# COCKLE DEFECT OF SHEEPSKIN: ITS NATURE, MONTHLY INCIDENCE AND SEVERITY IN DOMESTIC WOOLSKINS

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## ABSTRACT

Cockle consists of a scattering of small, firm nodules in the grain layer of sheepskin which ordinarily cannot be detected until the skin is removed from the animal and processed. The nodules vary considerably in size and arrangement but they are characteristically light to dark brown in color. The defect seriously impairs the properties of both grain and suede types of leather. In commercially pulled skins the incidence of cockle rises sharply in the early spring but is of little consequence during the summer. Although it occurs in many parts of the world, published studies are extremely scarce and there is no conclusive proof of its cause.

Salted woolskins obtained from a local woolpuller during a six-month period were evaluated for cockle in the laboratory. Data on the numbers and distribution of nodules confirmed the occurrence of a seasonal peak in late winter and spring and an early preference for neck and shoulder areas, with eventual spreading over the entire body. The number of cockle nodules ranged up to 7,200 per skin and usually exhibited a fair degree of symmetry. The defect is best evaluated in pickled skins by means of transmitted light. This method also shows cockle in soaked, unprocessed skins after the wool is closely clipped. Chemical analysis showed no significant abnormality in lipid composition of cockle tissue from a salt-cured skin nor did stained cross sections from a pickled skin.

## INTRODUCTION

The mysterious enigma known as "cockle" has plagued the sheepskin industry for many generations. It is a skin eruption peculiar to woolbearing sheep that is known only to woolpullers, fellmongers and sheepskin tanners, but unknown to veterinarians because the wool completely conceals it and there are usually no obvious symptoms of disease. Even close shearing and palpation fail to reveal

it on the living animal. Tanners recognize it readily on pickled skins and have learned from experience that it is difficult to make any type of saleable leather from severely affected skins. It has been estimated (1) that cockle is responsible for annual losses of at least $2 million in this country alone, based on the price differential between normal and affected skins. It is also prevalent in many other countries as well.

The exact origin of the term "cockle" is obscure. Most likely it arose from the similarity in appearance to the warty, crinkled shell of the shellfish with the same name. This and many other interesting observations are found in Seymour-Jones' authoritative book (2) on "The Sheep and Its Skin" published in 1913. His chapter on cockle, representing some 35 years of careful observations, is the only extensive publication on this subject to the best of our knowledge. A few brief comments appeared in a 1924 note (3), and later a short histological description of cockle was published in 1929 as part of a general paper on sheepskin defects (4). This seems to be the extent of available research literature.

Various terms have been used to describe the surface appearance of cockle. It may resemble a hard pimple or boil (2) and was even thought to contain pus (3), but more simply it appears as dark, raised spots (4) of varying size and elevation. A good picture of its appearance on a dewooled skin has been published (5, p. 5). It is commonly observed that the nodules often show a linear pattern in the midsection roughly parallel to the ribs; also that the spots can occur almost anywhere on the skin, but in early stages there seems to be a preference for close patches in the neck and shoulders.

There is a definite seasonal pattern in the incidence and severity of cockle. Skins from sheep slaughtered during the winter and early spring months, especially January, February, March and April, can be expected to show the defect to varying degrees. It is thought to be essentially absent during the summer but, as pointed out long ago (3), it can always be found to some extent. An amazing observation, or belief, in this connection is that cockle disappears shortly after shearing (2, 3). This has led to the conclusion that overheating due to the long wool is the cause of cockle (3). Seymour-Jones (2) was convinced that it resulted from a nutritional disturbance caused by certain types of dry feeds used during the winter. He described a feeding test to support his theory, claiming that an abnormal type of fat accumulated in the skin which was directly responsible for the nodules, as he apparently showed in his cross sections. However, other workers were not able to confirm the presence of fat deposits in sections of skin (4, Figure 7) or leather (6, p. 282) but they did show cellular congestion and compacted grain fibers. While it is possible that there may be more than one form of cockle, it seems more likely that selection of material for sectioning is the real basis of the controversy.

At a meeting of the Research Liaison Committee of the ALCA in October, 1966 (1), the seriousness of the problem was reviewed, and a decision was reached

to undertake a thorough study. This report attempts to define cockle in more quantitative terms as a preliminary step in seeking its cause.

## EXPERIMENTAL METHODS

**Experimental Design.**—A local woolpullery was chosen as a good source of wooled skins. Early each month, from December, 1966, through May, 1967, six salt-cured skins were purchased for laboratory evaluation in order to confirm the seasonal variations in incidence and severity. Also these frequent contacts allowed us to gain familiarity with the appearance of commercially processed skins through the cooperation of the skin sorter. The plan was to cut the skins in half and first process the left sides to the pickled stage. After examining these, and assuming symmetry, selected right sides were further examined in the cured, soaked state after clipping the wool. Finally the right sides were processed and the pickled skins were evaluated carefully for cockle.

