

STUDY OF RESISTANCE TO ABRASION OF MUSKRAT FUR

Fall Term Zoology 500.

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Study of resistance to abrasion of muskrat fur.

The study of resistance to abrasion of muskrat fur is a new approach to the problem of determining the season of the year producing the most durable fur. Seasons at present are determined annually by the Conservation Commission upon advice of the Game Division. The advice which the Game Division forwards is offered after careful consideration of the administrative and biological factors involved. To date a fall season has been favored as the time for trapping muskrats because of certain advantages it offers⁽¹⁾. However, spring pelts bring a higher price on the market. The premium placed on late winter and spring pelts lies in the better condition of the pelts. At this time the fur is considered prime when the length, density, sheen, texture, and color of the pelage are seen in the optimum state.⁽²⁾ Although there are visible differences in the fall and spring pelts, there is no record of differences of durability. If there is a marked difference in wearing ability, then perhaps this warrants a reconsideration of the dates for the present muskrat trapping seasons.

Most of the preliminary work necessary for this problem will center around the development of a method to accurately determine durability. The dictionary defines durability as "the power of resisting agents or influences which tend to cause changes." It will be the extent of this "power of resisting" that will be examined in the furs. In textiles the capacity of offering resistance toward wear is often regarded as an independent property of materials, quite apart from other properties such as tensile strength, modulus of elasticity, or elongation at rupture. But with what factors in furs is the resistance to wear associated or not associated? Results from textiles tests cannot be applied to furs because of the great difference in materials. But if the mass of data on textile testing cannot be used, we can use some of the methods of testing because both textiles and furs made into garments are subjected to probably the same factors making up wear. The wear types applied to textiles include steady loading wear, flexing wear, shearing wear, internal wear resulting from the application of repeated or oscillating stresses, and abrasive wear.⁽³⁾ Abrasive wear probably is the most important factor in fur wear. Therefore, a machine has been designed and built to measure the resistance to abrasion of furs. Plate 1 illustrates the machine.

A survey of the literature on wearing qualities of furs reveals a paucity of material in this field. There is one reference relating to durability of furs and that is a table which appears in Peterson's "Fur Trade and Fur-bearing Animals." This table gives the comparative durability of the common furs using the otter as 100. Rabbit fur is the other extreme in this table, being rated as 5. Muskrat fur in this table is placed at 45. No explanation is offered regarding the method used in making this list. The assumption is that the table was compiled with the aid of furriers with long years of experience in handling furs.

There has been only one attempt made to determine the durability of furs by using an abrasion machine. In the September 1921 issue of the Scientific American Monthly, Dr. L. A. Hausman describes the work done. The machine that was used used both the back and forth rubbing movement and the beating movement. From the information given it seems the author worked on only a few furs—several types of rabbit fur. Using this attritometer or wear-measurer, Dr. Hausman worked mainly upon clipped and unclipped rabbit pelts.

From these experiments he concludes that unclipped fur is more durable than clipped fur. No wear index was developed so that the difference in degree of wear was not given. Whether other furs were used is not stated. From the work done on rabbit, Dr. Hausman also makes the following statements: the durability characteristic of furs and fabrics is determined by the structure of the individual hairs, particularly by the cortex element in each hair shaft. The cortex, or rigid and solid portion of the hair shaft, composed of elongate, fusiform, horny, glassy cells, which have become fused together into an almost homogeneous mass gives strength to the hair. The greater, in proportion to the medulla, the cortex, the greater the resistance of the hair to wear. There is a slight variation in the resistance character of the cortex in different species of fur-bearing mammals. This variation is probably due to the quality of the keratin, which composes the cortex cells, or to the length of the cells, or to their degree of fusion. The medulla, is an element of weakness in the make-up of the hair-shaft, for this structure is composed of empty, or nearly empty cells, often with loose strands of elastic substance ramifying between them. A hair with a large medulla is merely a hollow tube which does not offer much resistance. The otter hair (most durable) has a hair shaft that is solid, almost homogeneous horny, an elastic rod, well adapted to withstand attrition.

The recent literature contains no material expanding Dr. Hausman's early work.

Among the many things that will have to be determined in this experiment is the type of abrasive to use in the machine. In textile testing, various materials have been used. Some of the more common abrasives used in textile testing include emery cloth, garnet paper, canvas, monel wire screening, iron blocks, steel cylinders, leather-covered pulleys, and even the fabric itself.⁽⁴⁾

In textiles wear is measured by noting the following: decrease in tensile strength, loss in thickness, loss in weight, increase in porosity to air, change in reflecting power or luster. The first point is suitable for textiles which are made up of numerous fibers the strength of which affects the strength of the whole, but for pelts, it seems unlikely that fur fibers having a weaker tensile strength will wear off a hide sooner than the fur with fur fibers of a stronger tensile strength. If this work is extended, this phase should be investigated, however. Loss in thickness does not promise to be a good criteria of wear in pelts because of the difficulty of measuring the depth of such a loose and structureless zone as makes up the hair side of a pelt. It would be useless to measure the hide for changes of thickness in that a pelt is considered worn out as soon as the hide begins to be visible through the fur much before there is any wear on the hide. Loss in weight in pelts due to wear might be used to record the degree of wear. This will be investigated. Increase in porosity to air is not applicable to pelts. The last point which is using the change in reflecting power or luster to note wear should be observed in the tests but the lack of different degrees of reflecting power will make it impossible to use this criteria for fur tests. The fur is either lustrous or not lustrous, depending whether it has been tested or not. Other factors must be discovered to determine the degree of wear in furs. Several points that suggest themselves include the number of strokes of the abrasive arm to completely remove the fur fibers, the number

of strokes required to remove all of the guard hairs, the appearance of the fur fibers (microscopically) after being subjected to a certain number of strokes of the abrasive arm.

