

**A STUDY OF THE CHANGES
IN SKINS DURING THEIR
CONVERSION INTO
LEATHER**

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A Study of the Changes in Skins During Their Conversion Into Leather by Anton Augustus Schlichte

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ANTON AUGUSTUS SCHLICHTE

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EXCHANGE
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A Study of the Changes in Skins During Their Conversion into Leather

A thesis submitted in partial fulfillment of the requirements for the
Degree of Doctor of Philosophy in the University of Michigan

By

Anton Augustus Schlichte



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EXCHANGE

*Meinen lieben Eltern in
Dankbarkeit gewidmet*

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CONTENTS.

ACKNOWLEDGEMENT	3
INTRODUCTION	3
STUDY OF MICROSCOPIC CHANGES IN HIDES DURING THEIR CONVERSION INTO LEATHER	6
Review of Literature	6
Experimental Work on Technique of Imbedding and Cutting Tissue	7
(a) Paraffine Methods	7
(b) Celloidin Methods	9
(c) Freezing Method	10
Study of Changes in Structure during Tanning.....	12
STUDY OF CHANGES IN VOLUME AND WEIGHT OF CALFSKINS DURING THE LIMING PROCESS	14
Apparatus	15
Experimental Work on Calfskins.....	17
Attempts to Remedy Thinness of Flank.....	34
Results	39
STUDY OF DEPILATION IN STERILE LIMES.....	42
Review of Literature	42
Experimental Work	43
(a) The Sterilization of Skins.....	46
(b) Laboratory Tests on Depilation.....	48
(c) Depilation and Subsequent Tannage.....	56
CONCLUSION	60
BIBLIOGRAPHY	62

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INTRODUCTION.

The use of hides both as skins and leather for protection against cold and rain, for weapons, or for ornaments, dates back to the remotest history of man.

While the hides were tanned in the earlier times with the hair on, methods were soon found to remove it and thus improve the product. The first substance used was probably wood ashes and this continued as the standard for some time. After tanneries were established, for up to this time the tanning was done only on a small scale, new substances were sought for, and lime, one of the oldest depilatory agents, was used. The method followed was to slack the lime in pits and soak the hides in a saturated solution of calcium hydroxide. This method although slightly modified has remained practically the same for centuries.

The tanning process was and is in general the following:

1. Hides are soaked to remove blood and dirt and to bring them back as nearly as possible to their original condition.

THE HISTORY OF LEATHER

2. They are placed in pits containing milk of lime, bacteria being always present and sulphides being frequently added, for from 3 to 18 days until the hair "slips" easily, that is, can be easily removed.

3. They are then bated to remove lime and bring the skin into the desired physical condition. The bate may be either acid or bacterial.

4. The next step is the pickling process in which the skins are treated usually with salt and sulphuric acid.

5. Then follows the tanning process proper, which may be either a mineral or a vegetable tannage.

6. The last step is a finishing process.

The entire tanning process has thus far been outlined to show the dependence of the finished product upon the correct performance of each succeeding step of the process. It is only through tests on the finished leather that the effect of any alteration in any step of the process can be detected.

The liming process is the one studied in greatest detail in this paper but any changes due to this operation can be detected only in the finished product. Moreover, the method of soaking must, because of its influence, also be specified. The object of soaking hides is to cause them to resume as nearly as possible their original clean and pliable condition. This part of the process while not so important when green hides are used becomes a matter of great importance when dried hides are to be investigated. The length of soaking, number of changes of water and the acids or alkalies which may have been added, all have an effect on the final product. Should the hides be soaked too long or should the water not be renewed frequently enough, bacteria multiply and a part or, in extreme cases, all of the hide may be lost. On the other hand acids and alkalies cause swelling of the hide and if too much of either be added the hide will be "plumped" too much.¹ This, while not fatal to a good final product, has its disadvantages and as a rule causes trouble.