**Improved Sampling.**—It was realized that a sample of six skins would not be very representative of a whole carload processed on any given day, much less of a whole month's production. Towards the end of this work a better procedure was devised. Several skins from each of six successive shipments were set aside and one from each lot was then selected for our sample. As will be shown later the selected April and May samples yielded a much more typical range of counts.

**Skin Processing.**—Since our primary objective was to evaluate cockle in the pickled skins without any modification rather than to make good leather, processing was shortened by omitting the usual reliming step and by bating under minimal conditions.† Six half-skins were soaked overnight in cold water, drained, and painted on the flesh side with:

| | |
|---|---|
| Hydrated lime | 4.5 lbs. |
| Sodium sulfide flakes | 1.0 lb. |
| Water, approx. | 2 qts. |

The painted skins were stacked overnight and the wool was pulled the next morning. The dewooled skins were weighed, then well washed in a small, rotating, wooden churn to simulate drumming action.

Bating was carried out in the same churn using the following formula (based on dewooled skin wt.):

| | |
|---|---|
| Ammonium sulfate | 4.0% |
| Oropon N‡ | 0.2% |
| Water at 85°F. | 100 % |

†Effects of processing modifications will be the subject of a later report.

‡Mention of brand names does not constitute an endorsement by the U. S. Department of Agriculture over others of a similar nature not mentioned.

The churn was run for 30 to 60 minutes, after which the pH was about 8.5 and a freshly cut piece of skin remained clear when treated with phenolphthalein. After washing for about 30 minutes the skins were pickled in:

| | |
|---|---|
| Sodium chloride | 10% |
| Sulfuric acid (conc.) | 2% |
| Cold water | 100% |

The churn was run for two periods of 15 minutes each, with a similar resting period between, after which the pH was between 1.2 and 1.5. Skins remained in pickle overnight, were churned again the next day and were then removed.

**Cockle Counts.**—It was found that the cockle nodules could be seen best by means of transmitted light; for example, by holding the pickled skin up to a sunny window. For convenience in counting we used a wooden light box (20 x 26 x 8 in.) with a hinged glass cover, evenly illuminated with six 20-watt fluorescent tubes. This permits viewing one-quarter of a skin at a time, and is also suitable for photographic use.

To facilitate accurate counting the skins were marked off in a standard grid pattern, shown in the diagram of Figure 1, using a blunt wooden stick as a marker. These guide lines are readily visible for some time, but can be erased by drumming the skins briefly in pickle liquor. Photocopies of left and right versions of the grid diagrams were used to record the counts from each skin.

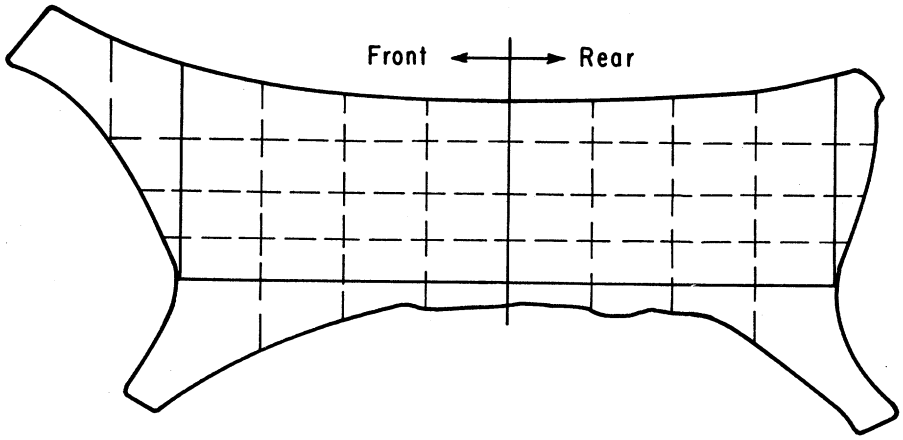


FIGURE 1.—Grid pattern marked on pickled skins to facilitate counting of cockle nodules; copies of diagram used to record counts for each skin.

**Lipid Analysis.**—Clipped skin was briefly soaked in water, drained, and carefully sampled over a light box. Narrow strips of skin containing cockle were cut out and accumulated in one container, while similar strips showing no cockle were collected in another, until pooled samples of about ten grams were obtained.

