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Signed: Sarah

Date: 17 July 2019
BRUSHTAIL POSSUM
A Comparison to Other Luxury Fibres

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Master Spinner Program
Submitted to Olds College 15 October, 2018
Brushtail Possum – A Comparison to Other Luxury Fibres

Abstract

Brushtail Possum is a relatively novel fibre for most handspinners and is a by-product of existing pest-control programs in New Zealand. In this study, Possum fibre was compared to seven other luxury fibre species including Alpaca, Bison, Camel, Cashmere, Mink, Yak and Qiviut. All eight species were spun into 2-ply yarns using four spinning tools including the Wheel, a Quill head attachment for the wheel, the Charkha and the Tibetan spindle. Skeins and knitted swatches were evaluated for softness and personal preference by either “novice” (limited fibre experience) or “expert” (members of a spinners’ guild) volunteers.

There was close alignment between the average softness and the average personal preference scores. Mink and Cashmere consistently rated high in both softness and personal preference. Bison, Alpaca and Possum typically ranked at the lower end of both softness and personal preference rankings. Fibre preparation may have been a contributing factor to this as Alpaca and Possum were the only two species that were prepared from raw fibre; all other species were spun from a mechanically processed preparation.

There was not a specific tool or spinning method that consistently showcased the best of any fibre. As long as there was an appropriate amount of singles and ply twist, the yarns and swatches tended to rank well.

Brushtail Possum when prepared and spun unblended is a difficult fibre to work with, but when blended with other fibres that add strength, lustre or crimp, it will produce a lightweight
and warm fabric. This unique fibre industry is an important addition to the New Zealand economy and is a practical addition to pest control methods.
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Brushtail Possum – A Comparison to Other Luxury Fibres

Introduction

Although commonly referred to as the New Zealand Possum, the Brushtail Possum (Trichosurus vulpecula) is not a native species to New Zealand. It is a completely different species to the Virginia opossum (Didelphis virginiana) native to North America (World Atlas, 2018). The Brushtail Possum was introduced to New Zealand in 1837 from Australia to help develop a fur industry (New Zealand Fur Council, 2014). Within New Zealand there are no known predators to the Brushtail Possum and as a result the population is currently estimated at approximately 30 million animals with the potential to explode to >70 million if no control measures are put into effect. It is currently estimated that New Zealand’s Possum population eats approximately 21,000 tonnes (21,044 tons) of forest vegetation every 24 hours. Their feeding habits also have a devastating impact on songbirds including chicks and eggs as well as the population of beneficial insects (New Zealand Fur Council, 2014).

The Brushtail Possum is also a carrier of Bovine Tuberculosis, a threat to the beef and dairy industry within New Zealand. It is estimated that they cause roughly $35 million NZD damage to New Zealand pasturelands annually. As a result of all these factors, the Brushtail Possum was declared a noxious environmental pest in 1946 (New Zealand Fur Council, 2014). This is in stark contrast to its native home of Australia where it is currently a protected species.
(Bureau of Research Sciences, 2010). It is important to recognize that the Possum fibre sourced by New Zealand fibre mills is a by-product of government-eradication programs and that the animal is not specifically hunted for its fibre (Woolyarns Limited, n.d.).

The New Zealand government currently spends more than $111 million NZD annually on Possum control methods. In 2014, the Possum fibre industry contributed $127 million NZD to the country’s Gross Domestic Product and employed approximately 1,500 people (NZIER, 2014). Economic analysis suggests that the current harvest levels could be doubled, contributing an additional $58.5 million NZD to the economy and adding an additional 750 jobs.

The economic realities of the Possum fibre industry in New Zealand were recognized as such a significant contribution that in 2015 the Department of Conservation and the New Zealand Fibre Council signed a Memorandum of Understanding (MoU). This MoU allows licensed hunters and trappers access to Department of Conservation public lands prior to the use of Department Possum-control methods. It also provides for the establishment of an Industry-wide Code of Practice to ensure adherence to international and local standards of animal welfare when harvesting the animal for fibre production (New Zealand Fur Council, 2014); (Department of Conservation, 2015). In addition, this MoU allows for a sustainable, reliable supply of Possum fur to support this innovative industry.

Despite the goals and intentions of Pest Free NZ, it is unlikely that the Brushtail Possum will be eradicated from the country within the next 20 years (New Zealand Fur Council, 2014). As such, the Brushtail Possum fibre industry within New Zealand presents an innovative, sustainable and pragmatic adjunct to an environmental pest management program.

Possum is a relatively new fibre for artists and handspinners. In 1992 Woolyarns, a New Zealand-based mill, pioneered a method for blending Possum fibre and Merino to produce
commercial yarns. In 2011, they made changes to their manufacturing practices so that they can spin yarns to an Nm 48/2 (i.e. 48 meters of 2 ply yarn from 1 g of fibre) (Woolyarns Limited, n.d.). While I have seen and purchased commercial Brushtail Possum yarn and blends, finding raw fibre for spinning is somewhat difficult. I'm currently aware of only 2-3 sources and supply is very erratic from at least one of these sources.

**Investigative Study**

Since Brushtail Possum is a difficult fibre to find in raw form, and in many advertisements and literature references it is claimed to be warmer than equivalent cashmere or wool fabrics while maintaining a soft hand (Woolyarns Limited, n.d.), I decided to compare characteristics of this fibre to other luxury fibres that are commonly available. Seven comparator species were selected, including Alpaca, Bison, Camel, Cashmere, Mink, Qiviut and Yak. In order to investigate if there is a specific spinning method that showcases the individual species to their best advantage, each of the eight species of fibre was spun using four different methods, including a Lendrum Wheel, a Book Charkha, a Tibetan Support Spindle and a Quill head attachment for the Lendrum.

Each species was spun 100% and in its natural colour (i.e. no blends, no dyeing). Test species were selected largely for their staple length, availability of differing preparations, the belief that all eight would lend themselves to the spinning methods chosen (see page 18 below) and I have a roughly equal experience spinning the different species, with the exception of Brushtail Possum and Mink, which were brand new to me.
Materials and Method

The Species

Alpaca

The Alpaca (*Vicugna pacos*, formerly *Lama pacos*) is a New World member of the Camelid family (Robson, 2011, p. 364). They were originally domesticated approximately 6-7,000 years ago in the Andes mountains in Peru and are a distinct species from the Llama. Smaller than Llamas, Alpacas are primarily raised for their fibre. Although domesticated and still prevalent in South America, most of the yarn and fibre available in North America comes from North American herds. There are two varieties: Huacaya and Suri Alpacas, although Huacaya are more prevalent.

Alpacas are social animals and live in herds. They have 2 toes and a soft foot-pad rather than hooves. This foot structure results in less pasture damage compared to hooved animals such as cattle (Alpaca Owners Association Inc, 2017). There are 16 official colours in the United States, ranging from white, beige, and shades of fawn to brown, black, and grey. The fibre takes dye readily. The average fleece yield is approximately 3-5 kg (5-10 lbs) per animal. Alpaca fibre is generally recognized for its fineness, softness, light-weight, durability, excellent thermal qualities, and luster (Alpaca Owners Association Inc, 2017). The staple length is approximately 5-15 cm (2-6") for Huacaya and up to 28 cm (11") for Suri.
Although Alpaca is a longer staple length than most species selected for this study, it was selected for a few reasons. One, it is widely available. Two, it is often considered to be a more affordable luxury fibre compared to others included in this study.

**Bison**

Bison originated in Europe and Asia and migrated across the Bering Land Bridge to North America and moved south in search of food and appropriate climate as the Ice Age moved through Europe and Asia. At one time they migrated as far south as Mexico and then moved to the grasslands further north as the ice made its retreat.

There are two distinct types of Bison: the Plains Bison (*Bison bison*) and the Wood Bison (*Bison athabascae*), which is larger and has a much fiercer temperament than the Plains Bison (MacKenzie, 2015, p. 39). As a result, the Plains Bison is more suited to domestication. Prior to European migration to North America, there were an estimated 30-200 million Bison in North America. The species was almost hunted to extinction during the settlement of the Northern Plains. Effective conservation programs have increased their numbers to 200,000 in the US and 250,000 in Canada.

Bison have five coats, including two outer coats that overlap three inner downy layers. The outside layers freeze in the winter to trap the animal’s body heat in the down. The down ranges from 18-24 μ in diameter and 2.3-3.8 cm in length (1-1.5”). The average Bison sheds 1.4-1.8 kg (3-4 lbs) of down fibre annually (MacKenzie, 2015, pp. 41-43).
Camel

In direct contrast to the Bison, Camels actually originated in North America (Canada, South Dakota, Wyoming and Montana) approximately 4 million years ago. As the climate changed, Camels migrated across the Bering Land Bridge to Asia and Africa (MacKenzie, 2015, p. 30).

As with Bison, there are two main types of Camel: Dromedary (*Camelus dromedaries*) with one hump, and the Bactrian (*Camelus bactrianus*) with two humps (Olds College, 2012, p. A8). Although the Bactrian Camel is rarer, most spinning fibre comes from this type. The Camel typically sheds in June or July, when the animal’s entire coat (outer guard hair and inner down both) is shed. The full coat prior to dehairing weighs approximately 3.6-4 kg (8-9 lbs). The down is sold either as cloud straight off the dehairing machine or combed top where it has been further processed (MacKenzie, 2015, pp. 32-33). Camel hair is also available. Readers who have completed Level 4 of Olds College Master Spinner Program will remember that spun Camel hair produces a suitable rug yarn.
Cashmere

Confusion still seems to exist as to whether it is a specific breed/species of goat that produces Cashmere fibre. According to the Level 4 manual (Olds College, 2012, p. A18), cashmere fibre comes from the Cashmere (Kashmir) goat – *Capra hircus laniger*, native to the Himalayas. However, Judith MacKenzie’s book (MacKenzie, 2015, p. 52), and the Canadian Cashmere Producers Association (Canadian Cashmere Producers Association, 2018) both state that it is not a specific breed of goat, but any goat capable of producing down fibres that are ≤19μ in diameter and at least 3 cm long (1.25”) and no more than 3% of the fibres by weight are >30 μ. This is the standard set by the Cashmere and Camel Hair Manufacturers Institute (MacKenzie, 2015, p. 52).

