

# Crimp Versus Crinkle

By Mike Safley

I want to thank *Alpacas Magazine* for allowing me to extend the discussion of crimp, now that we have been joined by Eric Hoffman with his recent article entitled, "[Curvature: Is it Crimp or Something Else?](#)" His article takes issue with some of what I had previously reported, and I welcome the opportunity to expand on my ideas and to disagree with Eric's points of view.

Before I turn to the substance of the debate, crimp versus crinkle, I would like to point out some sleight of hand in the structure of Eric's article. First, I must say that I was disappointed with the editor of *Alpacas Magazine*, for allowing Eric to mislead the reader about the content of my article and to mischaracterize certain conclusions from third party research to support his hypothesis about crinkle. I invite each of you to critically analyze both of the previous articles and review the new material which I offer in support of my original hypothesis, that crimp is a positive fleece characteristic and selection marker.

## INCOMPLETE QUOTES

Eric began his article by minimizing my account of his bias against crimp. Here is what Eric had to say:

"... Before we get started on a discussion of curvature in fiber, I'd like to free myself from the anti-crimp role Mike has assigned me. He offers the following quote from my book, *The Complete Alpaca Book*, as evidence of my supposed bad attitude towards crimp:

'... Huacaya, as a breed, has some amount of curvature in fibers, in other words, crimp or crinkle. In some alpaca show systems, the various types of crimp are assigned different values. Such hair-splitting distinctions between styles of crimp may serve the purpose of identifying differences between individual animals in high-stakes alpaca shows, but the commercial processors in Peru who move tons of fleeces through their scouring vats based on handle classing (with some recently introduced micron sampling) are not making such distinctions in the fleece used to create their high-fashion end-products found in the top salons in Milan, Paris, and Geneva ..."

You will note the three periods before the quotation mark above. The problem with this is that Eric left out the full quote that I made of his work, which follows and was included **with** the above quote in my article:

**"... At the time of this writing, no research institution anywhere in the world has presented definitive information correlating crimp to other desirable fiber characteristics in alpacas."**  
[Emphasis added.]

I think you will agree that including the entire quote creates a different meaning. Eric's omission is particularly problematic when you consider that he was editing his own language in order to rebut my assertion that he is anti-crimp. Using quotes out of context (especially your own) amounts to not leveling with your audience.

Eric claims he is not anti-crimp, yet the thrust of his article suggests that crinkle is every bit as important a fleece characteristic as crimp. Furthermore, anyone reading the *Complete Alpaca Book* pages 259-277 and 307 can decide whether they think Mr. Hoffman believes that crimp is an important selection marker for alpacas. In fairness to Eric, the book was written several years ago and the data that he presented on crimp is simply out of date.

## MISCHARACTERIZATION OF RESEARCH CONCLUSIONS

The tone of Eric's article is intended to communicate an aura of scientific support for his conclusions about fiber with crinkle. He quotes extensively from a study which is entitled, "[Fiber Characteristics of U.S. Huacaya Alpacas](#)" that was published in *Alpacas Magazine*, summer 2004. The article was authored by Angus McColl, Chris Lupton, and Bob Stobart. Here is an example of how Eric represents the findings:

"The study mentioned above has provided valuable information for new areas of inquiry and developed expanded types of histograms that will allow breeders to get directly involved in their own correlations of objective fiber measurement. The first version of the article ran in the Summer 2004 issue of *Alpacas Magazine*. The original article has been revised and is awaiting publication in the *Small Ruminant Research Journal*. **Here are some conclusions from the study:** [Emphasis added.]

- "Alpaca, as a species, has low curvature compared to sheep breeds. In alpacas, the range in curvature in the U.S. was between 15.4 and 52.4 deg/mm. **This might possibly mean holding alpaca to the same standard as sheep may be counterproductive if other desired qualities of alpaca fiber are compromised.**" [Emphasis added]

The problem is that nowhere in the *Alpacas Magazine* article does it make the conclusion: "This might possibly mean holding alpaca to the same standard as sheep may be counterproductive if other desired qualities of alpaca fiber are compromised." This conclusion was apparently crafted by Eric to fit his argument that crimp in alpacas may be something other than a positive trait; it is not a conclusion to be found in the original article.

Even more interesting than Eric's misleading use of the study's conclusions and his deceptive representation of his views as those of the authors', is that he omits certain pieces of information from the article that directly support the argument I made in the "Case for Crimp". Here is what the study actually said about curvature:

"The highest reported r [correlation] value is a negative correlation between AFD [fineness] and AC [curvature and crimp], i.e., as fiber becomes coarser, curvature decreases i.e., crimp frequency declines."

As I said in my article: "The pathway to finer fiber may be as simple as selecting huacaya with better defined, more frequent crimp". In other words, the study cited by Eric Hoffman supports my conclusion.