The samples were extracted on a shaker with Bloor's Solvent (3 parts ethanol : 1 part ether) and further extracted with Folch's Solvent (2 parts chloroform : 1 part methanol). The dried, combined extracts were dissolved in n-hexane; small portions were applied to thin-layer silica gel plates and chromatographed with petroleum ether:ethyl ether:acetic acid (80:20:1) according to a published procedure (7).

## RESULTS

**Monthly Incidence.**—It is well known that the incidence of cockle increases during the winter and early spring and then recedes abruptly in summer. The cooperating woolpuller confirmed this by supplying figures from his records for the two preceding years, as shown in Table I. Records were not kept for the warmer months because cockle was relatively absent. Further questioning revealed some explanation for this. Due to spring shearing the supply of mature woolskins runs out early in May. From there on they process lamb skins, which do not usually show much cockle.

TABLE I

PERCENTAGE INCIDENCE OF COCKLE FOUND BY COMMERCIAL WOOLPULLER

| Month | 1964–65 | 1965–66 |
|---|---|---|
| December | 15 | 22 |
| January | 31 | 27 |
| February | 38 | 42 |
| March | 56 | 46 |
| April | 54 | 50 |

Even though we examined only small samples each month our results confirmed the fact that incidence of cockle peaks in the early spring, as shown in Table II. It should be explained that one lot of fresh skins, which showed only very light cockle, was obtained from a slaughterhouse in April. They are listed here under May since it was felt that most of the cured skins purchased represented the previous month's slaughter. It is of some importance to realize that the peak of incidence can vary slightly in different years or locations, and will also be influenced by the nature of the raw material; fresh skins obtained locally will be processed closer to the time of slaughter than will salted skins shipped from distant points. Incidence figures are of primary concern to the woolpuller since he suffers a monetary loss on all cockle skins. Tanners are more disturbed over severity; a scattering of small spots can be tolerated but heavy concentrations can be disastrous.

TABLE II

INCIDENCE OF COCKLE SKINS IN 1966–67 LABORATORY STUDY

| Month | No. Skins | Skins with Cockle | |
|---|---|---|---|
| | | Number | Percent |
| December | 6 | 0 | 0 |
| January | 6 | 3 | 50 |
| February | 6 | 3 | 50 |
| March | 6 | 6 | 100 |
| April | 12 | 11 | 92 |
| May* | 12 | 12 | 100 |
| | 48 | 35 | |

*Including 6 fresh April skins equivalent to May salted.

**Monthly Severity.**—As shown in Table II we studied a total of 48 skins over a six-month period, of which 35 had cockle. The actual counts on each skin are plotted in Figure 2, which gives a better picture of how serious the problem becomes in early spring. The graph also illustrates the sampling difficulties mentioned earlier. Note that the "x" points represent skins selected from different shipments while the "o" points were unselected skins taken from stock on hand, most likely from a single shipment. The wide range of cockle counts for April, reaching a peak of 7,200, is expected for this time of year. The selected May skins also showed substantial numbers, thus supplementing the information obtained from the woolpuller (Table I) who did not give records for May. Since the woolpuller does not process shorn skins we were unable to investigate the reported regression of cockle after shearing.

For some purposes it might be helpful to classify the skins according to the severity of cockle. Generally speaking, as the number of cockle nodules increases so do the average diameter and height of the nodules. Therefore a low number usually implies that most of the spots are relatively inconspicuous, and it would help to know the proportion of skins with low counts to the total. Based on the information in Figure 2 we have arbitrarily classified the skins into four grades as shown in Table III. Light cockle, occurring in one-third of our skins, would

TABLE III

CLASSIFICATION OF COCKLE SKINS ACCORDING TO SEVERITY

| Grade | Range of Counts | No. Skins | Percent |
|---|---|---|---|
| Clear | 0 | 13 | 27 |
| Light | 1–250 | 17 | 35 |
| Medium | 251–2500 | 7 | 15 |
| Heavy | 2501–7226 | 11 | 23 |

probably make acceptable leather in most cases. Admittedly the distinction between medium and heavy cockle may have no practical significance but it does help to indicate more accurately the relative degree of severity.