Cashmere has been used in textile production for thousands of years. It is the only truly commercialized fibre that cannot meet the demand for production. Britain and France both attempted to develop a European fibre supply, but both were unsuccessful. The goats that produce this luxury fibre do best in a colder climate, at higher altitudes and with a diet higher in browse than the typical European pasture (MacKenzie, 2015, pp. 48-52). Most of the world’s Cashmere is produced in China, and the finest is produced in Mongolia (Olds College, 2012, p. A19). There are also a small number of Cashmere producers in the US and Canada (MacKenzie, 2015, p. 53).
Mink

Mink is a new-to-me fibre for spinning. The Mink is a medium-sized member of the weasel family. The fibre available for spinning comes from farmed rather than wild animals and is from the downy undercoat (Fur Institute of Canada, 2018). Approximately 40% of the world’s Mink is produced in Denmark, and Poland is the second largest producer (International Fur Federation, 2018). There are Mink farming industries in the United States and Canada as well. In the US, there are approximately 275 farms in 23 states. The major Mink-producing states include Wisconsin, Utah, Idaho, Oregon and Minnesota (Fur Commission USA, 2018). In Canada, Mink are farmed in all provinces but are primarily raised in Nova Scotia and Ontario (Fur Institute of Canada, 2018). In farmed Mink, winter fur production begins in August and is regulated by number of hours of daylight, rather than ambient temperature (Canadian Mink Breeders Association, 2018). The fur and fibre is harvested in November or December (Fur Institute of Canada, 2018). Mink producers in Canada and the US adhere to strict codes of practice for animal welfare including the National Code of Practice for the Care and Handling of Mink in Canada (Canadian Mink Breeders Association, 2018) and the US Fur Commission’s Humane Care Farm Certification Program (Fur Commission USA, 2018).

There are three sub-species of wild Mink that farmed Mink is derived from: Mustela vison (Quebec, Eastern Labrador and Nova Scotia), Mustela vison ingens (Alaska) and Mustela vison melampeplus (Kenai). In the wild, Mink colour varies from a tawny brown to almost black.
Farmed Mink has been bred for a variety of colours. The US Fur Commission lists 17 colour variations on their website (Fur Commission USA, 2018).

Musk Ox (Qiviut)
I have seen the fibre referred to as Musk Ox (Ovibos moschatus), or the Inuktitut word Qiviut, meaning down (i.e. from an eider duck or goose) (MacKenzie, 2015, p. 36). The more I learn about them, the more fascinating an animal I find them to be. They can function comfortably at -40°C (-40°F).

The Musk Ox originally lived in the temperate areas of Asia, a far cry climate-wise from the Arctic regions where they now live. Fossils have been found in Britain, Germany, Spain and France as well as Siberia, Russia and Scandinavia. They migrated across the Bering Land Bridge approximately 200,000 years ago in search of food, water and shelter as the Ice Age moved across Europe and Asia. As the glaciers receded from North America, the Musk Ox migrated north with the ice as they had adapted to a colder climate. They are one of only four North American ungulates (hooved animals) that date back to the Pliocene period (200,000 to 90,000 BC). They share this distinction with Bison, Pronghorn Antelope and Caribou (MacKenzie,

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2 If Mink is a new to you fibre, you’ll be very interested in how it ranked in my survey, as well as my general spinning comments. Read on!!!

3 Having lived in Northern Alberta a couple of winters and experienced -40, this a skill I truly admire.
In the early 1900s, similar to the Bison, they were almost hunted to extinction. In 1917, with only about 500 animals left, the Canadian government banned all hunting and their numbers have increased to over 125,000 animals. Smaller herds, seeded from Canadian stock are present in Alaska, Greenland and Siberia (MacKenzie, 2015, p. 35).

Like Bison and Camels, Musk Ox has five coats, each with a slightly different function. The outer coat is coarse and extends down past the animal’s knees. In the winter, this outer layer freezes to trap the animal’s body heat in the remaining layers. The second haircoat is shorter and denser. It raises and lowers the down coats to regulate the amount of heat held in and how close to the skin it is held. The three undercoats are available to handspinners and each is finer and more crimped. It can range from 10-18 µ diameter and 3.8-7.5 cm (1.5 – 3") in length and is one of the rarest fibres that we can legally own (MacKenzie, 2015, pp. 35-38).

Yak

Yak (*Bos mutus* – wild Yak; *Bos grunniens* – domesticated Yak) were domesticated approximately 10,000 years ago by the Qiang nomads. Yak are typically non-aggressive to humans, a trait that is not shared with Bison or Musk Ox. Although physically they resemble Bison or Musk Ox, they are more slender and their movement and temperament make them similar to horses. However, very little is known historically about their ancestors or biological origins.

*Figure 8 Yak (Wikipedia, 2018)*

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4 If you know your history, you’ll recognize that these were the same people that domesticated sheep and horses.
They currently live in Tibet, Mongolia and Nepal (MacKenzie, 2015, pp. 44-48) and I believe there is a small herd outside the Denver area in Colorado.

Like Bison and Musk Ox, Yak have five layers to their coat. The long outer coat reaches to the animal’s knees and is like a horse’s mane and tail hair in texture. The second coat is long, coarse and strong and can be used to make felt. Unlike the Camel, only the undercoat sheds out and domestic animals can be brushed to remove the undercoat once it starts to shed (MacKenzie, 2015, p. 47).

Although approximately 14.2 tonnes (14 tons) of Yak fibre is produced annually, about 80% is used by the nomads themselves. There is interest from the fashion industry in Yak especially as a substitute for Cashmere, but animals still are not raised specifically for their fibre; it is still a by-product of an animal that used for primarily for other purposes (MacKenzie, 2015, p. 47).

Here are two pieces of Yak trivia that I didn’t know prior to starting this project. Number one: a friend of mine recently visited a Star Wars costume exhibit at the Detroit Institute of the Arts and told me that the Chewbacca costume was made, in part, with 18 pounds of Yak fiber (Rebecca Kitchen, personal communication Sept 2018). Apparently, it wasn’t until either the second or third movie that a ventilation system was installed in the suit! Number two: white Yak fibre is actually chemically depigmented, not a natural colour or genetic variation. Depigmented Yak is treated with pepin, an enzyme that is a waste product from the papaya and pineapple industry. The enzyme dissolves a portion of the wool’s outer cortex, where the fibre’s pigment is contained. This depigmentation turns the fibre a bright white, removes the fibre’s scales, allows the fibre to take dye well, and results in a silky hand that resists shrinkage (MacKenzie, 2015, pp. 47-48). Depigmented Yak was not used in this project. It would have been interesting to see how
it ranked compared to the other fibres that were used and whether it would have ranked differently than naturally-coloured Yak.

Table 1 shows a summary of the various animal and fibre characteristics for the fibres selected for this project.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Huacaya Alpaca</th>
<th>Bison</th>
<th>Camel</th>
<th>Cashmere</th>
<th>Mink</th>
<th>Possum</th>
<th>Qiviut</th>
<th>Yak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Size /Height</td>
<td>89 cm (35&quot;) at withers&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.8 m (6') at hump&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.6-2.29 m (5.5-7.5') at shoulder&lt;sup&gt;d&lt;/sup&gt;</td>
<td>76 cm (30&quot;) at shoulder&lt;sup&gt;e&lt;/sup&gt;</td>
<td>56 cm (22&quot;) long&lt;sup&gt;g&lt;/sup&gt;</td>
<td>32-58 cm (13-22&quot;) long&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1.5 m (5') at shoulder&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.9-1.5 m (3-5') at shoulder&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Live Weight (adult)</td>
<td>68 kg (150 lbs)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>907 kg (2,000 lbs)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>907 kg (2,000 lbs)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>55-60 kg (120-135 lbs)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.4 kg (3 lbs) females, 2.6 kg (6 lbs) male&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.2-4.5 kg (2.5-10 lbs)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>272-408 kg (600-900 lbs)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>227-726 kg (500-1,600 lbs) domestic Yaks&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fibre Diameter</td>
<td>15-35 µ, most in the mid 20s&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18-24 µ&lt;sup&gt;d&lt;/sup&gt;</td>
<td>19-24 µ&lt;sup&gt;d&lt;/sup&gt;</td>
<td>12-19 µ&lt;sup&gt;d&lt;/sup&gt;</td>
<td>15-17 µ&lt;sup&gt;f&lt;/sup&gt;</td>
<td>17-23 µ&lt;sup&gt;f&lt;/sup&gt;</td>
<td>10-18 µ&lt;sup&gt;d&lt;/sup&gt;</td>
<td>14-25 µ&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Staple Length</td>
<td>15 cm (6&quot;)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.4-3.8 cm (1-1.5&quot;)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5 cm (2&quot;)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.5-3.8 cm (1-1.5&quot;)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.8 cm (1.5&quot;)&lt;sup&gt;h&lt;/sup&gt;</td>
<td>2-3.8 cm (0.75-1.5&quot;)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3.8-7.5 cm (1.5-3&quot;)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.5 cm (1&quot;)&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Approximate Fibre Yield Per Animal</td>
<td>0.5-3.6 kg (1-8 lbs)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.4-1.8 kg (3-4 lbs)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8-10 kg (17-22 lbs) – full coat; 2-4.5 kg (4.5-10 lbs) down&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Approx. 113 g (4 oz) once dehaired&lt;sup&gt;d&lt;/sup&gt;</td>
<td>No information found, but probably similar to Possum</td>
<td>18-94 g (0.6-3.3 oz)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.7 kg (6 lbs)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.45-0.56 kg (16-20 oz)&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Approximate cost USD/oz</td>
<td>$4 – raw fibre</td>
<td>$20 – roving&lt;sup&gt;l&lt;/sup&gt;</td>
<td>$5 – down</td>
<td>$16-20 – Top</td>
<td>$16-46 – Roving, combed top</td>
<td>$19.75 – raw fibre</td>
<td>$36 – really nice roving</td>
<td>$14 – down</td>
</tr>
</tbody>
</table>