The muskrat skins that will be used in this problem will be collected at the rate of 20 a month from three regions in Michigan, namely, the Upper Peninsula, the northern part of the Lower Peninsula, and the southern part of the Lower Peninsula. It is well known that climate has a definite influence on the fur. The test will attempt to determine whether there is a difference in durability in skins taken from these three regions of Michigan. In the cold regions the animals require a heavy and thick growth of fur while in the warmer climates the fur is thinner and shorter. There is also a difference in the skin. The northern animal with poorer food resources quickly uses up the layer of fat beneath the skin so that the skin becomes very thin. In the warmer and less severe regions the animal remains in better flesh so that the skin is thicker. Fur on water animals like the muskrat is not influenced by the air temperatures as much as it is affected by the temperature of the water it lives in. Water is at its coldest some time after the weather has turned cold -- some time in the spring.

Each skin will be divided into three regions, each two inches wide. The three regions will be the ventral, the lateral, and the dorsal. The reason for doing this is the difference in time of priming for each region of the skin. Primeness begins in the ventral region first, then the lateral region, and finally the dorsal area.⁽⁵⁾ This means that a skin collected in the fall will have only the bottom strip of fur in prime condition. Whether this creates zones of different durability will be one of the purposes of the experiment.

To better understand the material with which we will work, it is important that something be known of the structure of the skin and hair. The skin of the muskrat, as in all vertebrates, consists of two parts, the epidermis and the dermis. "Four epidermal layers are recognized. The stratum germinativum, the deepest, is the layer where regeneration occurs. It contains three types of cells: germinal, spinous, and melanoblasts, which are believed to form melanin. The stratum granulosum, a thin layer of cells, is evident only where the epidermis is thickened. The stratum lucidum is also very thin and is not visible unless the skin is thick. The cells making up this layer are dead. The stratum corneum, the outermost layer, is composed of flattened, dry, dead cells, which gradually are exfoliated."⁽⁶⁾ The lower skin or dermis, known also as the corium, consists of blood vessels, nerves, lymphatics, and fibers of connective tissue. The fibers are made up of numerous thin, fine threads or fibrils, which are held together in a compact mass by a gelatine-like substance called coriin.⁽⁷⁾ "To tan or dress skin into leather, all the blood cells, fatty tissues, and connective substances must be removed by acids and by washing, so that only the fibers and horny cells remain. To prevent adhesion of these fibers and also to prevent any foreign matter from entering and causing either decay or the formation of a hard, glassy mass, oil or mineral salts must be worked into the skin. This process covers the fibers, fibrils, and cells thoroughly and completely."⁽⁷⁾

The pelage of the muskrat is made up of an integumentary structure known as hair. Hair is made up of the following structures: medulla (medullary cells and interspaces between the medullary cells (air vesicles according to some authors (7))), cortex, cuticular scales or cuticle, and pigment granules. (8) The medulla is a central core or pitch including cells, air spaces, and pigments. An interesting observation regarding medullas is that the otter rated 100 for durability has a very small medulla while the mole rated at 7 and 10 has a very large medulla with many air spaces. The cortex surrounds the medulla and is made of cells of a horny material, keratin. The outside layer of the cortex is composed of scales of thin, horny, transparent plates of keratinized protoplasm. These scales are imbricated with the tips of the scales pointing towards the apical part of the hair. It is to these scales that the lustrous quality of the hair is due. When the scales form a regular and almost unbroken surface, the luster will be very great; but when they are long and have an overlapping lip, the result is a scattered reflection or dull appearance. (7) These overlapping lips have a tendency to interlock when rubbed against each other; this condition is known as felting or matting. Color in the hair is due to pigment matter or granules that are spread throughout the hair. The pigment material within the hair shaft may be diffuse so that the shaft is homogeneously stained (ex. yellow and amber hairs). The most common cause of color is due to the presence of pigment masses occurring (1) in the cortex as separate granules, or, (2) in the medulla, usually as amorphous masses, though sometimes as discrete granules. (8) One view (7) has it that the pigment granules start in the medulla and gradually work their way into the cortex, then into the cuticle, and then to the surface, where they are thrown off. It is maintained that while on the surface the pigment granules shed water. This view is supported by the fact that in wet and marshy places, the hairs of mammals contain more pigment matter than under average conditions. There is no sexual variation in color in the muskrat, although there are color differences between areas. (9) Primeness is associated with pigment distribution in the individual hair. Gunn (5) has developed a technique for detecting primeness consisting of merely examining the hair roots for the presence or absence of pigment. If the hair root or shaft of the hair near the skin shows pigment then that section of the hide is unprime. But if the lower or basal part of the hair shaft is blanched, then the pelt is prime in that region. If the hairs indicate primeness that have been taken from the dorsal neck region, the last place to become prime in an animal pelt, then the whole skin can be considered prime.

With the exception of one form, all muskrats have only one moult, and this occurs during the warm summer months. (9) Ondatra rivalicusa, of the coast region of Louisiana, apparently molts twice a year, approximately spring and fall. Gunn has shown that the sequence of the growth of new fur, of the priming condition and of the moult is the same, and that the growth of new fur and the process of molting proceed synchronously, that the prime phase is separated from these by a definite period of time. (2)

The pelage of the muskrat is made up of a thick underfur, the main coat, and long overlying darker hairs, the guard hairs. The guard or protective hairs are the largest in both diameter and length. A typical form of guard hair is one which is fusiform in shape or of largest diameter near the mid-region and tapering toward both ends. Scales on the guard hair are

often closely appressed, giving the guard hair a high luster. The function of the guard hair is primarily one of protection against moisture, whether it be water or the dampness of the atmosphere. Intermediate hairs, an intergradation between guard and furhairs, are considered by some as undeveloped guard hairs and by others as a distinct type of hair.(10, 11) A common intermediate hair type is one that is enlarged distally while the basal part is finer and somewhat similar to that of furhairs in constitution. Furhairs, which form the thick, warm underfur, are the finest hairs of a pelt. The furhairs have nodes and internodes, an internode being a constriction of the shaft, while a node is that portion of the shaft lying between two internodes. Except near internodes and extremities, fur hairs have very little taper, the sides of the hair appearing parallel. The prominent scales on the furhair give it its dull appearance.