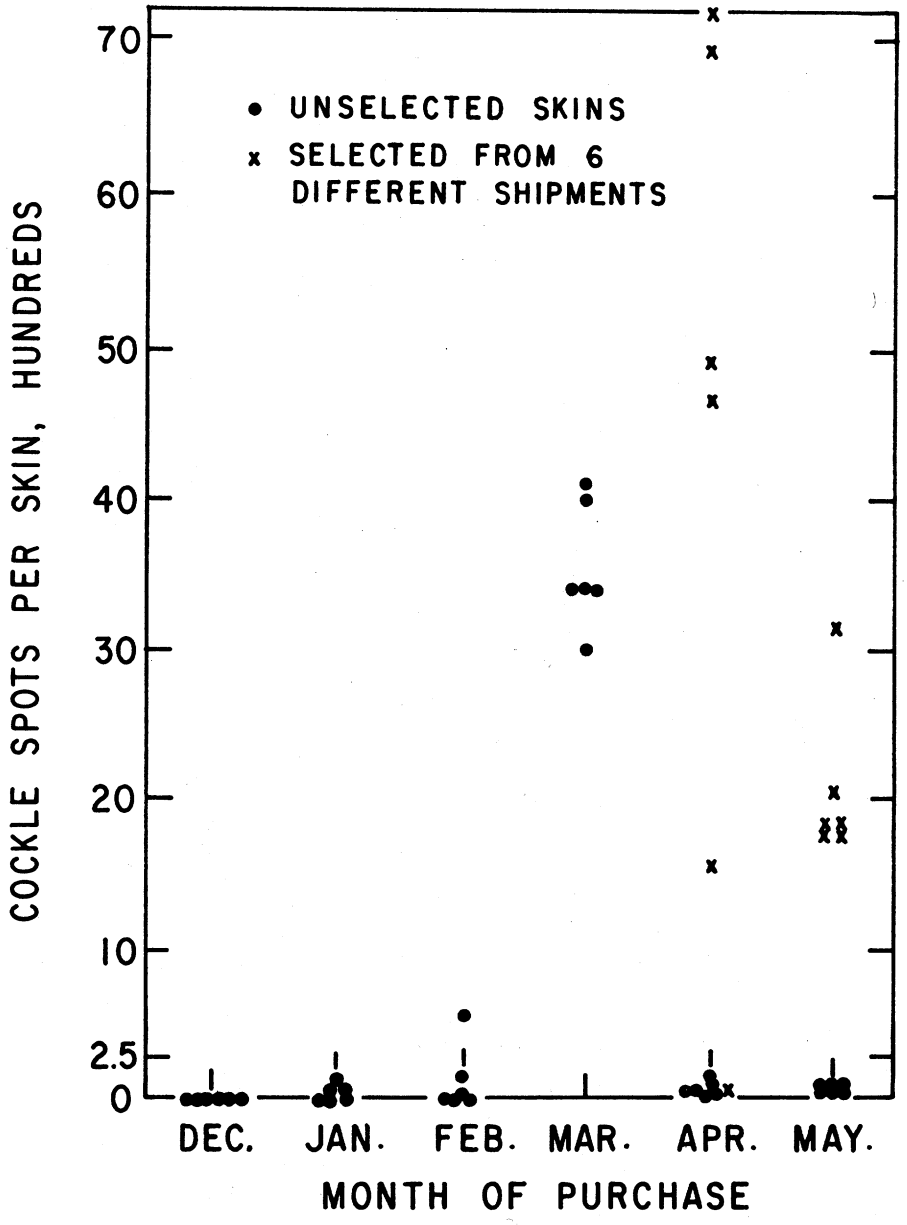


FIGURE 2.—Severity of cockle according to month of purchase, showing the seasonal variation and the value of more representative samples.

**Anatomical Distribution.**—In searching for the cause of this defect it is important to consider its typical distribution over the animal's body. This could be done with great detail from our data (see Figure 1). However, because of the small number of skins it was felt that greater significance could be attached to average values for the four quadrants: front and rear halves of left and right sides. The distribution figures in Table IV are given separately for each of the three degrees of cockle severity to illustrate the progressive nature of the condition. The consistently higher numbers in the front quadrants are largely due to their greater area resulting from inclusion of the neck. A tendency towards higher numbers on the left is probably not significant. There seems to be fairly good symmetry, judging from these limited data, but the early preference for neck and shoulder areas, shown especially by the skins with light cockle, would seem to argue against the incrimination of generalized effects such as overheating or metabolic disturbances.

TABLE IV

AVERAGE DISTRIBUTION OF COCKLE BY SKIN QUADRANTS

| Grade | Position | Average Cockle Counts | |
|---|---|---|---|
| | | Left Side | Right Side |
| Light | Front | 17 | 19 |
| | Rear | 5 | 9 |
| Medium | Front | 450 | 389 |
| | Rear | 399 | 375 |
| Heavy | Front | 1301 | 1155 |
| | Rear | 949 | 1000 |

**Appearance of Cockle Skins.**—When a pickled skin with cockle is spread out on a table and illuminated with light from one side, the shadowing effect gives a good three-dimensional view of the nodules. Such a skin with heavy cockle is shown in Figure 3a; this was the mid-section, left side, of a March skin. When this same area was viewed on a light box with strong transmitted light, as shown in Figure 3b, a somewhat better view is afforded which permits more accurate counting. Note the wide variation in size of the dense cockle spots, and the grid lines marked on the skin. Some care is necessary in counting to differentiate between cockle and bits of flesh on the lower surface. Also the raised, fatty pattern commonly seen along the backbone must be carefully pressed down and searched for cockle.

