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THE ALASKA FUR ID PROJECT: A VIRTUAL RESOURCE FOR MATERIAL IDENTIFICATION

ELLEN CARRLEE AND LAUREN HORELICK

ABSTRACT

The Alaska Fur ID Project, online at http://alaskafurid.wordpress.com, is a free internet resource developed at the Alaska State Museum. The website provides a reference set of images and data for more than 50 Alaskan animal furs used traditionally or commercially, as well as a compilation of practical observations and techniques for analysis. Both guard hair and underfur were examined for many clues, including maximum length in millimeters, diameter range in microns, medullary index, presence/pattern/appearance of the medulla, pigmentation in the cortex or medulla, banding, scale pattern and its change along the length of the shaft, and cross-sections. Slides mounted with Cargille meltmount and scale casts taken with Duco cement were examined under polarized light microscopy (PLM). This paper explains the design and methodology of the project as an example of a regional material identification dataset. It also discusses the possibilities and limitations of fur identification by this method. Many previous attempts to use microscopy for hair identification have suffered from the challenges of acquiring and disseminating good quality images as a reference set for the user, as well as limiting themselves to certain measurements while overlooking others. The project utilizes simple design and vocabulary to be accessible to many users, including museum conservators, archaeologists, biologists, forensic scientists, and students. An index, glossary, and annotated bibliography assist the non-specialist user.

1. BACKGROUND

Identification of materials in ethnographic, historical, and textile collections is often challenging, with a lack of comparative reference material as one limitation. Correct identification can inform cultural attribution, cultural meaning, trade relationships, historical period, methods of manufacture, and authenticity of artifacts. In the past, museum conservators grappling with fur identification had to rely on outside experts or have a reference set for comparative analysis. Before the advances of digital photography and the internet, photomicrography and publishing the images were limited. Previous studies of animal fur tend to concentrate on either general techniques for hair examination without dealing with a specific geographic area (Brown 1942; Deedrick and Koch 2004; Goodway 1987; Heyn 1954; Hicks 1977; Brunner and Coman 1974; Oyer 1946), or focused on detailed analysis of many species not found in Alaska (Adjordan and Kolenosky 1969; Blažej et al. 1989; Mathiak 1938; Mayer 1952; Moore et al. 1974; Stains 1958; Teerink 1991; Tóth 2002; Tumlinson 1983). Part of the Alaska Fur ID project hypothesis is that many previous attempts to use the microscope for hair identification have suffered from the challenges of acquiring and disseminating good quality images as a reference set for the user, as well as limiting themselves to certain measurements while overlooking others. In the heyday of the fur identification literature, roughly the 1930s through the 1970s, there was a focus on dichotomous key decision-making methodologies (Mathiak 1930; Mayer 1952; Stains 1958). These step-by-step either/or strategies were poor at integrating multiple kinds of data at once. A better result can be obtained by considering each sample on a case-by-case basis and using the various tools and clues explored in the Alaska Fur ID project to reach a conclusion based on a preponderance of the evidence. This approach considers aspects such as length, medulla, medullary index, width, shield, range, banding, color, cross section, provenance, and artifact type. Most users of the Alaska Fur ID project will be non-specialists without Scanning Electron Microscopy (SEM) access, which is the primary analytical tool used for "Furskin," the on-line

Czech fur identification guide (www.furskin.cz). The typical conservator will infrequently be called upon to identify a fur. In such an instance, if the methodology used for identification is simple and straightforward, the likelihood that the correct identification will take place is increased. For this reason, the project uses tools like plain language and polarized light microscopy that are widely accessible. The proceeding sections of the paper offer a glimpse of the content available on the Alaska Fur ID website.

2. ANIMALS

The species investigated here comprise the most common Alaskan mammals used traditionally and commercially for fur, and therefore process-of-elimination is a valid approach if cautiously employed. Generalities are given on the website for overall animal groupings, and there is more work to be done in this area of the project. The animals examined as part of the Alaska Fur ID Project are as follows:

ORDER ARTIODACTYLA (the even-toed ungulates)
Family Cervidae (the cervids)
Caribou/ Reindeer (*Rangifer tarandus*)
Moose (*Alces alces*)
Roosevelt Elk/ Olympic Elk (*Cervus Canadensis Roosevelt*)
Sitka Black-Tailed Deer (*Odocoileus hemionus sitkensis*)

Family Bovidae (the bovids)
American Bison (*Bison bison*)
Calf/ Cattle (*Bos Taurus*)
Dall Sheep (*Ovis dalli dalli*)
Mountain Goat (*Oreamnos americanus*)
Muskox (*Ovibos moschatus*)

ORDER CARNIVORA (the carnivores)
Family Canidae (the canids)
Arctic Fox (*Alopex lagopus*)
Coyote (*Canis latrans incolatus*)
Dog (*Canis lupus familiaris*)
Red Fox (*Vulpes vulpes*)
Wolf (*Canis lupus*)

Family Felidae (the felines)
Lynx (*Lynx Canadensis*)

Family Mustelidae (the mustelids)
Fisher (*Martes pennati*)
Least Weasel (*Mustela nivalis*)
American Marten (*Martes americana*)
Mink (*Neovison vison*)
River Otter (*Londra canadensis*)

Sable (*Martes zibellina*)
Sea Otter (*Enhydra lutris*)
Short-tailed Weasel (*Mustela erminea*)
Wolverine (*Gulo gulo*)