<sup>a</sup> (Big Meadow Creek Alpacas, 2018), <sup>b</sup> (Olds College, 2012, p. A21), <sup>c</sup> (Robson, 2011, p. 368), <sup>d</sup> (MacKenzie, 2015, pp. 30-53), <sup>e</sup> (Oklahoma State University, 2018), <sup>f</sup> (Paradise Fibers, 2018), <sup>g</sup> (Fur Commission USA, 2018), <sup>h</sup> (Jimmy Beans Wool, 2013), <sup>i</sup> (Common Brushtail Possum, 2018), <sup>j</sup> (Reid, 2007 (67)), <sup>k</sup> (The Woolery, 2018), <sup>l</sup> (The Buffalo Wool Company, 2018). Note that the price quoted is from the price tag/receipt I paid at the time I bought the fibre unless otherwise referenced.
The Tools

A second objective to this study was to evaluate if there are specific spinning tools that lend themselves more to the spinning of exotic fibres like Possum. To this end, four spinning tools were chosen: a Lendrum Wheel, the Quill head attachment for the Lendrum, the Charkha and the Tibetan spindle. While three of these methods all involve spinning off the point, the tools were selected for the reasons outlined below:

Spinning Wheel

Most spinners are familiar/comfortable with operating a spinning wheel. It is an efficient tool for spinning large amounts of fibre relatively quickly. It may be the only tool some spinners own and is very accessible to most spinners. Most wheels come with a variety of pulleys or attachments with higher ratios for spinning finer fibres. For this project, all yarns were spun using the Lendrum fast flyer with ratios of 12:1, 15:1 and 17:1. The ratio was adjusted based on how much twist the fiber needed or would tolerate; yarns were not all spun with the same ratio setting.
Quill Attachment for the Lendrum Wheel
I borrowed this attachment from a friend who also owns a Lendrum wheel⁵. The Quill attachment for a Lendrum wheel is very large and almost feels like one is spinning off the end of a large knitting needle. There is a fairly pronounced ticking/snap when spinning, more so than with smaller tools, although I didn’t find it a problem. In addition, the ratios are not as high as a Charkha. Lendrum Quill ratios are 6:1, 25:1 and 37:1 (The Woolery, 2018) and a spinner can create a large amount of yarn or singles in a small amount of time.

The Quill spindle will also hold more than either the Tibetan or Charkha spindles so alternative storage methods/additional bobbins are not as necessary if a lot of yardage is required.

Charkha
Although it’s primarily used for cotton, the Charkha can be used for spinning other fibres as well. A recent issue of SpinOff magazine (Helmen, 2016) inspired me to consider it for this project. I’ve also not spent a lot of time with this

⁵ My friend is not a big fan of any method that involves spinning off the point as she doesn’t like the ticking / small snap that is inherent to spinning off the point.
tool. Prior to this project, I had only spun with a Quill attachment once or twice and so my skill level and experience with the Charkha and Quill attachment are roughly the same. Due to an accelerator, the ratio on a Charkha is much higher, about 70:1, though I did not try to count. I wondered if more or less effort was needed to control the amount of twist using a Charkha vs Quill attachment. I also wanted to improve my Charkha skills and this project provided an opportunity to do so.

Tibetan spindle

Spinning using any type of hand spindle has not been one of my favourite things. However, I did decide to include a hand spindle as one of my test methods. I considered using the Tahkli instead of a Tibetan support spindle for this study, but I felt that the Tahkli might be too close to the Charkha in terms of amount of twist. My Tibetan spindle is quite a bit heavier than any of my Tahklis and definitely doesn’t spin as fast.

There were some fibres that just did not lend themselves to the Tibetan spindle. I wasn’t able to get enough twist to produce a singles or yarn that would maintain its integrity with Mink, Bison, and Possum. For these fibres, I substituted the Tahkli in order to produce a reasonable yarn.

---

6 I was very surprised that the skeins I earned the highest marks on in the Level 6 test were those that were spindle-spun.
Spinning Method

To ensure a reasonable comparison across all test fibres, all fibres were spun unblended at 100%. All fibres used were also a natural undyed colour. All yarns were spun 2 ply. For the Wheel samples, singles were spun and plied on the Wheel. The Quill samples were also spun and plied using the Quill attachment. Singles were transferred from the Quill to plastic BobbinsUp bobbins. These bobbins come with a plastic bit that will fit in the chuck of a regular drill and bobbins can be wound quickly and evenly using the drill.

I found it next to impossible to ply using either the Tibetan spindle or Charkha and so for both these tools, the singles were spun using the tool. Singles were then wound onto BobbinsUp bobbins. As shown in the photo, I used an old metal coat hanger to suspend my Tibetan spindle so I could wind the bobbins.

The Charkha spindles actually fit in a Chinese-takeout style gift box, shown in Figure 14. Both systems worked well for winding singles onto bobbins. The photo shows one of my Tahklis, but it works the same with a Charkha spindle. Two pieces of synthetic cork from a wine bottle have been pushed onto the spindle ends to keep it from pulling out of the box when winding onto a storage/plying bobbin.
Filled bobbins were placed on a lazy kate and plied using a regular drop spindle if possible. If the singles were too fine to support a drop spindle, the yarn was plied using the Wheel, but only as a last resort.

No attempt was made to standardize the spinning for the yarns produced (i.e. TPI, WPI, angle or other characteristics). In each sample, the objective was to use the test tool to provide sufficient twist for a stable yarn. I also used whatever drafting technique felt appropriate for the specific test fibre. With each tool and method used the goal was to use suitable techniques that resulted in a reasonably strong, well balanced yarn that showcased the best of both the fibre and the tool. I was more successful with some combinations than others (see Results on page 28).

I considered several options for spinning order, including consultation with a statistician/biometrician at work (Sean Mahabir, personal communication). One option I considered was complete randomization of fibre species and tool. However, since one of the goals was to showcase the best of each fibre, I decided that complete randomization would be like starting new with each skein that was spun. I also considered randomly assigning the fibre species by tool (i.e. randomize the order of the eight fibres and spin by Wheel, then re-randomize all eight and spin by Quill, etc.) but felt that this approach might showcase more about the tool than the fibre. There would always be one “first” fibre and one “last.” If the skill
with the tool improved more with time spent using it, the increase in skill might skew the results.

In the end, I decided to randomize the tools within the fibres (i.e. first fibre type - tools 1, 2, 3, 4, second fibre type - tools in a different order etc.) I also roughly worked from opposite ends of the alphabet in (i.e. Alpaca, then Yak, Bison etc.) so that I would end with Mink and Possum, the two species I had the least experience with, with Qiviut last. Complete spinning order is presented in Table 2.

All yarns were fulled prior to skeining into the final 10 yards. Weights, measures (i.e. WPI, TPI, angle etc.) and knitted swatches were done on the fulled yarns. To full the yarns, I filled one sink with hot water and the other with cold water. Skeins were put in hot water and agitated, then put in cold water and agitated. This process was repeated several times. Each skein was fulled individually. All skeins in this book are tagged with specific details of the preparation method, spinning, finishing and fulling techniques. Note that the labels are on the BACK of the sample cards in this book.

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\footnote{For some reason I missed it when I was spinning things in order}
Figure 15 Fulling arrangement, hot water on the left, cold water on the right and a clean plunger

Cards (8x11" cardstock sheets) were prepared for each of the 32 samples in this study (i.e. 8 species of fibre X 4 spinning methods = 32 samples). Each card has a sample of either the raw (Alpaca and Brushtail Possum only) or prepared (all other species) fibre used for spinning, a small bobbin with the spun singles, a 10-yard skein of the finished and fulled yarn and a 4 x 4-inch knitted swatch. All swatches were knitted on 4 mm needles, regardless of the finished yarn's WPI, TPI or count in an attempt to produce a comparable fabric from each of the yarn samples spun.

In order to organize and identify the species and spinning methods during the evaluation phase, cards were colour-coded based on spinning method (ivory = Wheel spun, green = Quill spun, yellow = Charkha spun and blue = Tibetan spindle/tahkli spun). The cards were numbered based on the order in which the skein was spun. There was no species identifier on any samples used during the evaluation period. Labels identifying the species, fibre
preparation, spinning method, WPI, TPI and other characteristics were affixed to the skeins after the evaluation period was complete.