The matching right side of this same skin was selected for study before processing. The wool was closely clipped with small animal clippers; then the skin was briefly soaked in water and drained (to make it more transparent) and viewed on the light box. As shown in Figure 3c, the cockle was almost as clearly

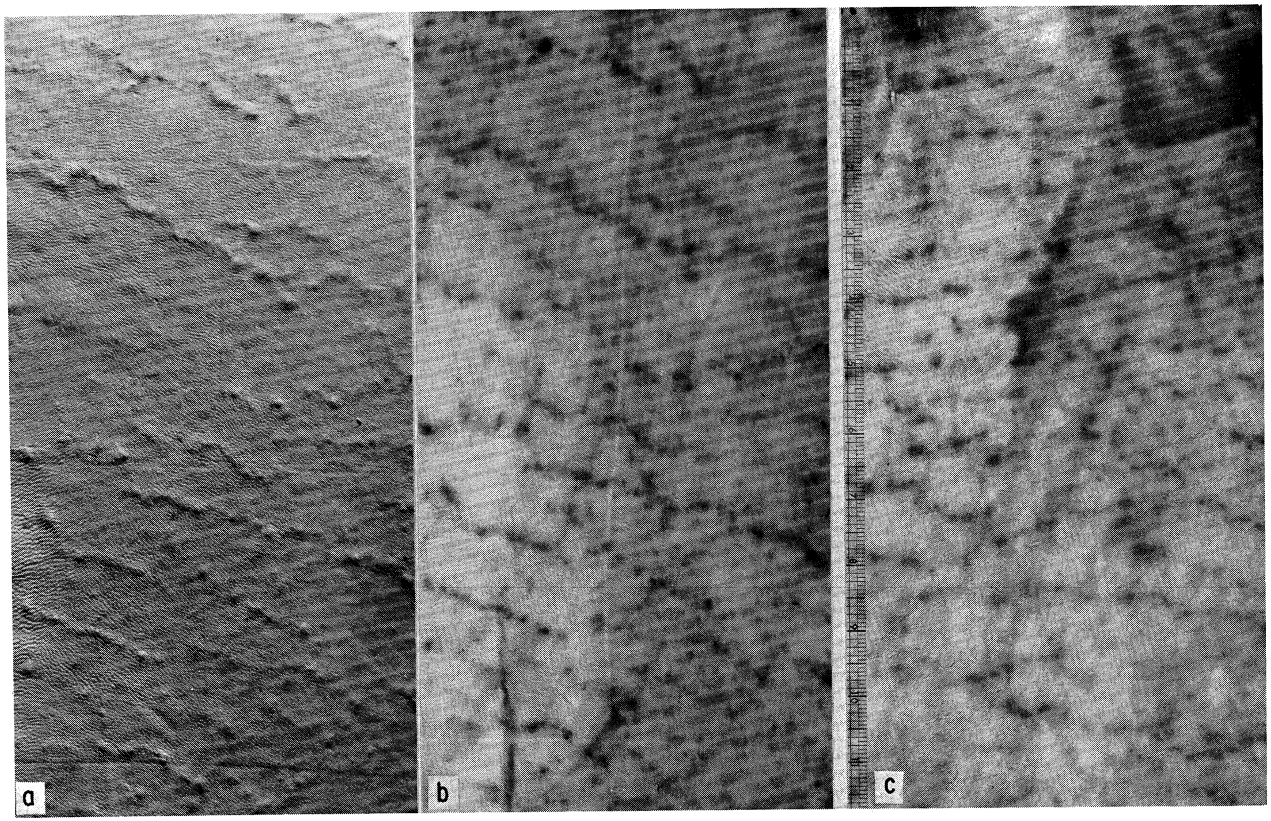


FIGURE 3.—Appearance of cockle in processed and unprocessed halves of the same skin: (a) pickled left side by low-angle reflected light; (b) same area by transmitted light; (c) corresponding area of right side, after clipping and soaking, by transmitted light. Scale (inches) applies to all.

visible as in the corresponding pickled side. Also the numbers and arrangements of the cockle spots are quite similar on both sides; linear patterns run parallel to the ribs. This may be the first time that cockle has been shown in an unprocessed skin.