The following merchandising details have been obtained from Bachrach(7):

There are three types of muskrats in general use in the fur trade. The first two types are really one. The brown muskrat (O. zibethica) is generally known to the trade as the Northern Muskrat. The Black Muskrat is a black phase of the brown type. The Southern Muskrat (O. rivalicia), or Louisiana Muskrat as it is known to the trade, is the type that comes from Louisiana and Texas. Details will be given only for the Brown Muskrat, which includes the Michigan muskrats. The muskrat peltry has two principal uses in the trade:(a) it is processed into Hudson Seal, the trade name for the sheared and dyed peltry that resembles the true Alaska Seal; or(b) it is left a natural product, that is, only dressed, not processed to resemble some other fur. Both these products are worked into ladies' fur coats, and sometimes, though seldom, into trimmings. Because of the huge quantities manufactured annually, they are known as the basic staples of the trade, and act as a barometer of business conditions.

Peltries used for Hudson Seal product must have a heavy, greasy skin which will produce a strong leather that will not be eaten up or made tender by the dyes. The fur fiber must be thick so the hide does not suffer from the shearing and unhairing process. Also the peltries must be fairly large, as the cost of processing is just as much for a small peltry as for a large one. Michigan is included as one of the Hudson Seal sections.

Quality is assorted in the individual lot according to seasonal names rather than as Firsts, Seconds, etc.

SPRINGS--spring-caught: skin is absolutely clear of any grayish or bluish spots, has a pinkish color, and is supple.

OVER-SPRINGY: supple feeling is absent and skin feels "board-like" with either a very dark red or cream-colored appearance. Spring-caught muskrats show marks of the teeth of males.

WINTER-CAUGHT: skin slight grayish or bluish marks in parts of back, mostly in the center back. Guard hair not very well developed.

FALL-CAUGHT: bluish or grayish marks throughout back and belly.

KITTS: are the lowest quality. Peltries are taken from young, half-grown "kittens."

For size, muskrat peltries are assorted as Extra Large, Large, Medium, and Small.

Musk rats from nearly all sections are cased-handled. Most sections handle their skins pelt-out (flesh side).

Generally speaking, the winter-caught peltry has the darker color and convenient size, whereas the fall-caught peltry lacks this size. The spring-caughts may have the size, but they lack the desired color, having taken on a reddish cast, both in the back and the belly.

How can wear in furs be measured? Dr. Hausman (12) in his early work on durability identified the beginning of "wear" at the time that the protective or guard hairs broke off and the cortex at the broken ends frayed out. The test was continued until the same stage of disintegration was reached in the fur hair. These stages of pelage wear were followed and checked by examination of the fur sample under a microscope from time to time during the test. No indication of what was used as the wear index (as time required to attain "wear" of fur fibers or the number of movements required by abrasive head to achieve "wear" conditions) is given.

In some experiments upon carpets three workers of the Bureau of Standards (13), (14) first evaluated the rate of wear by measuring the change of thickness of the pile of the carpet at regular intervals and by collecting the material worn off and weighing same. The weight of the material removed was plotted against the total number of revolutions the turntable containing the sample made against the abrasive wheel. In further experiments this was simplified to where the number of revolutions required to wear the pile of the carpet down to $\frac{1}{4}$ of the original pile thickness was used. Variations of the wear indexes in carpets might be adapted for fur wear experiments. This will be one of the first steps in the experiment.

Results obtained from the wear tests on carpets indicate that the wear produced by the machine is similar to that produced in service and they indicate a direct correlation between serviceability and the machine wear index. We hope a similar correlation will be found in the fur tests.

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GLOSSARY

| | |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FUR | An animal's skin with the hair intact. |
| QUALITY | Refers to density of coat — in colder climates there is a heavy, thick growth of hair and fur; skin becomes thin; in warmer climates fur is shorter, scander and hide is thick. |
| TEXTURE | Associated with terms like silkier and coarser; colder climates or altitudes cause fur and guard hair to grow longer so fur is silky. |
| LUSTER | The unbroken reflection of light from any surface; depends upon type of scales making up the hair; scales with overlapping lips give the hair a dull appearance. |
| PRIME | To the trade refers to the condition that is in pelts during the coldest and dryest time of the year. Skin is free from any discoloration either bluish or reddish, both of which are indications of unprime quality. |

Report of Progress of Durability of Muskrat Pelts Experiment.

PERIOD - Fall term, September 25 to December 15, 1939.

RESEARCH INTO LITERATURE - A survey of the literature revealed that very little work had been done in the field of determining the durability of fur. Only one reference mentioned work done along these lines. Dr. L. A. Hausman, of the Zoology Dept. of N. J. College for Women, New Brunswick, N.J., designed and constructed a wear-testing machine, called attritometer, back in 1921. With this machine, Dr. Hausman showed that unclipped rabbit fur is more durable than clipped fur. Another conclusion of some interest was that wear resistance was attributed to the cortex material of the fur fiber. This experiment represents the only recorded work of a nature similar to the experiment on durability in muskrat furs.

SKINS - A survey of the pelts on hand as of Dec. 1, 1939 at the Conservation Laboratory, Anatomy Building, on college campus, shows the following figures:

| | 1934 | 1935 | 1938 | 1939 |
|-------------|------|------|------|---------------|
| Sept. | | | 1 | |
| Oct. | 2 | | | |
| Nov. | 3 | | | |
| Dec. | 8 | 1 | | |
| Jan. | | 6 | | 4* |
| Feb. | | | | 36 (32+4*) |
| March | | | 22 | 135 (131+4*) |
| April | | | 11 | 95 (69+26*) |
| May | | | | 45* |
| TOTAL | 13 | 7 | 34 | 315 (232+83*) |
| SUM TOTAL - | 369 | | | |

A complete set of skins for the purposes of this experiment should include 20 skins from the Upper Peninsula, 20 from northern Lower Peninsula, 20 from southern Lower Peninsula for each month from November through May or a total of 420 skins for the seven month period from the whole state. Such a set does not exist. Mr. Ruhl, of the Game Division, has been advised of this (communication dated Oct. 23, 1939) and it has been recommended that a complete set be started November, 1939 to cover the period Nov. 1939 through May, 1940. A communication from Mr. Ruhl stated that a request for skins had been sent out to field men in the three areas of the state.