Family Ursidae (the ursids)
Black Bear (*Ursus americanus*)
Brown Bear (*Ursus arctos*)
Polar Bear (*Ursus maritimus*)

Suborder/superfamily Pinnipedia (the pinnipeds)
Family Otarvidae (the otarvids)
Northern Fur Seal (*Callorhinus ursinus*)
Steller Sea Lion *(Eumetopias jubatus)*

Family Phocidae (the phocids)
Bearded Seal (*Erignathus barbatus*)
Harbor Seal (*Phoca vitulina*)
Ribbon Seal (*Phoca fasciata*)
Ringed Seal (*Phoca hispida*)
Spotted Seal (*Phoca largha*)

ORDER LAGOMORPHA (the lagomorphs)
Alaskan Hare/ Tundra Hare (*Lepus othus*)
Collared Pika (*Ochotona collaris*)
Snowshoe Hare/ Varying Hare (*Lepus americanus*)

ORDER RODENTIA (the rodents)
Alaska Marmot (*Marmota broweri*)
Arctic Ground Squirrel (*Spermophilus parryii*)
Beaver (*Castor canadensis*)
Hoary Marmot (*Marmota caligata*)
Muskrat (*Ondatra zibethicus*)
Northern Flying Squirrel (*Glaucomys sabrinus yukonensis*)
Porcupine (*Erethizon dorsatum*)
Raccoon (*Proycon lotor*)
Red Squirrel (*Tamiasciurus hudsonicus*)
Woodchuck (*Marmota monax*)

Several of the smaller animals mentioned have not yet been observed on artifacts at the Alaska State Museum (for example, least weasel, collared pika, or northern flying squirrel) but are similar in size to small furbearers known to be utilized in the region, such as the arctic ground squirrel. Smaller mammals such as mice, voles, or bats are not included in the project as there is little evidence of their utilization in Alaska, and because distinguishing between the hairs of those smaller mammals is difficult to achieve with the techniques described here.

3. FUR FEATURES

Most animal furs have two components: guard hairs and underfur. Fur is primarily made of hard keratin arranged in three major structural features: medulla, cuticle and cortex. The medulla runs down the center of the hair. The cuticle is the outer surface layer, generally made of overlapping scales. The area between the medulla and the cuticle is the cortex. These features are easily observed in the muskrat guard hair in figure 1. Muskrat underfur (fig. 2) also shows these features, although underfur in general shows less variation and contains less information than guard hair. When similarities occur in the appearance of guard hairs from different animals, identification can sometimes be secured by observing differences in the underfur. In some cases, processing of the fur by plucking or shearing involves the removal of guard hair, leaving only the underfur for analysis. Most underfur has a medulla, and therefore its absence is an important clue.

Biological variation of these structures for each animal occurs within parameters that must be considered during the identification process. Variation and overlap can lead to incorrect conclusions if applied without an awareness of the possible parameters. A holistic application of different variables leads to the most confident result. Gender, season, age, and location on the body are generally not relevant except under specific circumstances. Color and length are the most typical exceptions. In the Alaska Fur ID Project, data was captured separately for the guard hair and the underfur of each animal. Because guard hair is often much wider than underfur, mounting them separately on the same slide under two different coverslips is recommended. Otherwise, only small sections of the underfur can be in focus at a time. The parameters reported on the website for guard hair and underfur include: length, medulla, medullary index, diameter range, cuticular scale, and color.

3.1 LENGTH

The overall length of the hair from the surface of the skin to the tip is measured in millimeters under the “length” sections for each animal. Sources in the fur identification literature vary in how measurements are given. Some use a maximum length which is usually taken from the longest guard hairs on the center back near the shoulders (dorsal hairs). Some use an average from hairs on various regions of the body. The Alaska State Museum samples were measured directly on the pelt with the hair in place, putting a metal rule at the skin and seeing how far the tip reached along the ruler. Awareness of the potential variation for each animal is very important in evaluating the significance of the hair length. For example, many hoofed animals like the caribou have a “bell” under the neck (fig. 3) that represents the longest hair on the animal. Caribou bell hair is seen on a headdress illustrated in figure 4. However, leg hair of the caribou is often used for boots and is very short (fig. 5). Other examples of long furs that do not occur on the dorsal area include the tail hairs of some rodents and the belly fur of the lynx.