The object of liming is not alone the removal of the hair but also the loosening of the fiber bundles. More surface is thus exposed and hence the tanning agents are taken up more readily.

¹ Jettmar Handbuch, p. 56.

In the vegetable tannage this makes a heavier leather. In the mineral tannage the loosening of the fiber bundles makes a more pliable leather.² The latter object is of great importance in the chrome tannage which is the method most used in manufacturing light or upper leathers. The hides after soaking are placed in pits in which an excess of calcium hydroxide is always present and to which some sodium or arsenic sulphide may or may not have been added. The hides are "hauled," that is, taken out and the lime "bettered" once a day until the hair "slips" easily. It requires much practice and experience before one is able to tell exactly whether a hide is done or not, and the method is not only unsatisfactory but also very unscientific, for the personal equation of the operator plays too important a part. The hides are then soaked in warm water, paddled and beamed. In the latter process the skin is placed over a piece of wood semi-circular in cross section and the hair is removed with a blunt knife. The long hairs come off very easily but the fine or "ground" hair and the pigment, especially in the case of black skins, cause some trouble. Part of the intercellular substance, corium, "scud" or "gneiss" and some lime soaps³ are also removed in this treatment.

The next operation, "bating," has as its main object complete removal of the lime remaining from the previous treatment. The loosening of the fiber bundles, however, is also materially aided by bating and this, as before mentioned, is, in the case of light leather, of greatest importance. The bates most commonly used owe their activity to bacteria and are frequently more or less unsatisfactory and harmful to the skins. Bates of known bacterial cultures are used somewhat and give good results, but the most common ones consist of organic acids such as butyric, lactic, etc.

The skins are then pickled. The pickling consists usually of a treatment with sulphuric acid and salt. One object is to partially reduce the excessive swelling caused by the bate. Another, without doubt, is to furnish some free sulphuric acid which is considered necessary in the subsequent chrome bath. This sulphuric acid is probably absorbed by the skin and thus carried over to the tan bath. This finishes the treatment received by the

² *Gerber*, No. 938, p. 253; *Procter's Principles of Leather Manufacturing*, p. 126.

³ *Procter's Principles of Leather Manufacture*, p. 136.

skins in the "Beam House," which is probably the most important division of the tanning process. The most important part of the beam house work is the liming process, and hence this was made the object of the subsequent investigations. The object was to gain some insight if possible, into this apparently simple but actually very complicated process and to furnish something of practical value to the industry.

It seemed obvious that some accurate way of controlling the liming and of judging the product afterward was absolutely necessary in order that improvements could be noted. The ordinary method of judging the product by the "feel" left much to be desired and it was recognized that the personal equation had to be eliminated as much as possible if anything of real value were to result. The most natural idea was to obtain some means of following the action of the lime step by step. This could not be accomplished with the naked eye and hence the assistance of the microscope was necessary. A review of the literature at hand showed that although considerable work with the microscope had been done the results were not very satisfactory.

STUDY OF MICROSCOPIC CHANGES IN HIDES DURING THEIR CONVERSION INTO LEATHER.

Some of the earliest work on the cutting of sections of leather was done by Kathreiner in 1879.⁴ This work was never published and on inquiring of Prof. Procter it was found that although notes had been preserved, they were in no shape to allow of their being published. Thus we have no authentic record of his work. The next reference found was to some work by Prof. Thomas Palmer.⁵ He applied his method to determine the penetration of vegetable tanning agents. The sections were mostly cut by hand. Some sections after dehydration in alcohol and clearing in clove oil were infiltrated with "Strickers" solution (gum arabic and glycerine 3 : 1) and cut with a microtome. In some cases he also dehydrated in alcohol two or three hours, cleared in a mixture of cedar oil and benzol, infiltrated in a mixture one part 50° melting point and two parts 40° melting point paraffine until transparent, and then changed to a bath of two

⁴ Procter's Leather Industries Laboratory Book, p. 424.

⁵ *Collegium*, 1902, p. 325.