Table 2 Species, sample number, spinning method and card colour

<table>
<thead>
<tr>
<th>Species</th>
<th>Sample Number</th>
<th>Spinning Method</th>
<th>Card Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpaca</td>
<td>1</td>
<td>Charkha</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Tibetan</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
<tr>
<td>Yak</td>
<td>5</td>
<td>Charkha</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Tibetan</td>
<td>Blue</td>
</tr>
<tr>
<td>Bison</td>
<td>9</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Charkha</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Tibetan*</td>
<td>Blue</td>
</tr>
<tr>
<td>Cashmere</td>
<td>13</td>
<td>Tibetan</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Wheel</td>
<td>Ivory</td>
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<tr>
<td></td>
<td>15</td>
<td>Quill</td>
<td>Green</td>
</tr>
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<td></td>
<td>16</td>
<td>Charkha</td>
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</tr>
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<td>Tibetan</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Charkha</td>
<td>Yellow</td>
</tr>
<tr>
<td>Mink</td>
<td>21</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>Tibetan*</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Charkha</td>
<td>Yellow</td>
</tr>
<tr>
<td>Possum</td>
<td>25</td>
<td>Tibetan*</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>26</td>
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<td>Ivory</td>
</tr>
<tr>
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<td>28</td>
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<td>Qiviut</td>
<td>29</td>
<td>Tibetan</td>
<td>Blue</td>
</tr>
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</tr>
<tr>
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<td>31</td>
<td>Quill</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Wheel</td>
<td>Ivory</td>
</tr>
</tbody>
</table>

* These were actually spun with the Tahkli but have been considered as Tibetan-spun for purposes of analysis.
Yarn Evaluation

"Expert" (i.e. with fibre experience/spinners) and "novice" (i.e. minimal fibre experience) volunteers were recruited to evaluate the yarn samples. Twenty "experts" were recruited from the Spinner’s Flock Guild in Chelsea, MI during their September 2018 meeting. The eighteen "novice" recruits were friends and co-workers from my office. Three novice evaluations sessions were set up during the lunch hour to accommodate various work schedules, and respondents chose the one that best suited their schedule.

![Evaluation Day at Spinner's Flock](image)

*Figure 16 Evaluation Day at Spinner's Flock (photo courtesy of Christine Wilson de Medina)*

Respondents were given a stack of the eight samples spun using a single method (i.e. yellow = Charkha, green = Quill, blue = Tibetan spindle, ivory = Wheel). There was nothing on the cards to identify the fiber species. Respondents were asked to rank each fibre subjectively on a scale of 1 to 10 (1 = harsh, 10 = soft) and then rank the samples in order of their personal preference, from most preferred to least preferred. The last section was optional, but respondents were also given the opportunity to guess which sample came from which fibre.
species. The major difference between the expert and novice evaluation was that I asked the experts to rank the softness of both the yarn and the swatch independently (i.e. a rank was assessed for each). For the novices, I only asked for a single ranking on their overall impression; they weren’t asked to distinguish between the yarn and the knitted swatch. Copies of the expert and novice reviewer forms are available in Appendix 1.

Many respondents told me the survey was good fun. It was interesting to watch respondents evaluate the yarns. Most of those surveyed took at least 15 mins, and several volunteers held the knit fabric up to their face to evaluate softness. One of the novice reviewers was ready to order a Qiviut sweater until I told her how much it cost per ounce and that I’d need a couple of pounds of fibre (before time and labour)!

Most of the expert reviewers took a guess at what fibre came from which animal. Less than half of the novices took a guess, although most of my veterinarian co-workers did. Everyone was definitely interested in the reveal when I identified the species. No one who
guessed got all eight correct, although several of the experts got six of the eight. They typically either interchanged Yak and Qiviut or Mink and Possum.

Results

There were a few expected and several unexpected results. Appendix 2 (see page 49) provides general comments on the spinning experience for each of the fibre-tool combinations. As expected, there were some fibres that were more difficult to spin with certain tools. As well, only the Alpaca and Possum were spun from raw fibre, with all other species spun from a commercial preparation. Most were spun from cloud/roving, but a few were from combed top. These differences in preparation may have influenced how the skeins or fabric ranked both in softness and personal preference. Ideally, all should have been from the same preparation type, but I used what was in my stash or what I could access easily.

One of the more challenging aspects was getting enough ply twist into those yarns that were plied using a drop spindle — typically those done on the Charkha or Tibetan spindle. Quite a few of them came off the spindle very unbalanced but evened out when the twist was set. However, I felt quite a few of them could have benefitted from just a bit more ply twist. The other thing I found somewhat surprising was that the Wheel-spun samples were not necessarily the favourites for a lot of the species, despite this being the tool I had the most experience with.

As seen in Table 1 on page 17, most species have a comparable staple length except for Alpaca which is quite a bit longer. Alpaca definitely did not spin easily with the Tibetan spindle, and it was a bit of a fight on the Charkha although it was more manageable. The experience with Alpaca on the Charkha was very much in line with Devin Helmen’s experience described in Spin Off (Helmen, 2016). Most of the spinning methods work best with at backwards long draw that was challenging with the long staple length for this species.
As mentioned earlier, there were three fibres (Bison, Mink and Possum) where it was difficult to generate enough twist with the Tibetan spindle to create singles or yarn with any integrity. Singles were spun with the Tahkli for these three species. Additionally, for Bison and Camel there was a narrow window between enough twist for integrity and enough to snap the yarn. Neither would tolerate as much twist as Cashmere.

Possum on its own (i.e. not blended with other fibres) was extremely difficult to spin, which is likely the reason there aren’t 100% Possum commercially spun yarns. It needs to be blended with something to give it strength and something to stick to as it doesn’t stick to itself. I also did not remove the guard hairs due to time and waste concerns, and I wanted to test the raw fibre for ease of spinning and prickle factor. However, the raw fibre was extremely difficult to process. The Woolery website recommends carding with equipment designed for fine fibres (The Woolery, 2018). The samples for spinning in this project were all carded using cotton cards, but it was very difficult to remove the carded Possum from the card surface. I tried scraping the fibre off by reversing one of the cards. I also used a pair of knitting needles to roll punis. Even this left one-third to one-half of the fibre on the cards as waste. Based on personal observation, the fibre tends to grow on Possum in little tufts. If these tufts are not broken up effectively during carding, they do not take up enough twist when spun into singles, resulting in a weak spot that would either shred when winding the singles on to the BobbinsUp bobbins or when plying. For most species, 15 g of fibre would yield enough yarn for the necessary skeins and swatches (i.e. approximately ~40 m of yarn). However, during the first attempt with Possum I did not have a continuous 10 m of yarn anywhere. On one of the subsequent attempts, I charged my cotton cards sideways (i.e. across the length of the cards rather than down the width) in the hopes that this would help break up the tufts and more passes between cards were used. This helped somewhat, but uncarded tufts still had to be removed from the punis
during spinning. The resulting yarn wasn’t as prone to weak spots, but it was still not as consistent as desired. Knitting and fulling the Possum yarns improved things remarkably. The knitted fabric is soft, lightweight, and wearable, while the yarn does not seem to have those qualities. In fact, most of the expert reviewers ranked the spun yarn at least one ranking lower in softness than they ranked the knitted fabric. Overall, Possum ranked lower on the personal preference scores as well (Figure 19, page 35).

In a paper describing the fibre characteristics of Brushtail Possum, Reid et al (2007) mentioned the following characteristics that render Possum fibre more difficult to process versus other fibre species. The outer hair cuticle is smoother than Merino, which makes the fibre more “slippery”. During commercial blending, Possum fibre tends to fall out during carding and will continue to shed from the garment during use. The fibre itself is very short, especially when compared to other similar diameter fibres. The average staple length of an 18-19μ-diameter wool is approximately 78 mm, about three times longer than Possum. Commercial Possum-blend yarns are typically spun semi-woollen and the resulting yarn tends to be hairy and a lower count yarn (Reid, 2007 (67)). These comments are very consistent with my spinning experience during this project.

Most of the other fibers (Bison, Yak, Qiviut, and Camel) generally spun well on any of the four tools selected, the exception being Camel on the Tibetan spindle. The singles seemed to be stable, it wound on to the storage bobbins without issue, but it shredded multiple times when I was plying on the drop spindle. Using a lighter drop spindle or plying on the Wheel may have been an alternate choice.

The other thing I noted was that Bison, while still needing some level of twist, would not tolerate as much twist as the other fibres, even Yak and Qiviut. Given the similarities between
these three fibres, it seems reasonable to expect that they would be roughly equivalent in twist tolerance. However, the quality of the Bison fibre used was mediocre compared to the Qiviut or Yak due to nep in the preparation. Overall, it tended to rank lower on the softness scale compared to the other two. I am not convinced that the fibre quality influenced the twist tolerance; Bison may just need a lower amount of twist in general.

Spinners that have worked with Cashmere probably recognize that it requires a very high amount of twist. There are some thin spots in both the Tibetan and Charkha-spun yarns, but I was very surprised at how strong the yarns were, even in the thin sections. It spun easily on the Charkha, Quill and Wheel. It spun with a bit more effort on the Tibetan spindle, other than it was a lot of work to get enough twist for stable singles. Overall, these yarns had far more lustre than any of the other test species.