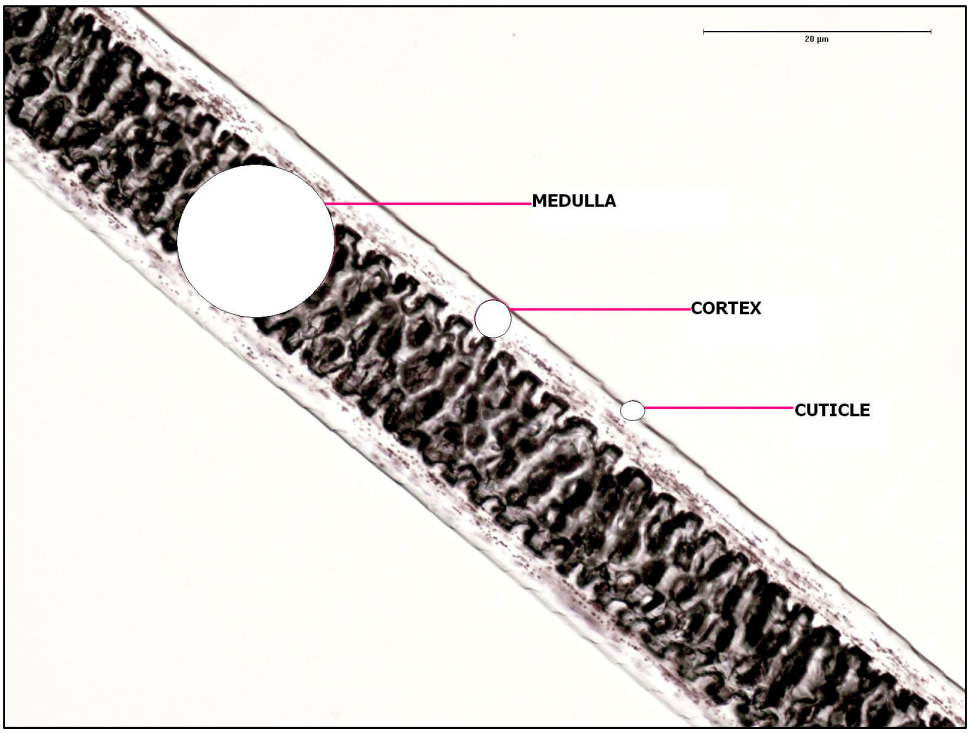

Fig. 1. Muskrat guard hair (200X) with main structural elements indicated (Photograph by Lauren Horelick)

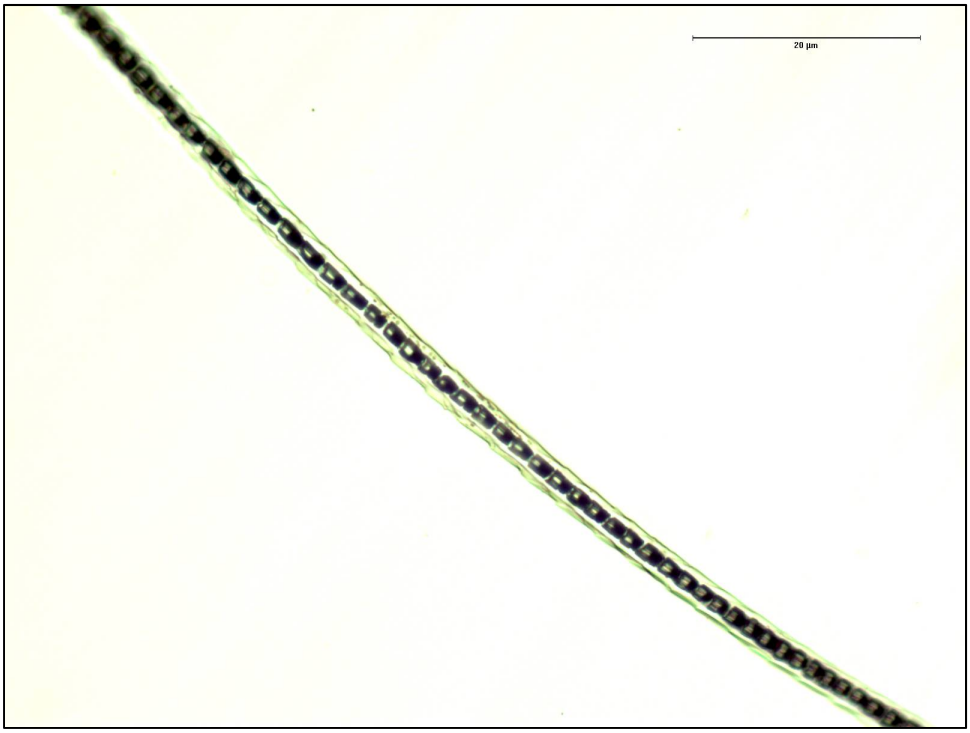

Fig. 2. Muskrat underfur (200X) (Photograph by Lauren Horelick)

Fig. 3. Bell under the neck of a caribou, Alaska State Museum collection I-B-27 (Photograph by Ellen Carrlee)

Fig. 4. Yup'ik dance headdress with caribou bell hair, Alaska State Museum II-A-4835 (Photograph by Ellen Carrlee)

3.2 DIAMETER RANGE

The "Range" section for each animal contains measurements taken at the widest part of each hair for a group of hairs examined, not the various widths along the shaft of a single hair. Measurements are in microns at the widest part of the hair under 200X or 400X magnification. Most hairs are fusiform in shape, with a taper at each end and the widest part of the hair occurring near the middle. However, some animals have a hair shaft shape that begins narrow near the skin, extending in a long stalk and then abruptly widening into a shield before tapering at the tip. This gives the overall hair a paddle shape. The presence of a shield is diagnostic for certain kinds of animals, particularly those of the family mustelidae. The only hairs on the body that are wide at the base and taper all the way to the tip are generally the tactile hairs (also called vibrissae or whiskers). These have little diagnostic use and are not included on the website.

