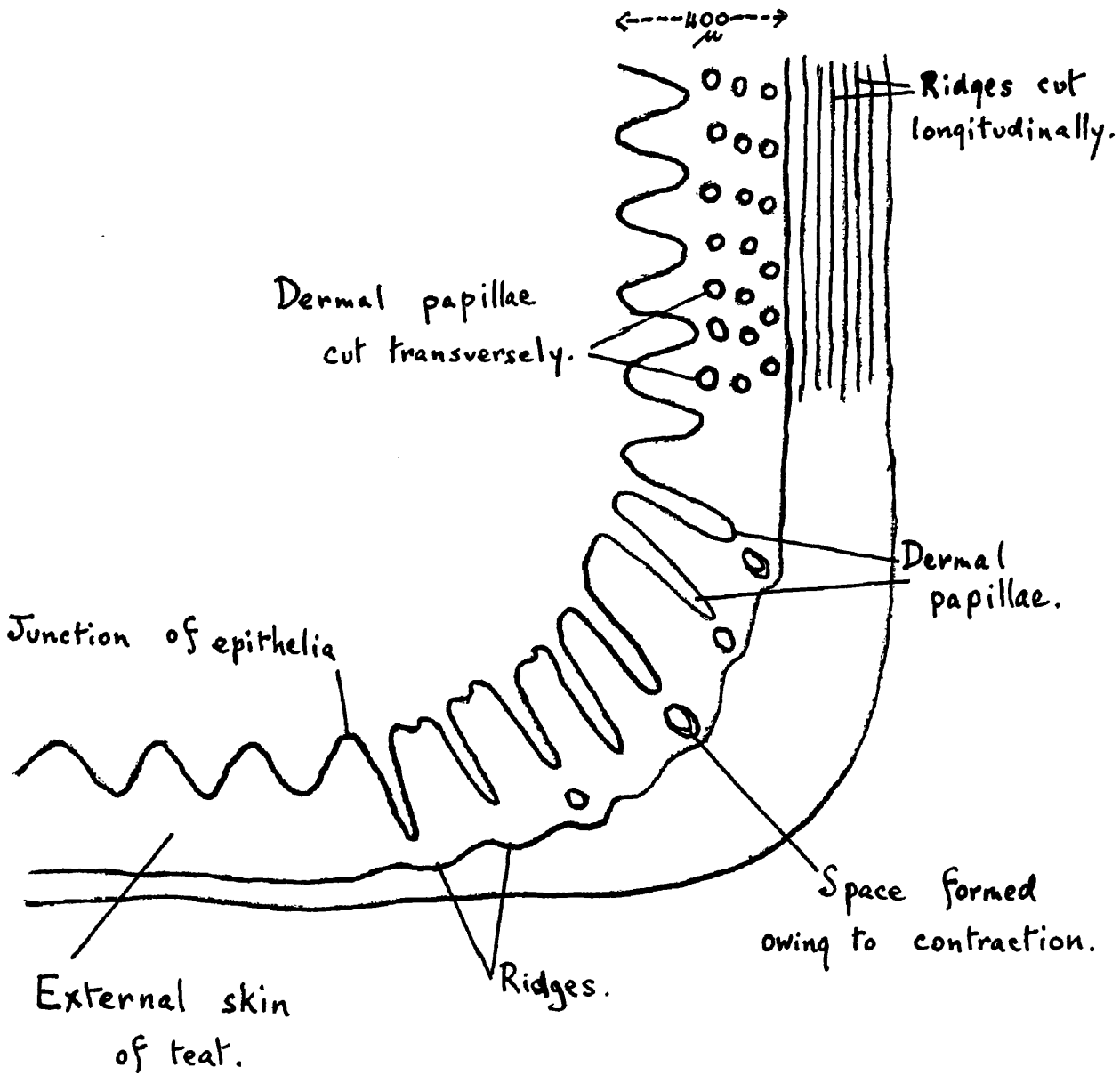


Diagram of part of Transverse Section of apparently
normal Test Canal Epithelium.