Mink, in addition to Possum, was also new to me. There were two fibre samples in my stash, one grey and one brown. I used both in this project. Visibly, there didn’t seem to be much difference in the preparations, and both were listed as Mink down roving, but the grey one seemed to be much easier to spin. As with other fibres, it spun easily with the higher-twist methods but didn’t need the same level of twist as Cashmere. However, it was very difficult to get enough twist using the Tibetan spindle. As a result, I substituted the Tahkli, which resulted in a better yarn. Overall, it produced a very soft yarn and fabric, and was generally ranked very highly by both the novice and expert volunteers both in softness and personal preference. The yarns and fabric have very little lustre, which I found interesting especially when you consider how shiny/lustrous Mink fur is. I also found that there was very little memory in these yarns. All four Mink swatches stretched out during fulling and had to be pushed back into a 4” square when I was blocking my samples, opposite of all the other fibre types.
As mentioned previously, there were two major sections to the evaluation form. In one section, respondents were asked to rank each sample from 1 (harsh) to 10 (soft). Expert respondents ranked both the yarn and knitted swatch, while novices were only asked to rank the swatches. Results are presented in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Charkha</th>
<th>Tibetan</th>
<th>Quill</th>
<th>Wheel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>Alpaca</td>
<td>Yarn</td>
<td>7.3</td>
<td>7-8</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>7.0</td>
<td>5-10</td>
<td>6.7</td>
</tr>
<tr>
<td>Yak</td>
<td>Yarn</td>
<td>8.2</td>
<td>7-10</td>
<td>7.9</td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>7.6</td>
<td>5-10</td>
<td>8.2</td>
</tr>
<tr>
<td>Bison</td>
<td>Yarn</td>
<td>7.2</td>
<td>6-9</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>6.5</td>
<td>4-9</td>
<td>6.5</td>
</tr>
<tr>
<td>Cashmere</td>
<td>Yarn</td>
<td>9.3</td>
<td>8-10</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>8.8</td>
<td>5-10</td>
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</tr>
<tr>
<td>Camel</td>
<td>Yarn</td>
<td>8.0</td>
<td>8</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>7.4</td>
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<td>Swatch</td>
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<td>Yarn</td>
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<td>5-9</td>
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<tr>
<td>Qiviut</td>
<td>Yarn</td>
<td>6.8</td>
<td>4-8</td>
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</tr>
<tr>
<td></td>
<td>Swatch</td>
<td>7.3</td>
<td>5-9</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Although the evaluations are entirely subjective, there are some notable trends. Very often, the novice volunteers had a wider range of rankings compared to the expert volunteers.

For example, on a specific knitted swatch the range from the experts might be 7-9, whereas the novice rankings might have ranged from 5-10. This was especially true for the samples that were perceived to be harsher.

Cashmere, Qiviut and Mink consistently ranked very high based on perceived softness, regardless of spinning tool. Alpaca, Bison and Possum consistently ranked harsher, regardless of spinning tool. In most cases, rankings for the swatch and yarn were well-aligned, but there were
some situations where the average values between yarn and swatch were numerically different. For example, with Qiviut on the Charkha the swatch scored higher than the yarn, as it did with Wheel-spun Possum; however, for Mink on the Tibetan spindle, the yarn scored higher than the swatch.

The second section of the evaluation form asked respondents to list the eight fibres they evaluated (i.e. across one spinning method) in terms of their order of preference where 1 was most preferred and 8 was least preferred. No guidance was given on how to evaluate preference, so respondents may have chosen different characteristics in making their selections (i.e. yarn integrity, loft, fibre colour, etc.). An average score was calculated for each of the 32 fibre x tool combinations based on how they were ranked using a calculation described on the Survey Monkey website:

The average ranking is calculated as follows, where:

\[
W = \text{weight of ranked position} \\
x = \text{response count for answer choice}
\]

\[
\frac{x_1 \cdot w_1 + x_2 \cdot w_2 + \ldots + x_n \cdot w_n}{\text{Total}}
\]

Weights are applied in reverse. In other words, the respondent's most preferred choice (which they rank as #1) has the largest weight, and their least preferred choice (which they rank in the last position) has a weight of 1. (Survey Monkey, 2018)
Figure 18 Blocked swatches laid out to dry
Figure 19 Overall fibre x tool rankings, based on personal preference as assessed by expert and novice volunteers.
There are several interesting findings in Figure 19. Apart from Mink Tibetan, Mink consistently ranked as one of the most preferred fibres. A similar trend was noted with Cashmere, except for wheel-spun Cashmere. I believe the wheel-spun Cashmere was overspun and, to me, felt harsher than the other three skeins from this species. Wheel-spun Qiviut was the most preferred sample, and yet the other Qiviut samples are spread throughout the graph, one each in highly preferred, medium preferred and lower preferred.

Bison was consistently one of the least preferred fibres. I initially thought it would rank similar to Yak and Qiviut. However, the Bison fibre I had to work with was of poorer quality than the Yak or Qiviut, so in the end it’s not overly surprising that it ranked where it did. Alpaca also was one of the lower-preferred fibres. I believe there are two reasons for this. Firstly, I worked with raw fibre that was hand-carded. Had I worked with combed top, either my own or commercially prepared, it might have scored more highly. I chose not to use a combed preparation, knowing that most of the tools needed a semi-woollen spinning technique. Secondly, even though Alpaca represents more of an “affordable” luxury fibre, even the best preparation and techniques won’t achieve the same lightweight, soft fabric when compared to fibres such as Cashmere, Yak, Qiviut or Mink.

The Quill-spun Possum was overall the least preferred yarn, and the remaining three samples were all in the bottom half of the ranking.

Conclusions

Overall, there was a strong correlation between how a fibre ranked in terms of softness to personal preference. I had several volunteers who told me they felt like they were just evaluating various “grades” of soft. This is probably true. All test species are classified as “luxury” fibres, in part because of their tactile qualities and the lightweight, warm fabrics that
they produce. Luxury may in part be associated with the cost or availability of the fibre, but I would argue that the subjective, tactile qualities of the fibre, yarn and fabric are also important factors in the definition of luxury.

There wasn’t any particular spinning tool that was best at showcasing any particular fibre. Provided that there was enough twist in the fibre without over-spinning or over-plying, all yarns and swatches within a species were generally ranked similarly to one another. Any tactile differences across the eight test species were well demonstrated in the average rankings for softness and personal preference. Looking at average twists per inch (TPI) across the various tools, I was generally able to produce slightly higher TPI yarns with the Wheel and the Charkha (see Appendix 3 on page 53). The average TPI for Wheel and Charkha-spun yarns across all species was 5.3 for either tool, compared to 5.0 for both the Tibetan Spindle or the Quill-spun yarns. The Tibetan spindle is a slower tool and so it is not surprising that using it produced slightly lower TPI yarns, as it was often a lot of work to get the required amount of twist in. It also felt like I had better control of the twist going into the singles on the Wheel and the Charkha compared to the other two tools. I also found it interesting that the average TPI within species was well-aligned with my comments on twist tolerance (i.e. Alpaca, Bison and Camel in general all had lower TPI yarns).

This study was performed using multiple preparations (i.e. raw fibre, cloud, roving and combed top). An area that could be explored in future study would be to conduct a similar evaluation using consistent preparation methods across all species and tools to determine if the preparation method further influences the tactile qualities of the yarn and fabric. As mentioned earlier, depigmented Yak was not included in this study and it would have been interesting to compare it directly to naturally-coloured Yak to determine if the depigmentation process
influences the spinning or tactile qualities of the yarn or fabric either positively or negatively.

Since Possum is a difficult fibre to spin on its own, further study could also examine various Possum blends in an effort to determine if there are optimal fibre combinations or percentage blends that would improve either the overall yarn and fabric, or specific targeted characteristics such as twist tolerance, strength, insulating properties/heat retention etc.

Before I started spinning, I was expecting the Possum samples to rank higher on softness and personal preference than they did. However, it is a difficult fibre to process, and one that would definitely improve as a blend with other fibres. It wasn’t specifically tested in this project, but I have a hat and mitts that were knit with a commercially spun Merino-Possum blend that are very lightweight and warmer than most of my straight wool items. There is a place for this fibre in the handspun world, just maybe not as a 100% possum fabric.
Acknowledgements
I would like to acknowledge the following folks for their contributions to this project:

- Christine Wilson de Medina, for loan of her Lendrum Quill attachment, a couple of photos and for suggesting the Spinners Flock guild as a source of "expert" volunteers.

- The 18 "expert" volunteers from the Spinners Flock Guild, as well as their executive committee for allowing me to complete the expert evaluation phase of this project during their regular meeting. I appreciate your members' welcome and enthusiasm, and the feedback I received from the evaluations.

- The 20 friends and colleagues at my workplace for your interest in my project and willingness to give up your lunch hour to evaluate fibre samples. I hope it was fun and interesting for you.

- My instructors and classmates from all six levels of the Master Spinner Program. I appreciate your friendship and help in coming much farther as a spinner than I ever would have on my own.
Bibliography


Reid, T. C. (2007 (67)). Variation of fibre characteristics important in processing, over the body of Australian brushtail possum (Trichosurus vulpecula). *Proceedings of the New Zealand Society of Animal Production*, 351-355.


Appendix 1 Example Expert and Novice Evaluation Forms
Exotic Fibre Evaluation Form – Charkha (EXPERT)

A. About You:

_____ Male  _____ Female

I am a (check all that apply):

<table>
<thead>
<tr>
<th>Spinner</th>
<th>Crocheter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knitter</td>
<td>Felter</td>
</tr>
<tr>
<td>Weaver</td>
<td>Other</td>
</tr>
</tbody>
</table>

B. For each of the sample cards, please rank the hand of both the skein of yarn and the knitted swatch on a scale of 1 to 10.