APPARATUS - Using some of the features of textile wear-testing machines, a machine was built during the Fall Term by the College Machine Shop which will apply an abrasive action upon furs. The accompanying drawing illustrates the main features.

TESTING PROCEDURE - As the wear-testing machine was completed only two weeks before the end of the term, very little actual work with it has been done. The testing will be guided by the following points:—

A. Preliminary

1. Determining wear--an effort will be made to determine what constitutes wear.

a. Wear might be identified as the stage where all fur fibers have been removed from the pelt leaving only the bare skin, or

b. As suggested by Dr. Hausman, wear starts at the time the guard hairs break off and cortex at broken ends fray out, or

c. Perhaps wear can be measured after a certain weight of hairs have been rubbed off. An accurate index of wear will be worked out first before proceeding with actual experiment.

2. Testing machine

To see if the results of the machine are consistent, various tests will be applied. Strips of fur from the same general area of one skin will be tested to detect any variation in uniformity of results. Strips of fur from the otter, which is rated 100 in durability, and strips of rabbit, hare, or mole fur, which are rated at 5 for durability will be tested to see if the machine can demonstrate this difference in durability.

Various abrasive surfaces will also be tried out to determine the best suited for fur. Various weights on abrasive head will be tested.

3. Slides will be made of the fur fibers that have been worn off and by means of microscope examinations an attempt also will be made to determine the effect of wear on the fibers themselves.

B. Principal part of experiment.

Once the preliminary testing is finished the collected and tanned skins will be tested. Three strips 2 inches wide and 6 inches long will be taken from each skin. These strips will be cut from the ventral, lateral, and dorsal portions of the pelt. The results of the testing will be correlated with such data concerning the skins as date of trapping, place of capture, sex and age. It is hoped that the experiment will shed some light upon the problem of differential durability of muskrat pelts.

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"The Value for Clothing Use of Muskrat Pelts Taken Prime and Those Taken Out of Season"

Dagmar Christine Maurine Gustafson

Master of Science thesis at Iowa State College
Submitted in 1938. - Major subject - Textiles and Clothing

Experimental work:

Method of procedure:

7 sets of muskrat pelts were used -- taken from animals of different ages and at different months of year -- all practically from same locality. Pelts divided into two groups, the prime and out of season. In prime group there were 2 sets, one as young, other as adult. There were 5 sets in out of season group, the exceedingly young, very young, and three of adult. The out-of-season pelts were taken during the summer months from May to September while the prime were taken in November. The pelts were tested in various ways:-

Ether extraction - Soxhlet extractor - specimens were brought to constant weight in an oven at 105 C. - anhydrous ether for 18 hours. After removal they were dried and again brought to constant weight. Loss in wt. calculated and percentage loss determined.

Hair count - samples $\frac{1}{4}$ in. sq. were cut from various portions of back sections of each set tested. 5 determinations for each were made. The number of guard and underhair in each sample was found and each result was multiplied by 16. This gave number of guard and underhair per square inch. The average for each set with deviations was calculated.

Thickness of pelt - fur was shaved from the skin to determine the thickness of the pelt and ten readings were made for each set. Thickness was determined by means of an automatic micrometer.

Length of guard and underhair - measured by means of a linear steel scale in inches. 10 determinations - averages with deviations calculated.

Diameter of guard and underhair - specimens mounted on slide under cover glass. Diameters of 10 individual guard and underhair for each set were made.

Percentage glass - determined by Ingersoll glarimeter. 5 readings with the flow of the hair were made for each set. Both the degree reading and percentage glass were reported. Readings were registered to tenths of a degree and the percentage of glass obtained from the Ingersoll conversion table.

Breaking strength and elongation of pelts - The Scott Universal tester was used. The strip method in testing was used. All specimens were cut $6 \times 1\frac{1}{4}$ ". 5 lengthwise and 5 crosswise readings were made and averages with deviations calculated.

Abrasion - The samples to be tested were changed in the Wyzenboek abrasion machine and subjected to 3,000 double rubs at a pressure of 4 and at constant tension. The machine operates at a rate of 91 double rubs per minute. Three lengthwise and three crosswise cuttings for each set were tested. The average weight in grams before abrasion and the average weight after abrasion with deviations was calculated for each.

Photomicrographs - All longitudinal sections of both the guard hair and the underhair were mounted directly from the pelt in Gum of Damar. All the cross sections of both the guard and underhair were tied in separate bundles, allowed to infiltrate in the paraffin oven overnight in Altman's mixture. They were imbedded in Altman's mixture, cut 7 microns thick and mounted on slides. They were allowed to dry overnight and the Altman's mixture removed by xylene. After all the paraffin was removed, the slides were mounted in Gum of Damar. In making the slides to show the scales, the hairs were placed in 1% potassium hydroxide for $\frac{1}{2}$ hour. Each hair was mounted separately in a small amount of the potassium hydroxide and a cover slip applied. The wet preparations were used for the photomicrograph. The long. sect. of medullas of both guard and underhair were taken at 500 dia. Cross-sections and scales at 410 dia.

Results:

Ether extraction - least loss in wt. appeared in out of season, exceedingly young group - loss 5.94%. Greatest loss in wt. - prime adult group - 12.41%. Four specimens for each group should have been extracted and averages calculated. Only one extraction of each group was made due to insufficient material.

Number of guard hairs:- The greatest av. hair count - 72.058/sq. in. in adult prime group. Lowest average hair count - 25.509 in exceedingly young out of season. Least deviation in number of guard hairs was found in out of season May group - was 8.17%. Greatest deviation in number of guard hairs out of season - July - 47.92%. Least deviation of underhairs - out of season very young group - 5.29%. Greatest deviation of underhairs - prime young group - 30.03%. Least deviation of underhairs - and guard hair - out of season, very young - 5.48%. Greatest deviation of underhair and guard hair - prime young - 29.61%.