Fig. 5. Caribou leg hair used on the shin area and vamp of an Athabascan boot, Alaska State Museum II-C-180 (Photograph by Ellen Carrlee)

3.3 MEDULLA

The central structural feature of the hair is an arrangement of cells called the medulla. Sometimes the medulla pattern is variable along the length of the hair, which is described in the "medulla" section for both guard hairs and underfurs. In this section general descriptive language was used for medullary classification such as, absent, continuous, interrupted, or fragmented. Scanning electron microscopy images can see much more medullary detail than polarized light microscopy, but PLM can reveal patterns or certain unambiguous features. Increasing the amount of light transmitted through the sample can aid in visibility. Crossing the polars of the microscope to look at a blackfield image can also be helpful. Some hoofed animals have no cortex, with the medulla extending almost the entire width of the hair. Caribou guard hair is one such example (fig. 6). The cells of this type of medulla tend to have a large honeycomb or bubble-pack appearance, and the lack of cortex leads to brittleness and weakness of the overall hair. Another distinct medulla is the so-called "multiserial ladder" of hares and rabbits (fig. 7). This kind of medulla has a distinct corncob appearance. Northern fur seal medulla has a distinctive lumpy intestinal-looking medulla (fig. 8). Crossed polars may make the medulla easier to observe. Findings to date suggest that medullary pattern is reasonably consistent in samples from different body locations, but may be absent in certain paw hairs.

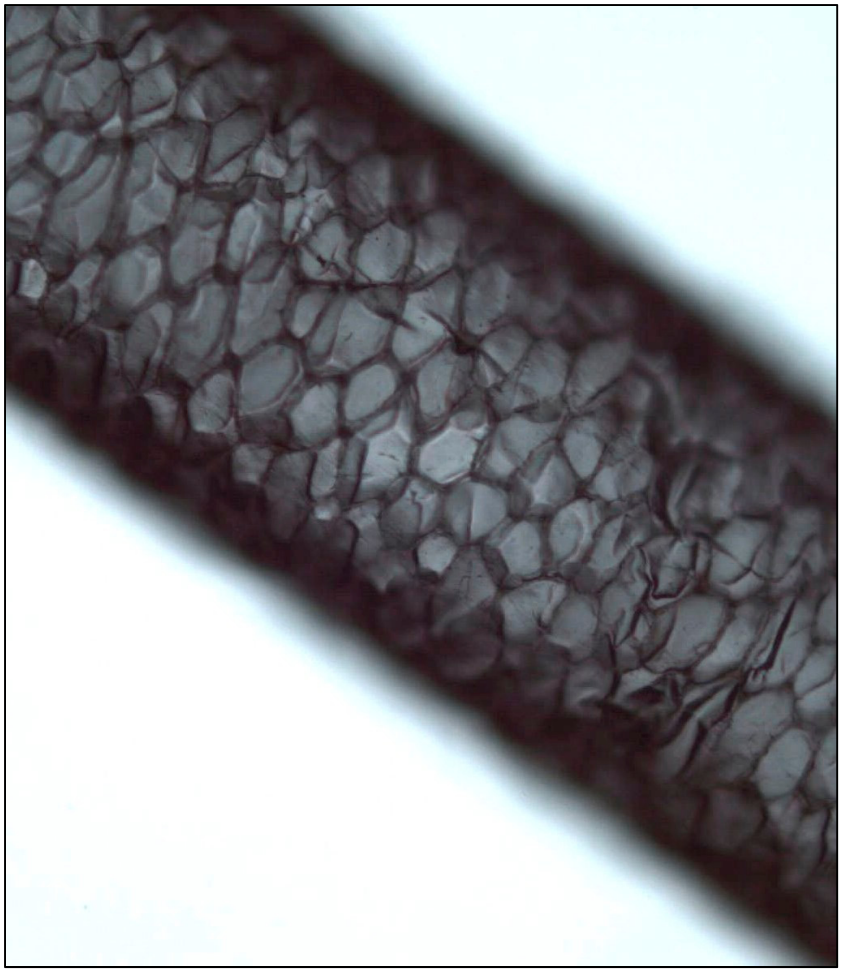

Fig. 6. Honeycomb-shaped medullary cells seen in caribou guard hair 200X (Photograph by Lauren Horelick)