Piano Wire (harsh) 1 2 3 4 5 6 7 8 9 10 Angel Hair (soft)

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Item</th>
<th>Assessment (1-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 5</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 11</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 16</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 20</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 24</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
<td></td>
</tr>
<tr>
<td>Sample 28</td>
<td>Yarn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swatch</td>
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</tr>
<tr>
<td>Sample 30</td>
<td>Yarn</td>
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</tr>
<tr>
<td></td>
<td>Swatch</td>
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</tr>
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</table>
C. Please rank the samples in terms of your overall personal preference

<table>
<thead>
<tr>
<th>1 Most Preferred</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
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</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
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</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8 Least Preferred</td>
<td></td>
</tr>
</tbody>
</table>

D. OPTIONAL

If you’d like, please identify the species for each sample:

<table>
<thead>
<tr>
<th>Species</th>
<th>Sample #</th>
<th>Species</th>
<th>Sample #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpaca</td>
<td></td>
<td>Mink</td>
<td></td>
</tr>
<tr>
<td>Bison</td>
<td></td>
<td>Possum (Brushtail)</td>
<td></td>
</tr>
<tr>
<td>Camel</td>
<td></td>
<td>Yak</td>
<td></td>
</tr>
<tr>
<td>Cashmere</td>
<td></td>
<td>Qiviut (Musk Ox)</td>
<td></td>
</tr>
</tbody>
</table>

THANK YOU VERY MUCH FOR YOUR TIME!!
Exotic Fibre Evaluation Form – Tibetan (NOVICE)

A. About You:

_____ Male  _____ Female  Fibre Art Experience: _____ Yes  _____ No

B. For each of the sample cards, please rank the softness of the fibre on a scale of 1 to 10 where 1 = harsh/piano wire and 10 = soft as angel wings

<table>
<thead>
<tr>
<th>Sample #</th>
<th>HARSH</th>
<th>SOFT</th>
</tr>
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<tbody>
<tr>
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<tr>
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<td>1  2  3  4  5  6  7  8  9  10</td>
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<tr>
<td># 12</td>
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<tr>
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<td></td>
</tr>
<tr>
<td># 17</td>
<td>1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td># 23</td>
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<td></td>
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<td># 25</td>
<td>1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td># 29</td>
<td>1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
</tbody>
</table>

Please continue to page 2
C. Please rank the samples in terms of your overall personal preference

<table>
<thead>
<tr>
<th>1 Most Preferred</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
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</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8 Least Preferred</td>
<td></td>
</tr>
</tbody>
</table>

D. OPTIONAL

If you'd like, please identify the species for each sample:

<table>
<thead>
<tr>
<th>Species</th>
<th>Sample #</th>
<th>Species</th>
<th>Sample #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpaca</td>
<td></td>
<td>Mink</td>
<td></td>
</tr>
<tr>
<td>Bison</td>
<td></td>
<td>Possum (Brushtail)</td>
<td></td>
</tr>
<tr>
<td>Camel</td>
<td></td>
<td>Yak</td>
<td></td>
</tr>
<tr>
<td>Cashmere</td>
<td></td>
<td>Qiviut (Musk Ox)</td>
<td></td>
</tr>
</tbody>
</table>

THANK YOU VERY MUCH FOR YOUR TIME!!
### Appendix 2 General Comments on Ease of Spin and Other Characteristics for each Fibre and Tool Combination

<table>
<thead>
<tr>
<th>Species</th>
<th>Charkha</th>
<th>Tibetan</th>
<th>Quill</th>
<th>Wheel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alpaca</strong></td>
<td>Alpaca spun reasonably well on the Charkha but feels a bit harsher than the others of this species. Little to no loft/bounce in any of the Alpaca yarns.</td>
<td>The yarn itself has several consistency issues but is surprisingly soft. This was the most difficult spin method for this fibre.</td>
<td>It was more difficult than Charkha, but less than Tibetan. The resulting yarn has similar twist to wheel- and charkha-spun samples but feels less harsh.</td>
<td>This was the easiest of the spinning methods for this species, although singles are slightly overspun.</td>
</tr>
<tr>
<td><strong>Yak</strong></td>
<td>Yak generally spun well on all 4 methods. There were some thick and thin areas with Charkha, but no weak spots. Medium loft was noted in the swatch.</td>
<td>The resulting yarn is very light, but it has good strength. It is somewhat underplied, but I am very surprised by this as it looked and felt like there was enough twist when I plied it. This was one of my favourites to spin.</td>
<td>This method resulted in a far more delicate yarn than the other three methods. It tended to draft more finely for this method than the others and I felt that I had less control over the singles twist. Although there are some thin spots, there do not appear to be any weak areas in the yarn.</td>
<td>Yak spun easily on the wheel, although the singles might be slightly overspun. The resulting fabric feels a little harsher than the Quill-spun Yak.</td>
</tr>
<tr>
<td><strong>Bison</strong></td>
<td>This was spun from better quality roving than the wheel/charkha samples. It was a comfortable, easy spin, although there were issues with the drive band slipping on the drive wheel early on. Replacing the drive band fixed this.</td>
<td>I was not able to get enough twist in the singles using the Tibetan spindle and switched to the Tahkli as a result. This was spun from poorer quality roving (neps) and at times it felt more like a garnetted yarn. Carding the fibre into punis did not improve the spinning experience.</td>
<td>There was a very fine balance between getting enough twist in the single and snapping it. The resulting singles were slightly more delicate than ideal with a couple of weak spots. While there was generally enough twist in the singles, the yarn may have benefitted from more ply twist.</td>
<td>This was spun from a poorer quality roving (neps) than the other samples, so there are texture/inconsistency issues, but a nicer handle than the Quill-spun sample. None of the bison samples are next-to-skin soft.</td>
</tr>
<tr>
<td>Species</td>
<td>Charkha</td>
<td>Tibetan</td>
<td>Quill</td>
<td>Wheel</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Cashmere</td>
<td>Since cashmere will tolerate a high amount of twist, it was very easy to overspin the singles using this method. There was also a tendency to draft very finely, more so than the other methods. Despite this, the resulting fabric has good bounce, drape and lustre.</td>
<td>Cashmere spun reasonably well on the Tibetan spindle, but there are several very thin spots in the yarn and knitted swatches. Despite this, the yarn feels very strong and maintains a good softness and lustre. The yarn is my least favourite of the cashmere samples. It seems to be somewhat overspun and underplied.</td>
<td>This was a difficult method until I realized I had the ratio at 6:1. It went much better at 25:1. Spinning from the fold prevented the singles from drafting too finely. There was lots of loft and lustre in both the yarn and fabric and a surprising amount of strength given how fine the singles were.</td>
<td>Although cashmere can tolerate a high amount of twist, it feels like the singles were overspun using this method. However, both the yarn and swatch have good loft and sheen. The resulting fabric feels almost slippery.</td>
</tr>
<tr>
<td>Camel</td>
<td>This was an easy, comfortable spin. Camel will not tolerate the same amount of twist as cashmere and it was easy to control the draft and amount of twist in the singles. The yarn might benefit from a small increase in ply twist but the yarn and fabric both have a good amount of loft.</td>
<td>Contrary to the other three methods, this was the most difficult of the Camel samples to spin. In general, the fibre tended to draft too finely and it seemed to take a lot of twist to produce singles that maintained their integrity. It was also very difficult to ply as it often wanted to shred, although plying with a lighter spindle might have helped with this.</td>
<td>Quill-spun camel was generally a nice, easy spin and it plied without difficulty. Both the yarn and fabric are next to skin soft with good loft and drape. The yarn is also surprisingly strong.</td>
<td>This was a nice easy spin as well, resulting in a well-balanced yarn with lots of loft and drape and memory.</td>
</tr>
<tr>
<td>Species</td>
<td>Charkha</td>
<td>Tibetan</td>
<td>Quill</td>
<td>Wheel</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Mink</td>
<td>If there was any negative to Mink, it tended to draft very finely when Charkha-spun, but it was still easy to control the amount of twist and generate a single with good integrity. The singles p lied well. Similar to the other samples, the fabric is very soft, but no lustre and no memory/elasticity.</td>
<td>It was difficult to get enough twist in the singles using the Tibetan spindle. The Takhli was used instead. Mink spun well on the Takhli, drafted easily and accepted the twist well. It also p lied easily. However, there is very little loft in the yarn/fabric, nor is there any elasticity in the swatch and any finished garment would likely stretch out when worn.</td>
<td>Again, this was an easy, comfortable spin if the spinner is comfortable with spinning semi-woollen yarns. In general, it was easy to control both the draft and amount of twist in the singles, and it p lied well on the Quill. However, the resulting fabric has no memory. It stretched out quite a bit and had to be pushed back in to the 4&quot; square when wet blocked.</td>
<td>Mink spun very easily on the wheel. It spins very similarly to cotton except that there's a very fine line between enough twist to maintain integrity and so much that it snaps. The resulting fabric is incredibly soft, but there is only a small amount of bounce or lustre, and the yarn is not as strong as other fibres, even when well-spun.</td>
</tr>
<tr>
<td>Possum</td>
<td>None of the spinning methods were easy with Possum. There was a lot of waste, shredding of singles and even the finished yarn spun using the Charkha. When removing this yarn from the swift to wind into a 10-yard skein, I found I had to manually turn the swift and gently gather the yarn rather than just pulling the yarn and letting the swift turn under its own power (i.e. the Possum yarn was much weaker than most other species). However, knitting improved all four yarns quite remarkably.</td>
<td>It was difficult to get enough twist in using the Tibetan spindle, so singles were spun using the Takhli. Even with the Takhli, it was difficult to provide enough twist if the raw fibre wasn't well prepared and there were several weak spots when plying. It also was difficult to ply. Although none of the Possum samples are my top favourites, this is my most preferred Possum sample.</td>
<td>The Quill-spun yarn wasn't as fragile as the other three, but it is not clear why. I faced the same challenges as with the other methods (i.e. intact tufts in the preparation resulted in weak spots in the singles) even though it drafted relatively consistently. The resulting yarn has more body/stiffness and will produce a garment with more definition (i.e. less drape) than most of the other species which is surprising given the fibre length.</td>
<td>This was the least difficult spinning method if the fibre was well prepared. However, any tufts that weren't broken up by carding had to be removed as they wouldn't take any twist and result in a weak spot in the singles that would shred/drift apart when plying. Since the twist is generally added more slowly (17:1 ratio compared to quill/charkha), it was easier to catch and remove these when spinning.</td>
</tr>
<tr>
<td>Species</td>
<td>Charkha</td>
<td>Tibetan</td>
<td>Quill</td>
<td>Wheel</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Qiviut</td>
<td>Qiviut spun well on the Charkha with no major issues. The resulting yarn and fabric have a small amount of loft and good balance. The samples do not have as nice a hand as the other three. The fibre may have been from a different source than that used for the other samples.</td>
<td>As noted with several other test species, it was often difficult to get enough singles twist using the Tibetan spindle. Qiviut spun well other than it required a bit of effort to get the correct amount of singles twist. It plied well, and the resulting yarn has good balance. The resulting fabric only has a moderate amount of drape, which is surprising, given the soft hand that it has.</td>
<td>Qiviut was an easy, comfortable spin on the Quill. In general, it was easy to control the draft and singles twist and the plied yarn is well balanced with no difficulty in plying. The resulting yarn and fabric as little loft and a small amount of elasticity</td>
<td>Overall, this ranked as the most preferred yarn/fabric. It drafted consistently and evenly and accepted singles twist well. It also plied easily on the Wheel. The resulting yarn has good loft/bounce and exceptional next-to-skin softness.</td>
</tr>
</tbody>
</table>
Appendix 3 Summary Technical Characteristics of the Sample Yarns by Tool and Species