Number of Guard Hairs per square inch

| | <u>Average</u> | <u>Underhairs</u> |
|-------------------|----------------|-------------------|
| Young - Nov. | 1,741 | 45,165 |
| Adult - Nov. | 1,757 | 70,301 |
| Exceedingly young | | |
| - June to Sept. | 1,027 | 23,482 |
| Very young | 1,302 | 30,419 |
| Adult - July | 240 | 32,842 |
| Adult - June | 950 | 32,666 |
| Adult - May | 893 | 36,730 |

Thickness in inches -

Least thickness of pelt - out of season exceedingly young - av. .0068 in
 Greatest " " " " " " July group - " .0236
 Least deviation in thickness of muskrat pelts in prime adult group -
 12.97%.
 Greatest deviation in thickness of muskrat pelts in out-of-season May
 group - 36.24%.

Length of hair - Least av. length of guard hair - out of season exceed.
 young - .79 inches.
 Greatest av. length of guard hair - prime young - 1.35 inches.

Diameter in inches -

Least av. dia. of guard hair in prime young - .0029 inches
 Greatest av. dia. of guard hair in out of season May - .0049 inches
 Least av. dia. of underhair - out of season very young - .00048 inches
 Greatest av. dia. of underhair - out of season June group - .00059 inches

Gloss reading -

Least av. degree in gloss - out of season June group - 16.8 degrees
 Greatest av. degree in gloss - prime young - 22.1 "
 Least deviation - out of season July group - 3.40 %
 Greatest deviation - prime young - 14.25%

Breaking strength in pounds (humidity 65% - Temp. 70 degrees F.)

The least av. breaking strength of lengthwise specimens - out of season
 exceedingly young - 5.4 lbs.
 Greatest av. breaking strength of lengthwise specimens - out of season
 June - 62.8 lbs.
 Least av. breaking strength of crosswise specimens - out of season
 very young - 18.2 lbs.
 Greatest av. breaking strength of crosswise specimens - out of season
 June pelts - 80.6 lbs.

Elongation - in inches

Least av. lengthwise - out of season exceedingly young - .3 inches
 Greatest av. " - prime young - .84 "
 Least av. crosswise - out of season July (poor) - .67 "
 Greatest av. " - prime young - .96 "

Resistance to Abrasion -

Least deviation in resistance in lengthwise specimens - prime adult group - 6.78%

Greatest deviation in resistance in lengthwise specimens - out of season, exceedingly young - 19.84%

Least deviation in resistance in crosswise specimens - out of season May - 3.31%

Greatest deviation in resistance in crosswise specimens - out of season exceedingly young - 17.59%

| Group | Month | Lengthwise | | Crosswise | |
|---------------|----------------------------------|----------------------------------|---------------------------------|-----------|--------|
| | | Av. wt. in grams before abrasion | Av. wt. in grams after abrasion | Before | After |
| Prime | (Young Nov. | 2.3634 (3 samples) | 2.1732 | 2.7812 | 2.6046 |
| | (Adult Nov. | 3.6161 (3 samples) | 3.3710 | 2.8287 | 2.6649 |
| | (Exceedingly young June to Sept. | .6468 (1 sample) | .5185 | .6519 | .5372 |
| Out of Season | (Very young June to Sept. | 1.485 (1 sample) | 1.3408 | 1.0507 | .8691 |
| | (Adult July | 1.8337 (2 samples) | 1.6437 | 2.5830 | 2.3726 |
| | (Adult June | 2.3807 (3 samples) | 2.1830 | 1.8056 | 1.5377 |
| | (Adult May | 2.3378 (3 samples) | 2.1720 | 2.7562 | 2.6649 |

Conclusions:

Unprime pelts contain less fat than prime pelts. Prime pelts were greater in thickness and more glossy than in the unprime. The guard hairs were fewer in number in the July pelts. The June and July pelts were light in color, dry and lacking in luster. As a whole the guard hair in the prime pelts was longer than in the unprime but the underhair on the unprime was longer. The lack of length in guard hair of the adult unprime pelts was probably the result of external wear. The diameter of hair was greater in the adult pelts than in the young, with very little difference between the prime and unprime groups. The greatest average thickness of pelt was found in the adult July group and the greatest variation in thickness of pelt was found in the adult May group. The pelts of the prime adult group were thinner than the unprime adult but thicker than the young. As a whole, the breaking strength was greater in the adult unprime than in the prime.

There was less loss in weight due to abrasion in the prime pelts than in the out of season. The exceedingly young, very young, and the July out-of-season had the fur entirely rubbed from the pelt.

Photomicrographs - Scales of young less pronounced than in adult; scales of underhair were sharper and deeper than in guard hair; medulla in young larger in comparison with rest of hair shaft; medulla of adult prime smaller in relation to rest of hair shaft than in adult out of season group.

References -

U. S. Bureau of Standards - Testing and properties of textile materials.

U. S. Bureau of Standards -
Circular 41. 3rd ed. Sept. 1918

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GRADING OF WORN PELTS

Ten pelts were selected that were all collected at about the same date and at the same locality. Dorsal strips, two inches wide, were cut from these pelts and then subjected to abrasion. A series of samples were made showing the effects of abrasion at intervals of 100 mbs, so that a set of pelts rubbed from 100 through 1000 rubs became available. A similar series was made using the lateral strips from the same pelts. These series became the standard series and all pelts that were tested were rubbed 500 times and then compared with the standard series. If the test pelt had the appearance of the standard series pelt that was rubbed 500 times, then a figure 500 was given this test pelt as its grade. Similarly, if the test pelt appeared like the standard series pelt that was rubbed 800 times, the number 800 would be the test pelt grade. Twenty one pelts were tested using this method. The table below shows the results that were obtained.