**Lipid Analyses.**—Seymour-Jones' theory that fat deposits were responsible for cockle nodules had not been confirmed histologically (4). Chemical evidence should help substantially in resolving this hypothesis. A large portion of the cured skin shown in Figure 3c was carefully divided, as described above, into control and cockle samples. Although the skin samples were not completely pure with respect to presence or absence of cockle, they should give useful information on the occurrence of any abnormal quantity or variety of lipid material.

Total lipids in the original wet samples amounted to 5.2 percent for the control and 4.4 percent for the cockle sample (19.1 percent and 15.4 percent respectively on a dry, ash-free basis). Thus the cockle tissue appeared to contain somewhat less fat than the normal, and certainly not an increased amount. Six known fractions were identified on the chromatograms: sterols, triglycerides, diglycerides, fatty acids, waxes and phospholipids. All of these were present in both samples, in bands of equal intensity. There was also a faint unknown spot (perhaps oxidized glycerides) of equal intensity in both. Therefore there was no evidence of any significant qualitative or quantitative difference in the composition of fats extracted from these samples, and no confirmation of the Seymour-Jones theory. Additional chemical studies are contemplated.

**Skin Histology.**—Early in this work a tanner supplied a sample of pickled skin with cockle for our benefit. Several nodules were examined histologically by preparing stained, frozen sections of gelatin-embedded tissue as described in a previous publication (8). Figure 4 shows the comparison between normal areas on the left and cockle nodules on the right. Fat staining (Figures 4a and 4b) showed no evidence of any unusual fatty deposits and thus no confirmation of Seymour-Jones' claim. There is, apparently, a swelling of the grain layer, disorganization of the follicles and a condensation of grain fibers in the nodules. Other sections (Figures 4c and 4d) also indicate that the nodules are primarily fibrous in nature, but show no increase in elastic tissue, with some evidence of inflammatory cellular infiltration but with no central core as in an abscess. Pickled skins, however, are not really suitable for histological evaluation because of the chemical treatments they have received. Additional studies of cured and fresh skin samples, when completed, should add considerably to our understanding of the true nature of this eruption.

**Appearance of Cockle Leather.**—Although no leather was made from the skins in this study, it was thought desirable to show a few typical commercial examples of the defect and to point out their external and internal abnormalities.

Figure 5a shows the smooth grain surface of normal, finished sheepskin slipper leather while Figure 5b shows the same type of leather made from a skin with