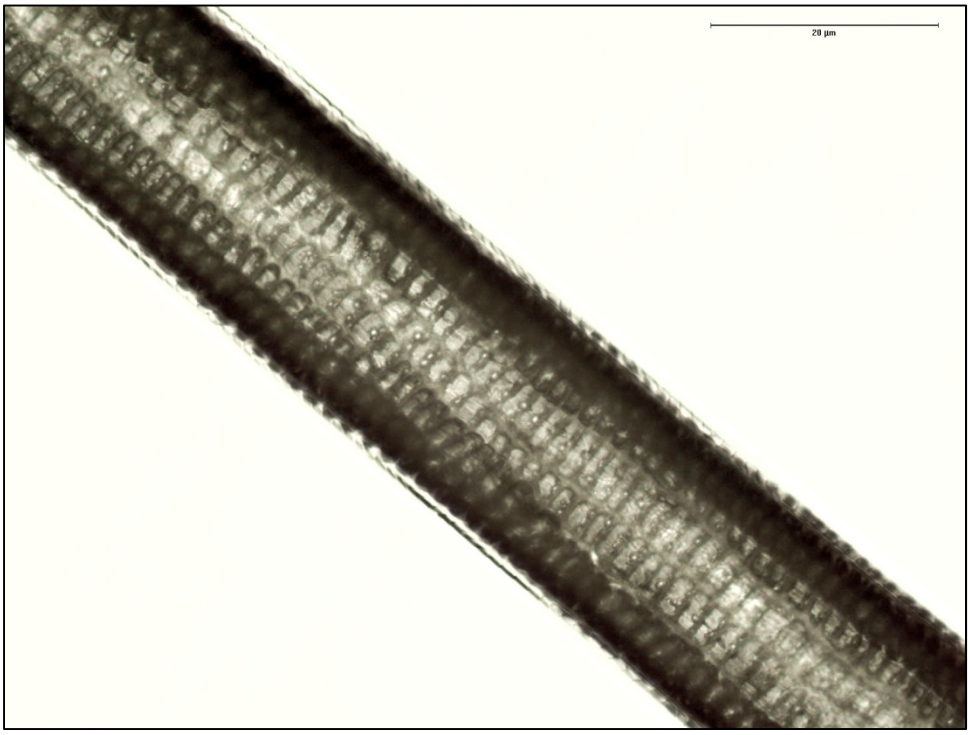

Fig. 7. Corncob or "multiserial ladder" medulla of the snowshoe hare (200X) (Photograph by Ellen Carrlee)

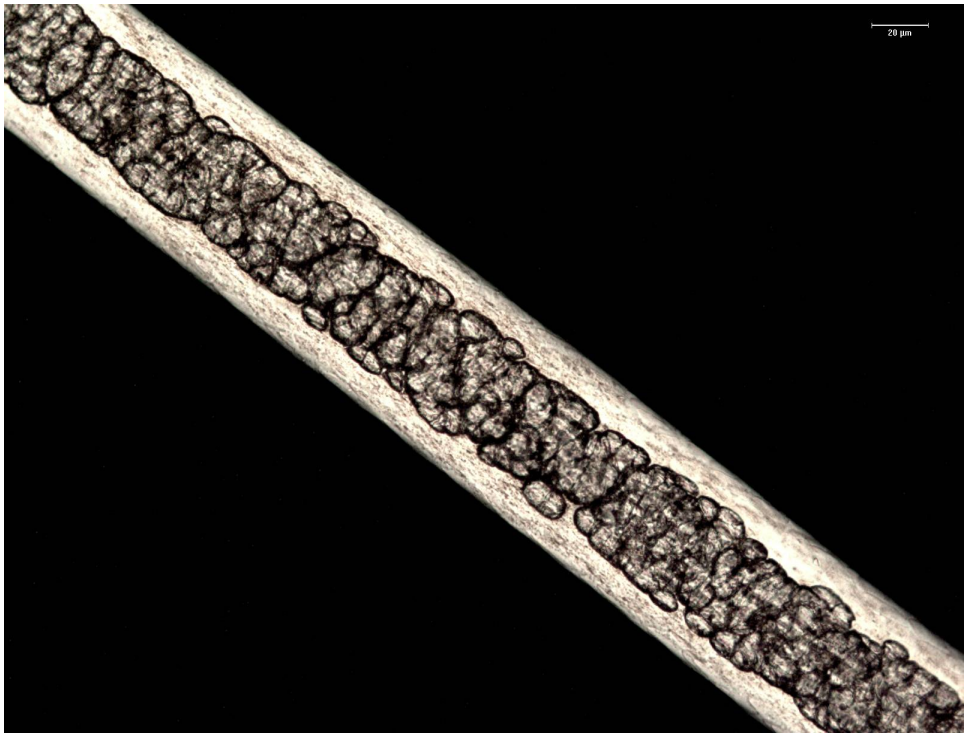

Fig. 8. Medulla of the Northern fur seal (200X) viewed with crossed polars (Photograph by Lauren Horelick)

3.4 MEDULLARY INDEX

Dividing the width of the medulla by the diameter of the hair at the point of greatest shaft width will give a ratio called the medullary index (M.I.). Since the medulla is always smaller than the overall hair, it will be a number less than one. This is a useful number because the findings of the Alaska State Museum correlate well with the data in the literature. Under the "M.I" section the reported measurements from the literature are reported in addition to reference samples. For any given animal, there is variation of 10-20% in the medullary index, and therefore it is most useful to consider the M.I. as large, small, or intermediate. Many of the Alaskan mammals are in the intermediate range, so outliers are notable. Animals with a small M.I. (less than 0.4) include bison, beaver, black bear, brown bear, polar bear, raccoon, sea lion and sea otter. Animals with a large M.I. (greater than 0.7) include Alaskan hare, snowshoe hare, arctic ground squirrel, red squirrel, collared pika, least weasel, short-tailed weasel, and lynx.

3.5 COLOR

Clumps of pigment granules and air spaces scattered throughout the cortex or medulla are responsible for the color of fur and can be observed best under magnification. The observed colors on the hairs are described in this section for each animal. An individual hair may be also be "banded", meaning it abruptly changes color over a short distance along the shaft. Colors and order of the banding can be diagnostic. Many references in the fur identification literature rely heavily on banding as a diagnostic tool, although there is lack of agreement about what is banding and what is a "bicolored" or "tricolored" hair, which often refers to more gradual changes in color. The pigmentation of the hair might show special features, such as a clumping of pigment particles near the medulla as opposed to evenly distributed throughout the cortex. Dyed fur will show pigment in the cuticle, which is naturally unpigmented. Additional aspects of color are described under the macroscopic features section, and may best be seen on a blue background with the naked eye.