TABLE E

| <u>Date pelt was trapped</u> | <u>Dorsal</u> | <u>Lateral</u> |
|----------------------------------|---------------|----------------|
| September 30 | 400 | 300* |
| October 27 (69) | 400 | 800 |
| December 1 (51) | 400 | 700 |
| December 4 (58) | 600 | 700** |
| February 25 (282) | 500 | |
| February (291) | 400 | 700 |
| March (94) | 500 | 800 |
| April 23 (331) | 400 | 800 |
| April (39) | 350 | |
| April (228) | 600 | |
| May (451) | 700 | 500* |
| May (457) | 650 | 800** |

*Dorsal strip showed more wear than lateral by visual examination.

**Dorsal strip showed less wear than lateral by examination.

Relation of loss of weight and wear:

Five samples from the dorsal strip were weighed on an analytical balance before and after abrasion. The table below records the differences observed.

TABLE A

| | 200 | 400 | 600 | 800 | 1000 |
|-----------------------|--------|-------|-------|-------|--------|
| Initial weight | 11.501 | 8.586 | 8.313 | 8.889 | 12.89 |
| Weight after abrasion | 11.388 | 8.449 | 8.179 | 8.807 | 11.935 |
| Difference | .123 | .139 | .134 | .082 | .154 |

There seemed to be no progressive loss of weight with the increase in number of rubs. Pelts abraded 600 and 800 times showed less loss of weight than pelts only rubbed 200 and 400 times. During the course of the weighing, the weights for the same sample were observed to vary if weighed again a few hours later. Evidently, some variable like humidity was affecting the weight of the fur. Not having the facilities for keeping the samples at constant temperature and humidity this phase of the experiment was discontinued.

Relation of the number of guard hairs and degree of abrasion:

In general, there was a decrease in the number of guard hairs with an increase in the number of rubs. But this decrease was not closely correlated with the degree of wear as recognized by visual examination.

Methods of counting guard hairs:

A. Number of guard hairs crossing a line

A line two inches long was ruled on an ordinary microscope glass slide. The slide was then placed on the abraded pelt in three different zones. In each zone a count was made of all the guard hairs that crossed the line. The three counts were then averaged. The results appear in the next table.

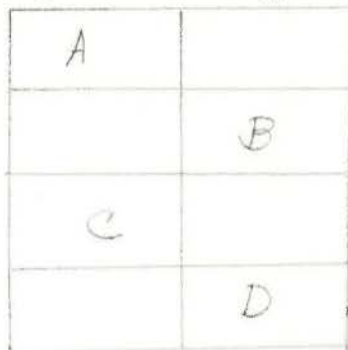
TABLE B

| Number of Strokes | Number of Guard Hairs | | | Average (nearest whole number) |
|----------------------|-----------------------|----|----|--------------------------------|
| | Zone 1 | 2 | 3 | |
| 200 | 25 | 51 | 70 | 49 |
| 400 | 33 | 70 | 40 | 48 |
| 600 | 29 | 46 | 38 | 38 |
| 800 | 30 | 26 | 22 | 26 |
| 1000 | 31 | 19 | 18 | 23 |
| 1200 | 23 | 4 | 22 | 16 |
| 1400 | 12 | 8 | 10 | 10 |
| 1600 | 15 | 2 | 6 | 8 |
| 1800 | 18 | 5 | 3 | 9 |
| 2000 | 18 | 2 | 2 | 7 |
| 2200 | 11 | 2 | 4 | 6 |
| 2400 | 2 | 2 | 0 | 1 |
| 2600 | 3 | 2 | 3 | 3 |
| 2800 | 4 | 4 | 2 | 3 |
| 3000 | 1 | 1 | 4 | 2 |
| 3200 | 3 | 0 | 0 | 1 |
| 3400 | 4 | 1 | 1 | 2 |
| 3600 | 3 | 2 | 0 | 2 |

The figures show a decrease in number of guard hairs with an increase in rubbing but the counts are so close (only a difference of one between 200 and 400 rubs; a difference of 11 between 200 and 600 rubs) that they are not at all correlated with the appearance of the pelt. The eye detected considerable difference between pelts rubbed 200 and 400 times but the count revealed only a difference of one guard hair.

B. Number of guard hairs remaining in a unit area

An area 2 by 2 $\frac{3}{4}$ inches was ruled on a glass plate. This area was divided into eight equal parts. See figure below.

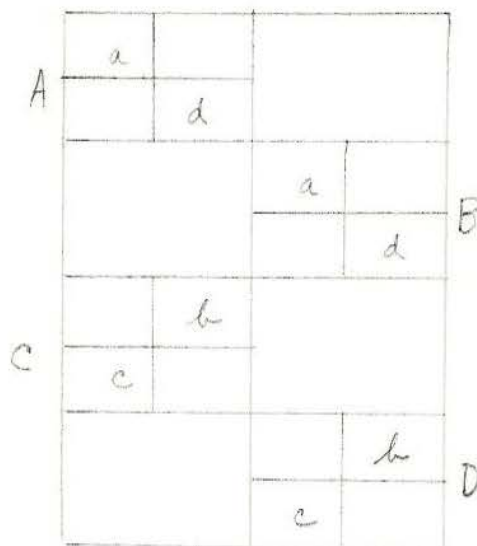


The dimensions were such that the ruled area approximately covered the worn-out region on the pelts. In making the count, the glass plate was placed on the pelt so that the ruled areas covered the abraded regions. Then all the guard hairs that were found ($\frac{1}{3}$ or more of the shaft showing) in the areas marked A, B, C, and D were counted. A count was made for a series of dorsal strips abraded 100 through 1000 times. The guard hair counts appear in table on following page:

TABLE C

| <u>Number of Rubs</u> | <u>A</u> | <u>B</u> | <u>C</u> | <u>D</u> | <u>Average</u> |
|---------------------------|----------|----------|----------|----------|----------------|
| 100 | 50 | 120 | 120 | 150 | 110 |
| 200 | 50 | 80 | 50 | 80 | 85 |
| 300 | 30 | 200 | 90 | 150 | 117.5 |
| 400 | 40 | 50 | 20 | 50 | 40 |
| 500 | 15 | 100 | 10 | 50 | 43.75 |
| 600 | 10 | 10 | 15 | 30 | 16.25 |
| 700 | 15 | 20 | 20 | 50 | 26.25 |
| 800 | 10 | 15 | 15 | 20 | 15.00 |
| 900 | 10 | 15 | 10 | 15 | 12.5 |
| 1000 | 15 | 25 | 3 | 20 | 15.75 |

A count was made on five pelts with an area containing even smaller subdivisions.