Table 4 Average, minimum and maximum TPI and WPI by Spinning Tool

<table>
<thead>
<tr>
<th>Tool</th>
<th>Average TPI</th>
<th>Minimum TPI</th>
<th>Maximum TPI</th>
<th>Average WPI</th>
<th>Minimum WPI</th>
<th>Maximum WPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charkha</td>
<td>5.3</td>
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<td>7.0</td>
<td>15.0</td>
<td>12.0</td>
<td>17.0</td>
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<tr>
<td>Quill</td>
<td>5.0</td>
<td>3.0</td>
<td>7.0</td>
<td>14.8</td>
<td>10.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Tibetan Spindle</td>
<td>5.0</td>
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<td>6.0</td>
<td>16.8</td>
<td>12.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Wheel</td>
<td>5.3</td>
<td>4.0</td>
<td>6.0</td>
<td>15.3</td>
<td>12.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Overall</td>
<td><strong>5.1</strong></td>
<td><strong>3.0</strong></td>
<td><strong>7.0</strong></td>
<td><strong>15.4</strong></td>
<td><strong>10.0</strong></td>
<td><strong>19.0</strong></td>
</tr>
</tbody>
</table>

Table 5 Average, minimum and maximum TPI and WPI by species

<table>
<thead>
<tr>
<th>Species</th>
<th>Average TPI</th>
<th>Minimum TPI</th>
<th>Maximum TPI</th>
<th>Average WPI</th>
<th>Minimum WPI</th>
<th>Maximum WPI</th>
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<tr>
<td>Alpaca</td>
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<td>Bison</td>
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<td>Camel</td>
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<td>Cashmere</td>
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<td>Mink</td>
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<tr>
<td>Qiviut</td>
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<td>6.0</td>
<td>14.5</td>
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<td>17.0</td>
</tr>
<tr>
<td>Yak</td>
<td>5.0</td>
<td>4.0</td>
<td>6.0</td>
<td>17.0</td>
<td>16.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Overall</td>
<td><strong>5.1</strong></td>
<td><strong>3.0</strong></td>
<td><strong>7.0</strong></td>
<td><strong>15.4</strong></td>
<td><strong>10.0</strong></td>
<td><strong>19.0</strong></td>
</tr>
</tbody>
</table>
Sarah Perkins, Independent Study, Skein # 20
100% Camel, Charkha-spun, 2 ply, Semi-woollen

Spun from the cloud using backwards long draw and
plied on drop spindle

Finished by soaking ~ 45 min in hot tapwater, smacked on bathtub several
times and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 5 TPI, 13 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted socks
Sarah Perkins, Independent Study, Skein # 21

100% Mink, Wheel-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and plied on the wheel

Finished by soaking ~ 30 min in hot tapwater, smacked on bathtub several times and fullled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 6 TPI, 15 WPI, 33° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: crocheted cowl with good drape
Sarah Perkins, Independent Study, Skein # 22
100% Mink, Quill-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and plied on the quill

Finished by soaking in hot tapwater ~ 20 mins and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 7 TPI, 17 WPI, 30° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: crocheted vest
Sarah Perkins, Independent Study, Skein # 23

100% Mink, Tahkli-spun, 2 ply, Semi-woollen

Spun from the cloud using backwards long draw and
plied on drop spindle

Finished by soaking in hot tapwater ~45 mins, smacked several times on
bathtub and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 6 TPI, 18 WPI, 37° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lacy crocheted wrap
Sarah Perkins, Independent Study, Skein # 24
100% Mink, Charkha-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and
plied on drop spindle

Finished by soaking in hot tapwater ~ 30 mins and fulled by alternated hot and
cold water with agitation. Repeated twice

Twist Direction: z,z,S, 7 TPI, 16 WPI, 33° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: knitted headband for winter
Sarah Perkins, Independent Study, Skein # 25
100% Possum, Tahkli-spun, 2 ply, Semi-woollen

Spun from handcarded rolags using long backwards draw and plied on wheel

Finished by soaking ~40 mins in hot tapwater, snapped VERY LIGHTLY once and fullled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 6 TPI, 18 WPI, 33° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lightweight knitted slouchy hat or beret
Sarah Perkins, Independent Study, Skein # 26

100% Possum, Wheel-spun, 2 ply, Semi-woollen

Spun from hand carded rolags using supported long backwards draw and plied on wheel

Finished by soaking ~50 mins in hot tapwater, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 7 TPI, 14 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted trim on doll clothes
Sarah Perkins, Independent Study, Skein # 27
100% Possum, Quill-spun, 2 ply, Semi-woollen

Spun from handcarded rolags using backwards long draw and plied on wheel

Finished by soaking ~25 mins in hot tapwater and fulled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 7 TPI, 14 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted travel mug cozy
Sarah Perkins, Independent Study, Skein # 28

100% Possum, Charkha-spun, 2 ply, Semi-woollen

Spun from hand carded rolags using long backwards draw and plied on wheel

Finished by soaking ~30 min in hot tapwater, snapped VERY LIGHTLY 1-2 times and fulled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 5 TPI, 13 WPI, 30° Angle, 10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: knitted tea cozy
Sarah Perkins, Independent Study, Skein # 29

100% Qiviut, Tibetan Spindle-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and plied on drop spindle

Finished by soaking ~25 mins in hot tapwater and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 4 TPI, 17 WPI, 23° Angle, 10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted kindle cover
Sarah Perkins, Independent Study, Skein # 30

100% Qiviut, Charkha-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and plied on drop spindle

Finished by soaking ~45 mins in hot tapwater, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 12 WPI, 27° Angle, 10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: crocheted scarf
Sarah Perkins, Independent Study, Skein # 31

100% Qiviut, Quill-spun, 2 ply, Semi-woollen

Spun from roving using supported long backwards draw and plied on quill

Finished by soaking in hot tapwater ~25 mins, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 6 TPI, 15 WPI, 30° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lightweight knitted hat to match a pair of mitts I have from commercial yarn
Sarah Perkins, Independent Study, Skein # 32

100% Qiviut, Wheel-spun, 2 ply, Semi-woollen

Spun from roving using supported long backwards draw and plied on wheel

Finished by soaking ~ 30 mins in hot tapwater, smacked on bathtub several times
soaked and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 14 WPI, 33° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: lacy crocheted scarf
Sarah Perkins, Independent Study, Skein # 1

100% Alpaca, Charkha-spun, 2 ply, Semi-woollen

Spun from hand carded sliver using backwards long draw and plied on top whorl drop spindle

Finished by soaking ~ 20 mins in hot tap water and fulled by alternately plunging in hot then cold water and agitated each time. Repeated twice

Twist Direction: z,z,S, 4 TPI, 16 WPI, 25° Angle,
10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: lightweight mittens
Sarah Perkins, Independent Study, Skein # 2

**100% Alpaca, Tibetan Spindle-spun, 2 ply, Semi-woollen**

Spun from hand carded sliver using short backwards draw and plied using top-whorl spindle

Finished by soaking ~20 mins in hot tap water, smacked 5-6 times on side of tub and fulled by alternated hot and cold water with agitation in both. Repeated 3 times

Twist Direction: z,z,S, 3 TPI, 12 WPI, 21° Angle,

10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: knitted skirt with lots of drape
100% Alpaca, Quill-spun, 2 ply, Semi-woollen

Spun from hand carded sliver using long backwards draw and plied on quill

Finished by soaking in hot water, snapped 2-3 times and smacked on the side of the tub several times and fulled by alternated hot and cold water with agitation, repeated total of 3 times

Twist Direction: z,z,S, 4 TPI, 15 WPI, 30° Angle,
10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: long crocheted duster jacket with lots of drape
Sarah Perkins, Independent Study, Skein # 4

100% Alpaca, Wheel-spun, 2 ply, Semi-worsted

Spun from hand carded sliver using short forward draw and plied on the wheel

Finished by soaking in hot tap water ~40 mins. Snapped several times to straighten and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 17 WPI, 37° Angle,
10 yards, weight: 3 g, Bradford Count: 2/5s