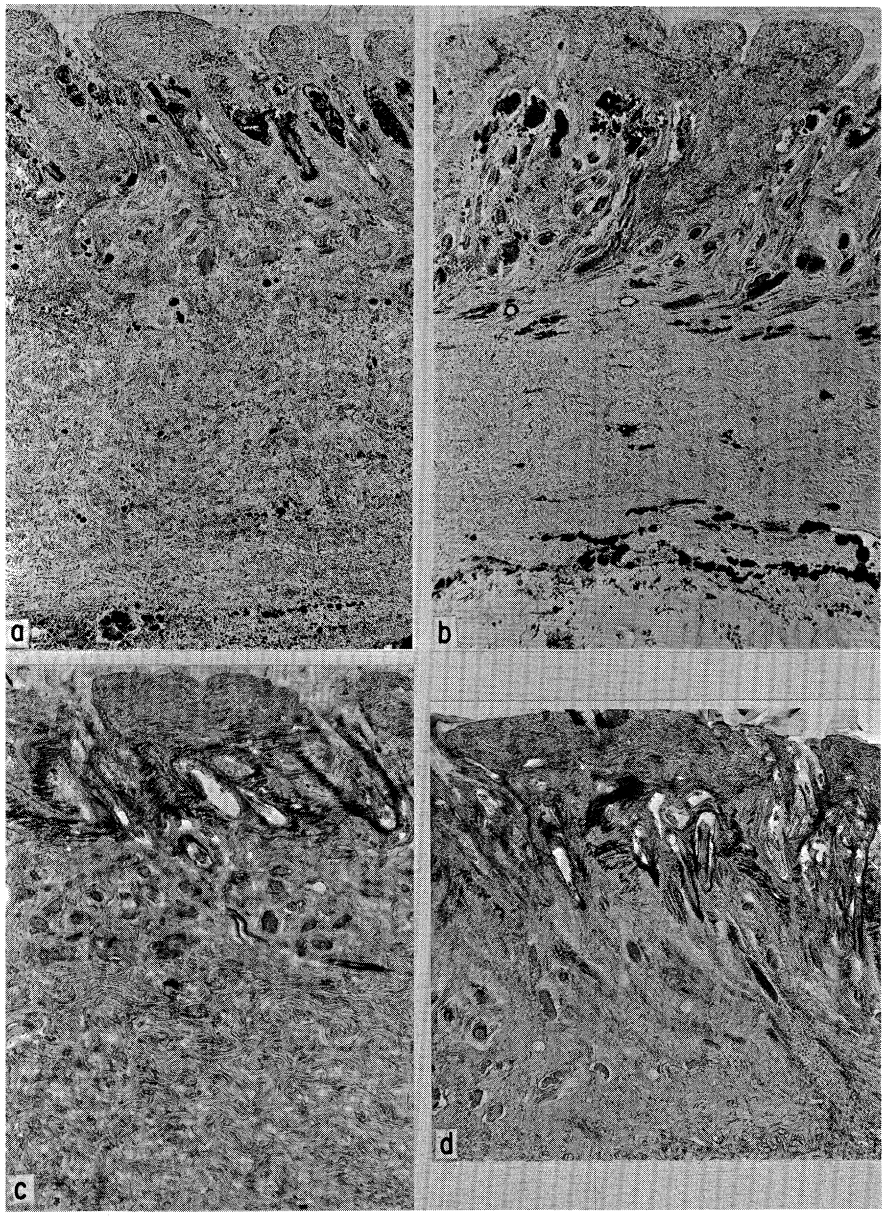


FIGURE 4.—Cross sections of pickled skin with cockle (right) and without (left): (a) and (b) fat stained dark with Oil Red O; (c) and (d) elastic tissue stained with orcein. All sections approx. x 30.

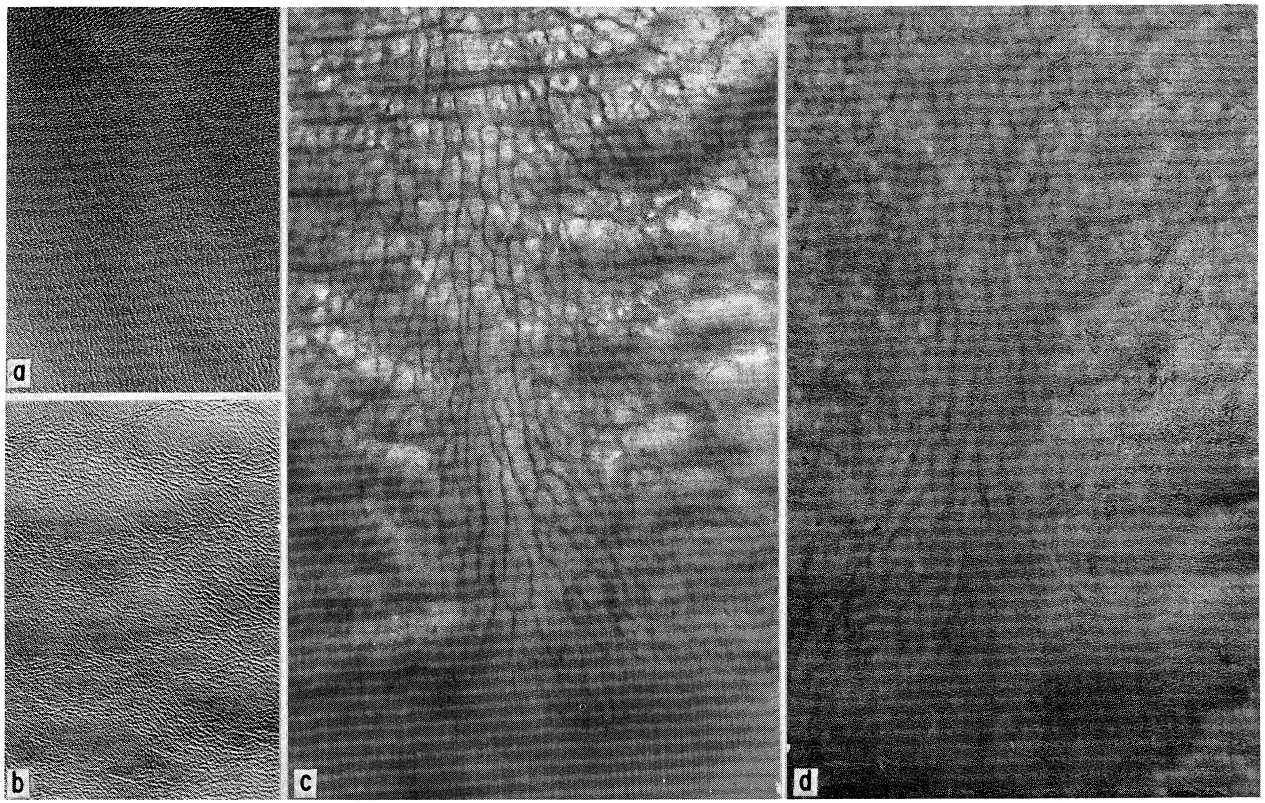


FIGURE 5.—Appearance of cockle in leather. Small blocks show grain surfaces of two samples of finished slipper leather: (a) normal; (b) cockle. Large blocks show shoulder region of crust leather with heavy cockle; (c) grain surface with hard, glossy ridges; (d) flesh surface with uneven coloring.