3.6 CUTICULAR SCALES

The appearance of the cuticle is described under the "scale" sections. Scale patterns can most easily be observed with a scale cast since observation can be confused by the appearance of the medulla under transmitted light. Switching between transmitted and reflected light can help confirm which feature is being observed, as reflected light will show only the scale pattern. Decreasing the amount of light transmitted through the aperture of the microscope can also aid in observing the scale pattern. As with medullary pattern descriptions, the literature for scale pattern is not standardized and tends to use specialized vocabulary. The Alaska Fur ID Project endeavors to use plain descriptive language in characterizing the appearance of the scales. The database would benefit from an expanded range of cuticular scale images. For many animals, scale pattern of the guard hair changes predictably along the length of the shaft, with scales appearing drastically different from the base to the tip. The Arctic fox is one example, with long, pointy petal-shaped scales near the base becoming shorter and widely-spaced near the center and then closely-spaced with jagged irregular edges near the tip. Other animals, such as the Sitka black-tailed deer, will have the same scale pattern along the entire length of the hair. Guard hairs tend to have much more detail and variation in the scale pattern, but observation of the underfur scale pattern can also be useful. The scale shapes tend to be shaped like stacked cups as on the Dall Sheep (fig. 9), pointy petal or pine cone-like as on the raccoon (fig. 10), or elongated and very pointy as on the sea otter (fig. 11). Underfur can be difficult to manipulate during scale

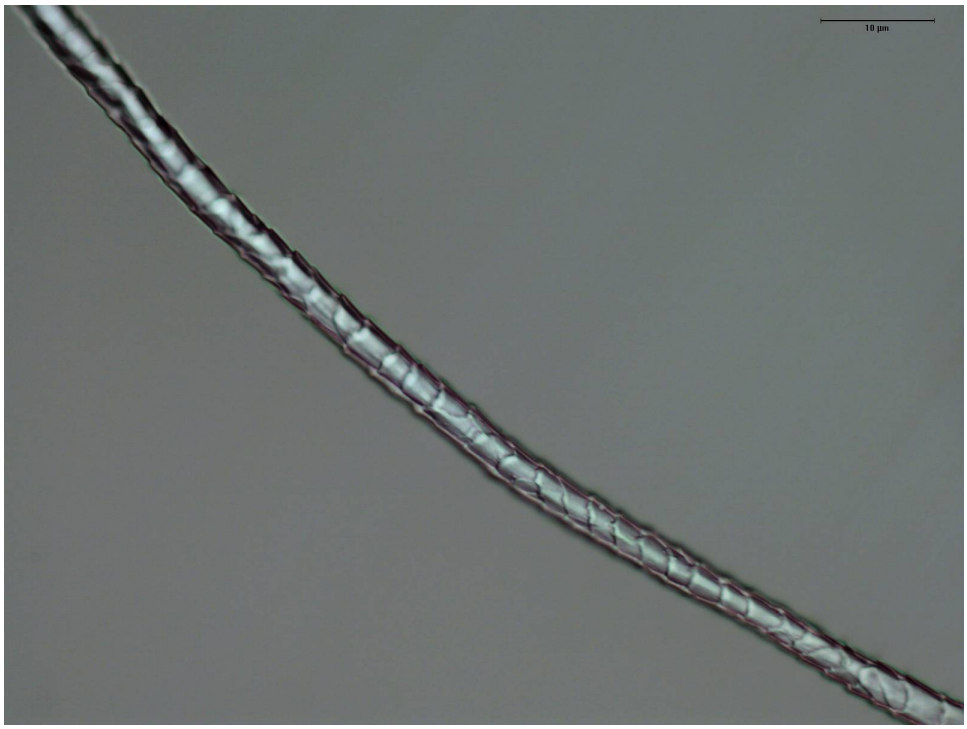

Fig. 9. Scale cast of Dall sheep underfur (400X) demonstrating scales that appear as stacked cups (Photograph by Lauren Horelick)