The table recording this count appears on the next page.

TABLE D

| Number of rubs | 100 | 200 | 200* | 300 | 400 | 500 |
|-------------------------------------|-----|------|------|------|------|------|
| Subdivision on pelt | | | | | | |
| A (a) | 19 | 15 | 17 | 20 | 10 | 8 |
| (d) | 29 | 35 | 40 | 20 | 25 | 20 |
| B (a) | 40 | 50 | 60 | 60 | 33 | 35 |
| (d) | 30 | 100 | 100 | 60 | 35 | 40 |
| C (b) | 60 | 30 | 50 | 55 | 20 | 10 |
| (c) | 60 | 25 | 35 | 30 | 25 | 8 |
| D (b) | 80 | 40 | 65 | 60 | 30 | 45 |
| (c) | 50 | 45 | 50 | 60 | 40 | 20 |
| Average | 46 | 42.5 | 52.1 | 45.6 | 27.2 | 23.2 |
| (*A binocular microscope was used.) | | | | | | |

Table C shows that enumerating the guard hairs after abrasion does not give any accurate means of detecting wear. Although there is a gradual loss of guard hairs with increasing number of rubs, the loss follows no orderly pattern. For example, the average number counted in four squares for 300 rubs was greater than the number in 100 rubs. Also the number at 600 rubs was practically the same as the number for 1000 rubs.

Table D which records the counts using smaller subdivisions also shows that there is little correlation of loss of guard hairs and degree of wear, at least for the first 300 rubs.

A binocular microscope was used to make one count. The figures were higher but not enough to be significant.

Wetting the fur before counting made the guard hairs darker and more visible, but it also tended to bring them together. This method was not adopted.

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Summary of Muskrat Pelt Durability Tests

Durability of the muskrat pelts submitted for this experiment was judged by comparing each abraded sample with a standard series of muskrat skins. The standard series consists of 10 pelts that show a progression of wear from 100 double-rubs (abrasive arm of attritometer makes a forward and backward movement while counter only records this as one; any reference to number of rubs will mean double-rubs) through 1,000, differing by a hundred from one another. This series represents the "yard stick" against which all the pelts were measured. Each skin that was tested, was rubbed 500 times. Then this worn sample was compared with the standard series. If the sample resembled number 400 of the series, then it was judged to be more durable than a skin that after also being rubbed 500 times appeared to resemble the number 200 of the standard series.

Although 154 skins were tested, the number for each of the six months and for the three zones of the state often was very small. For instance, only two pelts were on hand from Zone 1 for April. Where it was possible, 10 pelts were tested for each month from each zone. Time permitted only the testing of the dorsal strip. The lateral and ventral strips were saved and are stored at Rose Lake Experiment Station.

A few interesting figures were obtained in this experiment. The most durable strips were found during the months of Dec., Jan., and Feb. in Zone 1; in Nov., Jan., March, and April in Zone 2; and in Nov., Dec., Jan., and Feb. in Zone 3, as seen in Graph 1. In Graph 1A as a result of enlarging the groups a broader picture was obtained. Durability seemed to decrease from February on in Zone 1, and the same trend for Zone 3. In Zone 2 durability appears to increase from November to April.

More males were found in skins judged to be in the 400 and 500 classes. There were 30 males to only 16 females in these groups.

The canvas abrasive (#6 Army Duck) was used only twice and then was changed. Although the surface appeared not to change materially a coating of grease began to accumulate and the abrasive probably would have been affected if used on more than two pelts.

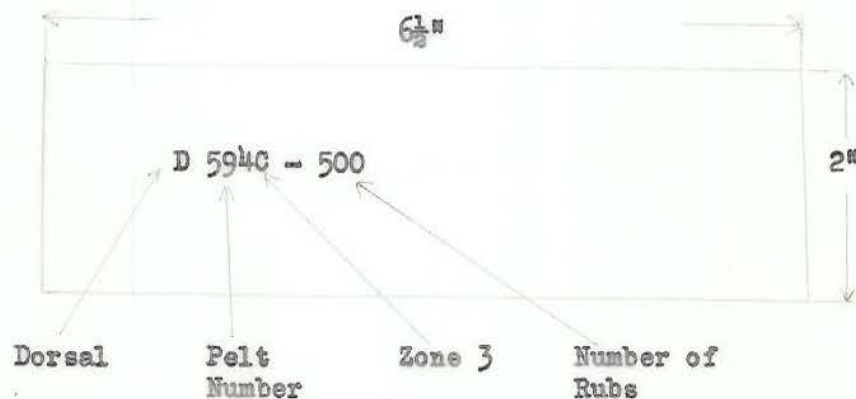
SYSTEM OF NUMBERING PELTS:

TABLE SHOWING RESULTS OF GRADING

| MONTH | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <u>Zone 1</u> | | | | | | | | | | |
| November | | | | 1 | 1 | 6 | 2 | | | |
| December | | | | 1 | 3 | 3 | 1 | 2 | | |
| January | | | | | 2 | 5 | 3 | | | |
| February | | | | 1 | 3 | | 6 | | | |
| March | | | | | | 1 | 6 | 3 | | |
| April | | | | | | 2 | | | | |
| <u>Zone 2</u> | | | | | | | | | | |
| November | | | | 1 | 1 | 1 | 2 | 1 | 1 | |
| December | | | | | 1 | | 7 | 2 | | |
| January | | | | | 2 | 3 | 3 | 1 | | |
| February | | | | | 1 | | 2 | 1 | | |
| March | | | | | 2 | 1 | 2 | 1 | | |
| April | | | | 3 | 2 | 1 | 3 | | | |
| <u>Zone 3</u> | | | | | | | | | | |
| November | | | | 3 | 2 | 1 | 1 | 1 | | |
| December | | | | 2 | 2 | 1 | 4 | 1 | | |
| January | | | | 3 | 2 | 2 | 3 | | | |
| February | | | | 3 | 2 | 1 | 3 | 1 | | |
| March | | | | 1 | 1 | 3 | 4 | | | |
| April | | | | | 1 | 3 | 6 | | | |

Number of pelt tested (dorsal strip):

Zone 1.....52

Zone 2.....45

Zone 3.....57

Total for State.....154

GRAPH I



Abraded pelts resembling the 400 and 500 in the "STANDARD SERIES" were considered as showing resistance to attrition better than the pelts resembling 600 and up of the series. The percentages of such "better pelts" are plotted on the above graphs.