cockle. The raised ridges are clearly evident in the latter sample. Figure 5c shows the shoulder area of an unfinished sheepskin leather with heavy cockle. The raised, glossy ridges and mounds on the grain surface represent severe cockle. This makes the grain surface very uneven, and it often shows darker streaks as well. The cockle areas are very hard and dense and therefore cause the "break" to be extremely irregular. In fact, the spots can be so hard as to cause breakage of sewing machine needles during stitching. The flesh surface of this same area (Figure 5d) is also defective, making it unsuitable for suede, because cockle areas color a lighter shade than the adjacent background. This is apparently a carry-through effect from the grain and cannot be corrected. All of these undesirable effects vary somewhat after different types of tannage or tannery procedures but it seems virtually impossible to make good leather of any kind from seriously affected skins.

Figure 6 shows cross sections of the two samples of similar types of finished leather (Figures 5a and 5b), one completely normal and the other with heavy cockle. In the normal leather (Figure 6a) there is the familiar normal structure. In the defective leather (Figure 6b) the grain layer is greatly disorganized. There is an irregular layer of fine, densely packed fibers that seem to overfill the area and distort the structural pattern. So far we have no clear explanation for the abnormal effect on the flesh side, but the sections suggest that the corium fibers are finer and have a more compact texture.

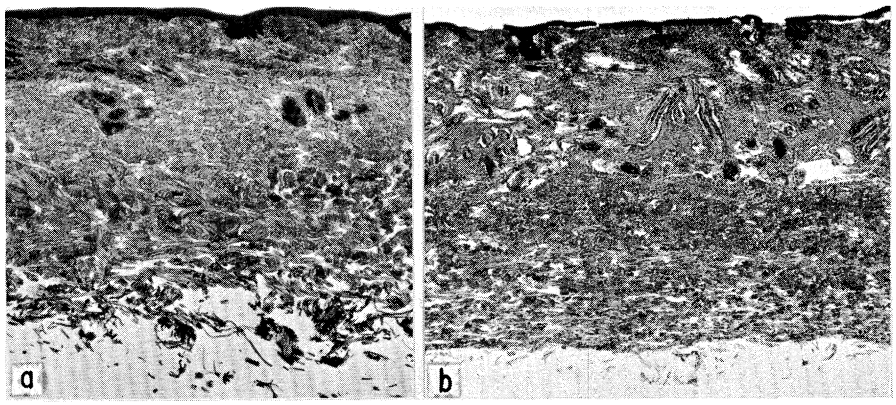


FIGURE 6.—Cross sections of finished leathers shown in Figure 5: (a) normal; (b) cockle; approx. x 38.

## CONCLUSIONS

It was confirmed that cockle is still highly prevalent in domestic woolskins during the late winter and early spring. Total counts of nodules, and their numerical distribution over the sheep's skin have been reported for the first time. It is also believed that cockle has now been unmistakably demonstrated for the first time in unprocessed skin, by clipping the wool and observing the skin by

transmitted light. Periodic sampling has given the impression that the discrete cockle nodules develop slowly to their maximal size, and that their eruption spreads gradually from the fore quarters to cover the whole body. Incomplete studies suggest that the nodules are primarily fibrous in nature and show no evidence of unusual fatty components.


## ACKNOWLEDGMENTS

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## REFERENCES


1. ALCA-ASTM Joint Committee Report (Report by ALCA Research Liaison Committee). *Leather Mfr.,* **83** (10), 30 (1966).
2. Seymour-Jones, A. The Sheep and Its Skin. The Leather Trades' Review, London (1913).
3. Anon. *Leather Trades' Rev.,* **57**, 520 (1924).
4. Blank, I. H. and McLaughlin, G. D. *JALCA,* **24**, 544 (1929).
5. Tancous, J. J., Roddy, W. T., and O'Flaherty, F. Skin, Hide and Leather Defects. Western Hills Publishing Company, Cincinnati, Ohio (1959).
6. Indian Hides and Skins — Histological Characteristics (Part I). Central Leather Research Institute, Madras, India (1963).
7. Rabinowitz, J. L., Luddy, F. E., Barford, R. A., Herb, S. F., Orlean, S. L., and Cohen, W. D. *J. Dental Res.,* **46** (5) : Part II, 1086 (1967).
8. Everett, A. L., Willard, H. J., and Naghski, J. *JALCA,* **61**, 112 (1966).



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