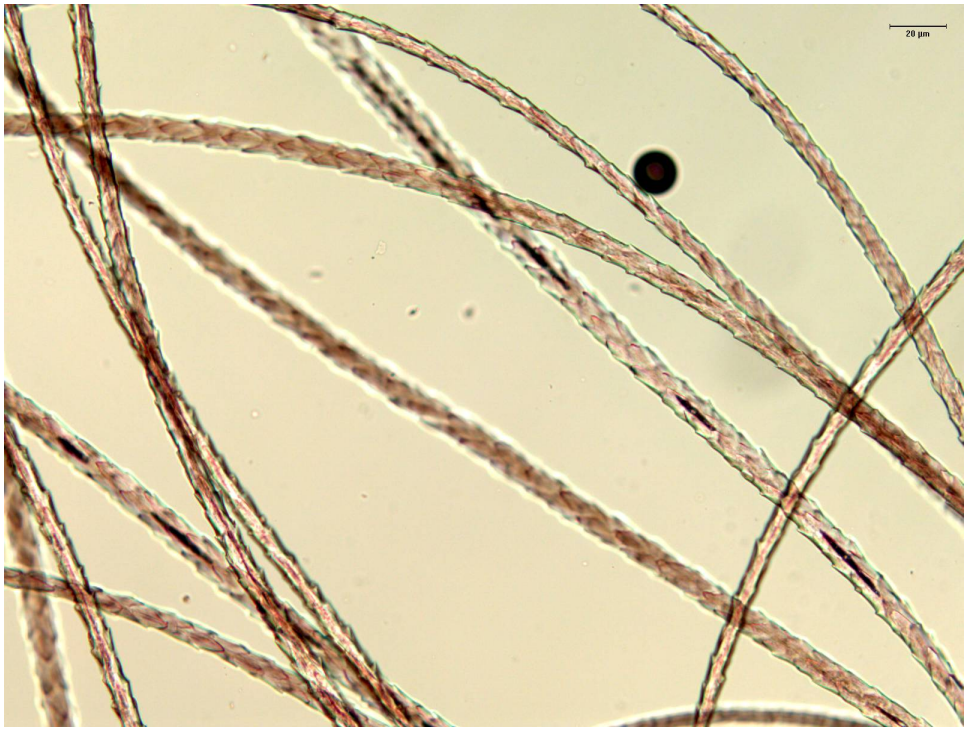

Fig. 10. Petal-shaped or pinecone-like scales on the underfur of raccoon (400X) seen with transmitted light. Note also the fragmented medulla present in some of the underfur fibers. (Photograph by Lauren Horelick)

casting, and therefore microscopy techniques such as adjusting the amount of light or focusing up and down through a mounted sample may be preferred. Different scale casting materials and techniques are described and illustrated on the website, finding that five minute setting Duco cement yielded consistent and legible scale casts. Additionally, Duco cement is inexpensive and simple to use.

4. MACROSCOPIC QUALITIES

The way the fur appears to the naked eye is described under the "macro qualities" section. Appearance of the overall pelt, seasonal color phases, clumping of guard hairs, curliness at the tips of underfur, gloss, readiness of shedding, and other helpful diagnostic information is included. Color is an especially salient macroscopic feature of fur, and potential variations must be taken into account. For example, light furs may be albinism, as seen on the beaver in figure 13. Polar bear fur is naturally white, but black bears may also show light color phases such as the Kermode bear or the glacier bear. Colors may also be darker than expected, such as the Alexander Archipelago wolf of southeast Alaska, or the black arctic ground squirrels in the vicinity of Carcross, Yukon Territory, just over the Canadian border from Alaska. Within a single species there may be considerable natural variation (fig. 12).

4.1 CULTURES

An incomplete listing of how this fur has been recorded in use is included in the "cultures" section as the information is encountered by researchers at the Alaska State Museum. The intent of this project is to see this section grow into its own body of evidence to aid in fur identification.

4.2 NOTES

The sources of the furs used by the Alaska State Museum are listed in the "notes" section of the database. Most samples came from pelts in the educational and permanent collections of Alaska State Museum. Additional sources included the Alaska Department of Fish and Game, the University of Alaska Museum, the American Museum of Natural History, taxidermists, and private collectors.

4.3 TROUBLESHOOTING

Specific ways to differentiate the hair on each animal from other similar animals is highlighted in the "troubleshooting" section. For example, marine mammals of the superfamily pinnipedia have a distinctive cross section. While most animals have an oval or round cross section, pinnipeds have a flattened cross section that appears cigar or aerofoil shaped. This may be observed through preparing a cross section, which is described and illustrated on the website, but the flatness of the hair also causes it to bend over itself in a ribbon-like kink that may be observed by microscopy (fig. 13). Pinniped hair also tends to have frayed tips. This project aims to see this section grow over time as unusual diagnostic features are verified.

Fig. 11. Underfur of the sea otter (400X), showing elongated pointy scales (Photograph by Lauren Horelick)

Fig. 12. Blanket made from over 300 fox paws, Alaska State Museum II-B-1498, showing the natural variation of color in the red fox (Photograph by Ellen Carrlee)

Fig. 13. Guard hair of spotted seal (400X) featuring distinctive kink from flattened cross section of the hair

4.4 RANGE

A general idea of where the animal is found in Alaska is given in the "range" with data from recent published sources (Forsyth 1999, MacDonald and Cook 2009). Historical ranges of each animal have not yet been added to the project.

4.5 NAMES

Nomenclature is ever-evolving, but the project follows the 2008 Alaska Department of Fish and Game scientific names whenever possible. Older names are given to help interpret references in the literature. Colloquial names are also given, and points of confusion are mentioned.

5. CASE STUDIES

Artifacts in the collection of the Alaska State Museum were used to conduct several case studies where the efficacy of the Fur ID project was tested. In each case study the cultural attribution, macro fur qualities, measurements, and micro-features were observed and used comparatively to narrow down possible choices. The following section of the paper summarizes three brief case studies illustrating a methodology for fur identification on cultural objects.

5.1 CARIBOU HAIR EMBROIDERY

A decorative element on a fur mat (fig. 14) was suspected to be hair embroidery, but porcupine quill and bird quill were also among the possibilities. Under magnification, the distinct honeycomb-shaped medulla of a hoofed animal was visible suggesting either moose or caribou. Both moose and caribou have a bell of long hairs under the neck, but the moose does not

typically have light-colored fur, and the width of the hairs did not reach the larger width range expected for moose, strongly indicating the use of caribou hair for the embroidery. As caribou hair is known to be brittle, the rolled storage conformation of this fur mat may not be best option for its preservation.