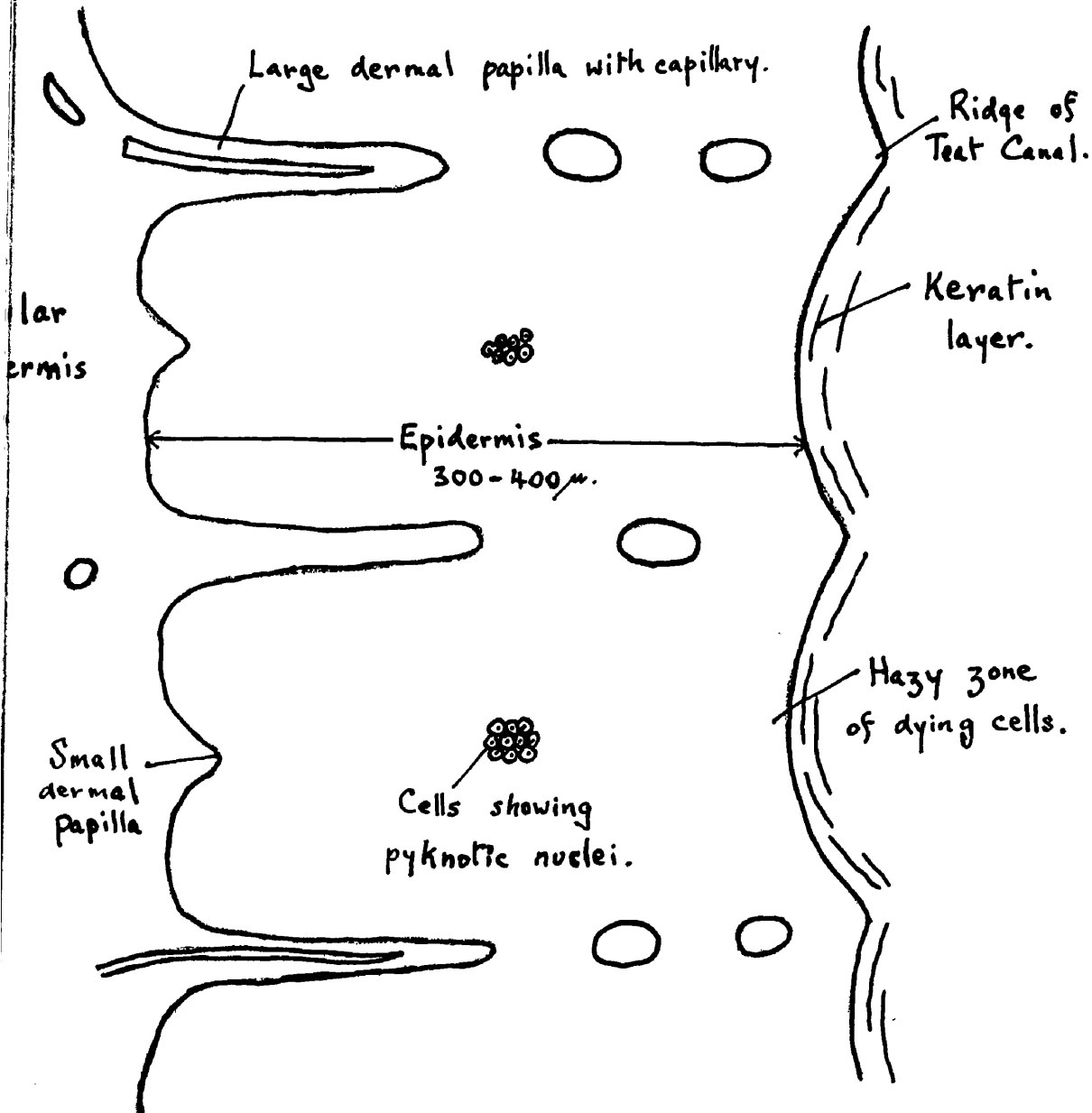


Diagram showing the three zones in longitudinal section of
canal epithelium in relation to the transverse section