## **SAMPLE SIZE**

In his article, Curvature: Is it Crimp or Something Else?, Mr. Hoffman is vociferous in his criticism of the sample size of the study that I used in The Case for Crimp to demonstrate the point that high crimp frequency and curvature are correlated to fineness. This study measured one hundred alpacas and Eric said "such a small selective group can hardly be considered definitive in the discussion of crimp." I find this statement particularly amusing, since Eric uses single animal histograms, six of them that he personally selected, to make his points and to refute the study's conclusions by arguing "unique sample" exceptions to the Grupo Inca study.

In the past, Eric has not been shy about using small samples to make a bigger point in his writing. He often talks about the alpaca mummies, which were discovered by Dr. Jane Wheeler. Here is what he has said in an article entitled, "Thoughts About Evaluating Alpaca Fiber", published in *Alpaca World Magazine*, spring 2004:

"... The 1000 year old El Yaral alpaca mummies [plural] with fleeces [plural] superior to today's alpacas had crinkle (curvature of individual fibres but not in the corrugated, wavy lock of crimp) and no crimp as does the parent species, vicuña, with its extraordinary fineness and amazing handle ..."

What Eric did not mention in his reference was that of the thirty-two mummies discovered at El Yaral, only four of them were alpaca, and only the finest one of these was tested. (I learned this during a conversation with Dr. Wheeler in Peru, January of 2005.) Using generalizations made on the basis of the one superior fleece did not slow Eric down when his goal was to justify his pet hypothesis about crinkle. Furthermore, his use of the plural form of fleeces and mummies was misleading.

But, enough of this quibbling about sample size and incomplete quotes. The real issue raised by Eric is, should we be selecting for crinkle or crimp?

## CRINKLE

Crinkle is the term that was first applied to alpacas by Cameron Holt in the early 1990s. It is not a standard textile term, and Cameron used it to describe alpaca fleece at a time when it did not exhibit staple crimp. The term originated in a cashmere preparation class in 1980 conducted by Cameron. While discussing the structure of cashmere fleece, a student said that the "crimp" in the individual fibers were "like a crinkle". Crinkle is used as an informal slang term to describe cashmere goat fleece which does not organize itself into staples.

The following quotations are from Wikipedia.org on cashmere goats.

Cashmere Goats can be characterized as follows:

"A cashmere goat is one which produces a fine undercoat of any commercially acceptable color and length. This down should be less than 19 microns (m) in diameter, **crimped** [Emphasis Added] as opposed to straight, non-medullated (not hollow) and low in luster. CaPrA, Concerning Cashmere, 1989 ..."

"Fiber character, or style, refers to the **natural crimp of each individual fiber** [Emphasis Added] and results from the microscopic structure of each fiber. The more frequent the crimps, the finer the spun yarn can be and therefore the softer the finished product ..."

"Very fine fiber, which lacks the requisite crimp, should not be categorized as quality cashmere. It is the crimp of quality cashmere fiber that allows the fiber to interlock during processing. This in turn allows it to be spun into a very fine, usually two-ply yarn, which remains lightweight yet retains the loft (tiny air spaces trapped between the individual fibers) that characterizes quality cashmere sweaters."

The tenth edition of *Textile Terms and Definitions* published by the textile institute does not define crinkle nor does *Sheep and Wool Science* or the *Australian Sheep and Wool Handbook*. In fact, the only textile definition I could find was online, in the Textile Connection Library, where it defines **crinkled** as uneven, wrinkled or puckered effect on the fabric surface which can be created by a variety of mechanical or chemical finishes, or through the use of high twist yarns.

Here is what an internet search for the general definition of crinkle produced:

### Crinkle:

- to turn or wind; to run in and out in many short bends or turns; to curl, to run in waves, to wrinkle, also to rustle, as stiff cloth when moved. (Webster)
- the crinkles in the glass, making objects appear double.
- A dim, fr. The root of cringe.
- A slight depression in a smooth surface.

This is what Eric says about crinkle in his article, [Curvature: Is it Crimp or Something Else?](#) and in *The Complete Alpaca Book*:

"... Crinkle is a term used to describe a type of crimp. When an alpaca's fleece is parted, not all of them have the crimped corrugated look; some possess fleeces characterized by a soft cotton-like look. These crinkly fleeces may have a great deal of fluffiness and curvature in the individual fibers, while other crinkly fleeces are flat, coarse, and undesirable... Huacayas with the cotton candy-like fleece type are often said to have crinkle instead of crimp ..."

I particularly like Eric's analogy of "cotton candy-like fleece". This simile brings to mind a light, fluffy fleece that lacks weight and is characterized by a volume of "crinkly" fibers filled with air. These types of fleece are open, light and have no barrier to resist dust. They are not very productive and I would select against them.