Suitable End Use: weft yarn for woven vest or top
100% Yak, Charkha-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and plied using a drop spindle

Finished by soaking ~20 mins in hot tapwater with lemongrass soap and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 17 WPI, 33° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: fine knit socks
Sarah Perkins, Independent Study, Skein # 6
100% Yak, Quill-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and
plied on drop spindle

Finished by soaking in hot water ~20 mins, snapped VERY lightly 1-2x to
straighten and fulled by alternated hot and cold water with agitation.
Repeated twice

Twist Direction: z,z,S, 4 TPI, 16 WPI, 35° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: landscape in a tapestry weaving
Sarah Perkins, Independent Study, Skein # 7

100% Yak, Wheel-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and plied on the wheel

Finished by soaking in hot tapwater ~ 40 mins, smacked on tub several times and fullled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 6 TPI, 16 WPI, 37° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted lace scarf
Sarah Perkins, Independent Study, Skein # 8

100% Yak, Tibetan spindle-spun, 2 ply, Semi-woollen

Spun from the cloud using backwards short draw and plied using drop spindle

Finished by soaking in hot tap water ~ 60 mins, smaked several times on tub and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 19 WPI, 37° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lacy crocheted stole
Sarah Perkins, Independent Study, Skein # 9

100% Bison, Quill-spun, 2 ply, Semi-woollen

Spun from poorer quality roving using long backwards draw and plied on drop spindle

Finished by soaking in hot tapwater ~25 mins, smacked on tub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 3 TPI, 14 WPI, 25° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: crocheted bear suit from "My Crocheted Doll" book
Sarah Perkins, Independent Study, Skein # 10

100% Bison, Wheel-spun, 2 ply, Semi-woollen

Spun from roving using supported backwards draw and plied on the wheel

Finished by soaking in hot tap water ~ 30 mins, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 13 WPI, 30° Angle,
10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: the Horse toy from the Knitted Farm Animals book
Sarah Perkins, Independent Study, Skein # 11

**100% Bison, Charkha-spun, 2 ply, Semi-woollen**

Spun from roving using backwards long draw and plied on drop spindle

Finished by soaking in hot tapwater ~20 mins, smacked several times on the bathtub and fullled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 4 TPI, 14 WPI, 25° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: weft yarn for woven trivet
Sarah Perkins, Independent Study, Skein # 12

100% Bison, Tahkli-spun, 2 ply, Semi-woollen

Spun from very poor quality roving and hand carded punis using long backwards draw and plied on drop spindle

Finished by soaking in hot tapwater ~35 mins and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 4 TPI, 15 WPI, 23° Angle,
10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: knitted tuque
Sample 13
100% Cashmere, Tibetan Spindle-spun, 2 ply, Semi-woollen

Spun from combed top using short backward draw and plied on drop spindle

Finished by soaking in hot tap water overnight, smacked on bathtub 3-4 times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 6 TPI, 19 WPI, 35° Angle,
10 yards, weight: 2 g. Bradford Count: 2/15s

Suitable End Use: very lightweight crocheted vest
Sarah Perkins, Independent Study, Skein # 14

100% Cashmere, Wheel-spun, 2 ply, Semi-woollen

Spun from Combed top using spun from the fold and plied on the wheel

Finished by soaking in hot water ~40 mins, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 5 TPI, 19 WPI, 33° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: warp yarn for lightweight woven top
Sarah Perkins, Independent Study, Skein # 15
100% Cashmere, Quill-spun, 2 ply, Semi-woollen

Spun from combed top using supported long backwards draw and
plied on drop spindle

Finished by soaking ~ 20 mins in hot tapwater, smacked several times on
bathtub and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 5 TPI, 17 WPI, 30° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted baby bonnet and booties
Sarah Perkins, Independent Study, Skein # 16

100% Cashmere, Charkha-spun, 2 ply, Semi-woollen

Spun from combed top using backwards long draw and
plied on drop spindle

Finished by soaking in hot water ~30 mins. Smacked on tub several times and
fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 7 TPI, 17 WPI, 33° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: knitted mini-mitts christmas ornaments
Sarah Perkins, Independent Study, Skein # 17

100% Camel, Tibetan Spindle-spun, 2 ply, Semi-woollen

Spun from prepared roving using short backwards draw and
plied on drop spindle

Finished by soaking in hot water ~45 min. Smacked on bathtub several times
and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 6 TPI, 19 WPI, 37° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lacy crocheted collar and cuffs for dress or fancy blouse
Sarah Perkins, Independent Study, Skein # 18

100% Camel, Wheel-spun, 2 ply, Semi-woollen

Spun from prepared roving using supported long draw and plied on wheel

Finished by soaking in hot tapwater ~45 mins, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 4 TPI, 12 WPI, 30° Angle,
10 yards, weight: 4 g, Bradford Count: 2/8s

Suitable End Use: crocheted mitts
Sarah Perkins, Independent Study, Skein # 19

**100% Camel, Quill-spun, 2 ply, Semi-woollen**

Spun from the cloud using supported long backwards draw and
plied on quill

Finished by soaking in hot tapwater ~ 1.5 hrs, smacked on the bathtub 5-6
times and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 4 TPI, 10 WPI, 25° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: weft yarn for woven shawl
Sarah Perkins, Independent Study, Skein # 20

100% Camel, Charkha-spun, 2 ply, Semi-woollen

Spun from the cloud using backwards long draw and plied on drop spindle

Finished by soaking ~ 45 min in hot tapwater, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z.z.S, 5 TPI, 13 WPI, 27° Angle.
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted socks
Sarah Perkins, Independent Study, Skein # 21

100% Mink, Wheel-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and
plied on the wheel

Finished by soaking ~ 30 min in hot tapwater, smacked on bathtub several
times and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 6 TPI, 15 WPI, 33° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: crocheted cowl with good drape
Sarah Perkins, Independent Study, Skein # 22

100% Mink, Quill-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and plied on the quill

Finished by soaking in hot tapwater ~ 20 mins and fullled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 7 TPI, 17 WPI, 30° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: crocheted vest
Sarah Perkins, Independent Study, Skein # 23

100% Mink, Takhli-spun, 2 ply, Semi-woollen

Spun from the cloud using backwards long draw and
plied on drop spindle

Finished by soaking in hot tapwater ~45 mins, smacked several times on
bathtub and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 6 TPI, 18 WPI, 37° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lacy crocheted wrap
100% Mink, Charkha-spun, 2 ply, Semi-woollen

Spun from roving using long backwards draw and
plied on drop spindle

Finished by soaking in hot tapwater ~ 30 mins and fulled by alternated hot and
cold water with agitation. Repeated twice

Twist Direction: z,z,S, 7 TPI, 16 WPI, 33° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: knitted headband for winter
Sarah Perkins, Independent Study, Skein # 25

100% Possum, Tahkli-spun, 2 ply, Semi-woollen

Spun from handcarded rolags using long backwards draw and plied on wheel

Finished by soaking ~40 mins in hot tapwater, snapped VERY LIGHTLY once and fullled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 6 TPI, 18 WPI, 33° Angle, 10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lightweight knitted slouchy hat or beret
100% Possum, Wheel-spun, 2 ply, Semi-woollen

Spun from hand carded rolags using supported long backwards draw and plied on wheel.

Finished by soaking ~50 mins in hot tapwater, smacked on bathtub several times and fulled by alternated hot and cold water with agitation. Repeated three times.

Twist Direction: z,z,S, 7 TPI, 14 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted trim on doll clothes.
Sarah Perkins, Independent Study, Skein # 27

100% Possum, Quill-spun, 2 ply, Semi-woollen

Spun from handcarded rolags using backwards long draw and plied on wheel

Finished by soaking ~25 mins in hot tapwater and fulled by alternated hct and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 7 TPI, 14 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted travel mug cozy
Sarah Perkins, Independent Study, Skein # 28

100% Possum, Charkha-spun, 2 ply, Semi-woollen

Spun from hand carded rolags using long backwards draw and plied on wheel

Finished by soaking ~30 min in hot tapwater, snapped VERY LIGHTLY 1-2 times and fulled by alternated hot and cold water with agitation. Repeated three times

Twist Direction: z,z,S, 5 TPI, 13 WPI, 30° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: knitted tea cosy
100% Qiviut, Tibetan Spindle-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and plied on drop spindle

Finished by soaking ~25 mins in hot tapwater and fulled by alternated hot and cold water with agitation. Repeated twice

Twist Direction: z,z,S, 4 TPI, 17 WPI, 23° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: knitted kindle cover
100% Qiviut, Charkha-spun, 2 ply, Semi-woollen

Spun from the cloud using long backwards draw and
plied on drop spindle

Finished by soaking ~45 mins in hot tapwater, smacked on bathtub several
times and fulled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 5 TPI, 12 WPI, 27° Angle,
10 yards, weight: 3 g, Bradford Count: 2/10s

Suitable End Use: crocheted scarf
Sarah Perkins, Independent Study, Skein # 31

100% Qiviut, Quill-spun, 2 ply, Semi-woollen

Spun from roving using supported long backwards draw and
plied on quill

Finished by soaking in hot tapwater ~25 mins, smacked on bathtub several
times and fullled by alternated hot and cold water with agitation. Repeated
twice

Twist Direction: z,z,S, 6 TPI, 15 WPI, 30° Angle,
10 yards, weight: 2 g, Bradford Count: 2/15s

Suitable End Use: lightweight knitted hat to match a pair of mitts I have from
commercial yarn