Fig. 14. Detail of a fur mat made of phocid seal fur (top) and Northern fur seal (bottom) with decorative caribou hair embroidery (center). Alaska State Museum II-A-4210. (Photograph by Lauren Horelick)

5.2 LANUGO

Dyed, kinky fuzz appears as a decorative element on several artifacts in the Alaska State Museum collection. One such artifact is a ball made from fur and skin (fig. 15). The bright color of the dye suggests the fur was originally light in color, pointing to one of many arctic animals with white fur such as polar bear, arctic fox, snowshoe hare, or fetal seal fur. Spotted, bearded, ribbon and ringed seals are collectively known as ice seals because they pup on the ice. The newborn ice seals are covered with white fetal fur, known as lanugo, for several weeks (fig. 16). Commercially available sheep wool was another possibility. Examination under the microscope revealed hair that was flattened in cross section, confirming seal. The Alaska Fur ID reference set is not extensive enough to determine differences between the phocid seals. Use of fetal fur illustrates an aspect of how seals were used as a resource.

Fig. 15. Decorative dyed fiber element made from lanugo (background fur is ringed seal) on a Siberian Yupik ball made by Irma Ungott from Gambell, St. Lawrence Island. Alaska State Museum II-A-6297. (Photograph by Lauren Horelick)

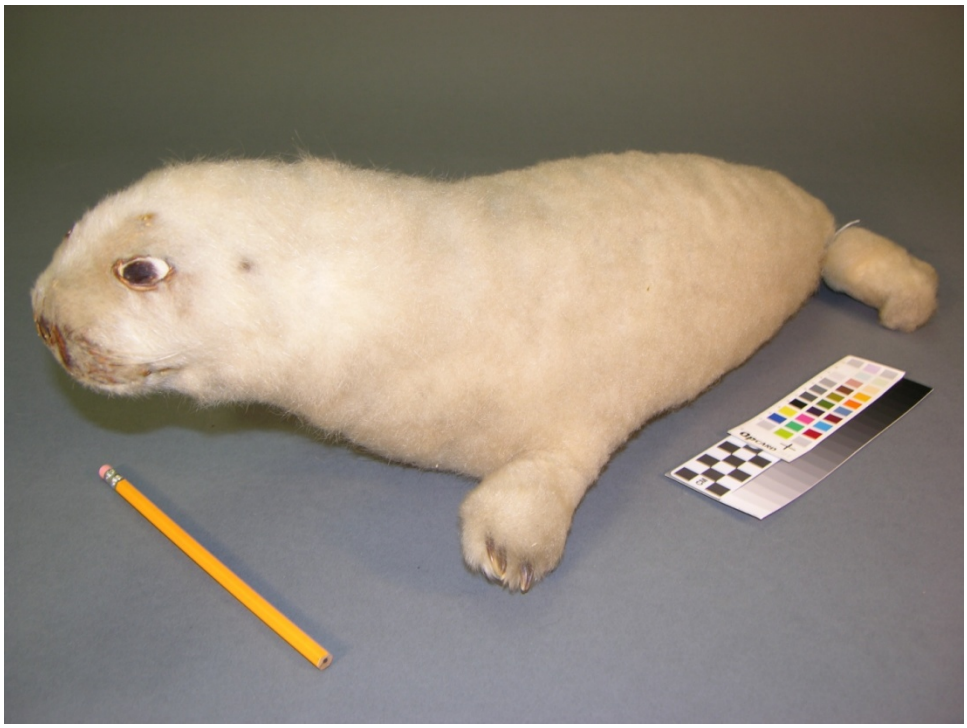

Fig. 16. Taxidermy specimen of a baby ice seal with white fetal fur known as "lanugo." Alaska State Museum, unaccessioned artifact 85-13. (Photograph by Ellen Carrlee)

5.3 FUR FELT

A Russian tri-cornered hat in the collection of the Alaska State Museum is important for its role in early diplomatic relationships between the Russians and the Tlingit people of southeast Alaska. Significant portions of the hat are made from fur felt (fig. 17). High quality fur felt is made from beaver, while lower quality fur felt is made from rabbit. The identification of fur felt from rabbit or hare was confirmed by observing the diagnostic corncob-like multiserial ladder pattern of the medulla in combination with a scale pattern of long chevron shapes with acute points and parallel diagonal margins. Curatorial investigation may take this identification into account in exploring the meaning of the hat.

Fig. 17. Detail of the brim of a fur felt tri-corner hat (black area is the fur felt), Alaska State Museum 94-2-1 (Photograph by Ellen Carrlee)

6. CONCLUSIONS

Alaska has long been a source for pelts used in the fur trade, making this resource potentially useful for identifying fur found on historic garments as well as Alaska Native artifacts. In general, pelts and individual hairs present features which, applied in combination, can lead to a secure identification at least down to family and often to the genus level. The Alaska Fur ID

Project is complementary to other material identification resources, such as the Czech website "Furskin" or Ohio State University's Fiber Reference Image Library (FRIL). In anticipation that technology will afford opportunities for integration and access of information, the master files of the Alaska Fur ID project are backed up in the simple and standard formats of Microsoft Word documents and jpeg images. The current weblog format facilitates easy updating and allows comments from users. Future directions for the project include gathering more data for underreported species such as the seals, and determining if species-level identification is possible with this methodology. Additional images of scale pattern and artifacts will aid further in fur identification, as will additional references to historical and cultural uses.

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