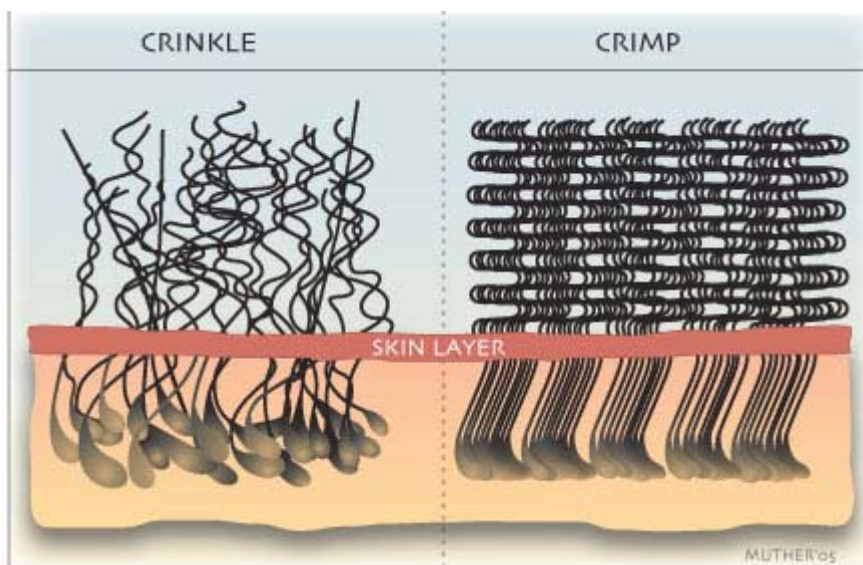
Eric seems to suggest that we should select for crinkle because that's the characteristic exhibited by vicuña, saying, "Vicuna fall into the crinkle category." It is true that vicuña are fine, but they also have a

very short staple, substantial guard hair, and shear only a pound or two every other year. I do not believe that any textile experts or animal scientists would advise alpaca breeders to select for short staple, light fleece weight and abundant guard hair, no matter how fine the fleece might be.

In his article, Eric makes a point about the importance of having articles "peer reviewed" prior to publication, saying about *The Complete Alpaca Book*, "There are five chapters addressing some aspect of fiber, and these focus solely on fiber. All of the fiber chapters were peer reviewed." Eric then goes on to cite the book repeatedly in his article. What I would like to know is who peer reviewed his constant use of the word crinkle and crinkly. I have searched for research material on "crinkle" and found none, and I found no peer-reviewed article on the subject. But who knows, someone out there may have a wrinkle on crinkle that both Google and I missed.

## SKIN: THE PLATFORM FOR FIBER

The drawing you see below was modeled on work by Dolling and Watts. There has been a considerable amount of research about skin thickness, follicular density and the organization of fiber in the skin and how it affects fleece characteristics. Cameron Holt says that "to keep it simple a breeder can determine what is happening below the skin by what is evident above the skin". In my opinion, if you see crinkly fiber that is fluffy and open with a light fleece weight then you will likely have an animal with randomly organized follicles below the skin like the illustration on the left below.



(image adapted from Dolling and Watts)

The fleeces that exhibit poor follicle organization will produce light crinkly fleeces, and the well organized follicles will produce uniform, fine, heavy cutting, well crimped fleeces.

## CRIMP

Here is what I said in my article, [The Case for Crimp](#):

"... Crimp in alpacas is a subjective, type trait. The first question is whether or not it is positively correlated to any important economic traits. If it is, we should select for it; if not, we should select against crimp or pay no attention to it at all."

I interviewed Luis Chaves in Arequipa not long after Eric's article came out. Luis is in charge of all aspects of alpaca processing for Grupo Inca. He supervises the purchase, scouring, combing, spinning, knitting, and weaving of alpaca fiber for the company, (Grupo Inca is the main consumer of fine alpaca fiber in the world). Here is what Luis said about crimp as a desirable alpaca fleece characteristic:

"I prefer crimp, I love crimp, I prefer high curvature. The main problem with alpacas is the weight of the garment; crimp gives the yarn bulk and allows us to make a lighter garment."

"Alpaca is less uniform than wool with a higher co-efficient of variation than wool. If alpaca had more crimp it would, in my opinion, be more uniform."