GRAPH 1A



In these graphs those skins placed in classes 300-400 and 500-600 are plotted. There was less difference (to the eye) between 300 and 400 of the "STANDARD SERIES," and greater change of appearance between 400 and 500. Grouping the 300-400 and 500-600 tends to reduce the number of mistakes made -- mistakes that crept in because judging was difficult in many instances.

STANDARD SERIES

Pelts used for the standard series came from Zone 2 (six from Midland County, four from Roscommon County) and were trapped during the month of April, 1940.

Number of double rubs:

100.....shows very little wear.

200.....small areas of matted underfur showing
fewer guard hairs beginning to appear.
These areas will be known as 'worn areas.'

Number of double rubs:

- 300.....worn areas increase in size (about $\frac{1}{3}$ of total area rubbed).
- 400.....about one-half of rubbed zone made up of worn areas; total number of guard hairs about $\frac{1}{2}$ of the number in 300.

Number of double rubs:

- 500.....worn area practically covers whole area
which is characteristic of all the suc-
ceeding pelts of the series; remaining
guard hairs straight and in clumps.
- 600.....most (90%) of the guard hairs are still
straight but are now single, no longer in
groups or clumps.

Number of double rubs:

700.....remaining guard hairs are all broken
and upon closer examination many (104)
show splitting and shattering.

800.....guard hairs now practically removed
from one-third of the area.

Number of double rubs:

900.....at least one-half of area now without
guard hairs.

1000.....much like 900; fewer guard hairs left.

Operating the attritometer. Parts of the pelts seen under the left hand make up the dorsal standard series with which all abraded furs were compared. At right end of the machine, is seen the celluloid form which was used to mark the skins into two-inch dorsal, lateral, and ventral strips.

A close-up of the attritometer. The hand is holding the abrasive head to which is attached a strip of No. 6 Army Canvas Duck, the abrasive material. The spring balance (part of it seen at center left) permits the maintenance of uniform pull of six pounds on the fur sample while it is being tested. At bottom center is shown the weight which rests on the abrasive head. The weight consists of a tin "boat" filled with lead shot and covered with paraffin. Together with the abrasive head total load on fur sample is 1500 grams. The speed of the abrasive head across the fur sample is 72 double rubs a minute. The above data approximates the specifications for textile testing procedure.

Differences in Durability

The two samples attached to the next page illustrate the difference in durability between different muskrat pelts. Pelt #594 came from an adult male muskrat trapped November 29, 1939 at Swan Creek Experiment Station in Zone 3. It was judged as resembling 400 of the standard series. Pelt #646, from an adult female muskrat trapped November 22, 1939 in Midland County, Zone 2, was placed in class 900. Both of these pelts were rubbed 500 times on the attritiometer under conditions as similar as possible.

The attritiometer can readily demonstrate the difference in resistance to abrasion between pelts from different species of mammals. All three pelts (attached to page) muskrat, otter, and cottontail rabbit were rubbed until most of the guard hairs were removed from the pelt. The number of rubs to accomplish this in the muskrat was 800, for the otter, 1700, and for the rabbit, 400.

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Dorsal strip of
muskrat --
Rubbed 800 times

Dorsal strip of
otter --
Rubbed 1700 times

Ventral strip from
cottontail rabbit --
Rubbed 400 times

Phenomena of Primeness

A pelt is PRIME when the length, density, sheen, texture and color of a pelage are seen in the optimum state.

The fur trade recognizes a pelt as prime when it is free from any discoloration, either bluish or reddish and with a full and thick covering of fur fiber.

To discover a more scientific method of detecting primeness, Dr. C. K. Gunn, of the Dominion Experimental Fox Ranch, Canada, studied the problem. As a result of his work a method was developed which permits the fur farmer to detect primeness in the living animal. Also primeness is explained.

PRIMING - a maturation process; phase of the life cycle of the hair.

- A. 1. New hair roots deep in the dermis and are highly pigmented. This accounts for the blue color in unprime pelts.
- 2. Hairs are arranged at a very acute angle to the skin surface.
- B. 1. Hair straightens out -- almost vertical; gives pelt a full and thick appearance.
- 2. Root separates from papilla; all vital connections not severed, however.
- 3. Pigment disappears from basal portion of hair shaft, the reason prime pelt is light pink in color.
- C. Total primeness lasts for a definite period (about a month in *Lepus americanus*).
- D. Shedding starts -- with the process of moulting growth of new fur proceeds synchronously.

ZONES OF PRIMING: (in muskrat)

- a. Ventral region becomes prime first - in fall.
- b. Next the lateral region becomes prime - in winter.
- c. Finally the dorsal region; last place to become prime are areas at back of neck and root of the tail - attained in spring.
- d. Total primeness lasts from the time the dorsal surface becomes prime until the ventral surface shows pigmentation again.

SUMMARY:

- 1. Primeness in all fur-bearing animals, save the albino, is solely dependent upon a blanching process of the hair roots.
- 2. This process is entirely independent of the thickness of the dermis.
- 3. Primeness is a part of life cycle of the hair.

REFERENCE:

- Gunn, C. K., Canadian Journal of Research, vol. vi, 1932, pp. 387.
- American Naturalist, vol. 66, Nov. 1932, pp. 546-559.
- Hadwen, S., Canadian Journal of Research, vol. 1, no. 2, 1929, pp. 189-200.

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5-15-42

Phenomena of Primeness

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