Here is what Australian wool industry expert, Dr. Paul Swan had to say about crimp and curvature in a study done for IWTO, New Delhi, April 1994, by Brims and Peterson, entitled, Measuring Fibre Opacity and Medullation using OFDA - Theory and Experimental Results on Mohair:

"... The evidence linking wool fibre crimp to wool processing efficiency and product attributes is now unequivocal. Fibre crimp is a determinant of both topmaking and spinning efficiency and has an important role in influencing the mechanical properties of wool fabrics, especially tactile properties. In an age of increasing specification and product differentiation, a measurement of fibre curvature is ideally suited on the role of specifying fibre crimp throughout the wool-processing pipeline. I believe that in the near future the distribution of fibre curvature will join those of fibre diameter and length in being the primary fibre dimensions specified in wool trading ..."

The February, 2005 AOBA/ARI sponsored Fleece to Fiber convention in Atlanta Georgia included a presentation by Dr. David Notter, which was titled The Genetics of Improving Alpaca Fiber Production. Dr. Notter pointed out to the audience that "crimp has many positive influences on fabric" and is an indicator of fineness.

Juan Pepper of Michell Co. gave a lecture entitled, The International Market Place: Large Industrial Perspective on Fiber Processing. Juan said that lack of crimp in Huacaya fiber is a significant problem for processors. Juan also said that crimp could be added artificially during the manufacturing process but that yarn made in this fashion did not retain a "memory" of the crimp, which was a problem.

I could go on quoting more studies and experts about the importance of crimp but it would be rather redundant. I really don't know of anyone, other than Eric, who seriously believes that crimp is not a desirable textile characteristic and an important selection marker in alpacas.

## **RESISTANCE TO COMPRESSION (RTC)**

"The resistance to compression in Alpacas is low" says Angus McColl, who co-authored the study of 606 alpaca, published by *Alpacas Magazine*. Angus believes that unless alpaca breeders select for crimp in huacaya, which increases RTC, then alpaca will be left out of the market for the woolen yarns that are suitable for knitwear. The study said the following about the relationship of crimp to RTC:

### **Fiber Curvature**

"Average fiber curvature is related to crimp frequency (fiber curvature increases as crimp frequency increases) and crimp is directly related to resistant to compression, a good indicator of yarn and fabric bulk or loftiness ..."

In a broad view, not only is crimp an indication of fineness, as all of the experts point out, but it gives yarn bulk and allows textile manufacturers to create lighter weight garments. We need more crimp in alpacas, not less. Selecting for crimp does two things for alpaca breeders: it helps to identify superior animals and it extends the end use of alpaca to include knitwear. This last part is important because manufactures often need to add crimped sheep wool to alpaca fleece to create the necessary bulk in knitting yarn.

Luis Chaves told me that Grupo Inca recently fielded a complaint from their largest U.S. account for hand knitting yarns, Cascade Wool of Seattle, Washington, who had purchased two lots of wool yarn with exactly the same micron specifications. They liked one lot and not the other. Luis was puzzled by the problem and completed an in-depth analysis of both yarns. Each had the same average fineness, the same co-efficient of variation for length and the same count. The only difference was average curvature. "In the past we would not have been able to measure curvature," Chaves said, "but today we can." The preferred yarn had an average curvature of between 59.50 and 83.84. The yarn that generated the complaint had curvature that measured between 43.47 and 58.53. The resolution of the complaint: Grupo Inca discontinued the use of low curvature fiber in hand knitting yarns.

## DEFINING FIBRE CURVATURE

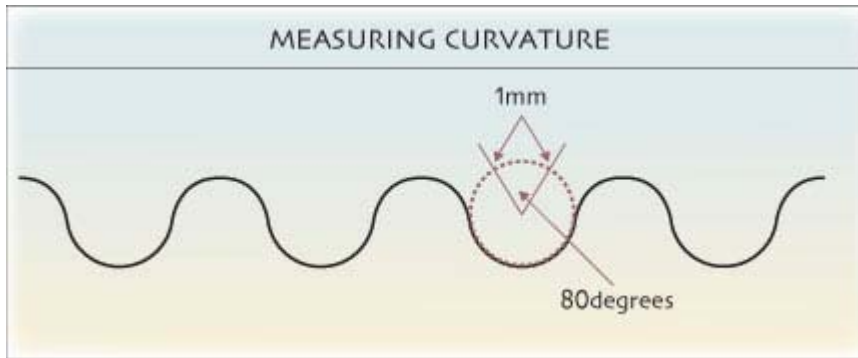
The mechanics of measuring fiber curvature are really very simple, all you need to do is send your fleece sample to Yocom-McColl Testing Laboratories Inc. and they can calibrate curvature for the sample that you provide. The [Commercial Technology Forum](#) in their report no. CTF 01 states:

"Curvature of wool fibres exists in three dimensions, i.e. fibres may be coiled. A definition has been provided [23] for the Curvature of a wool fibre in 3-dimensional space, which incorporates both geometric curvature (bending) and torsion (twisting) along the fibre length. However, because most curvature generally occurs on one plane and reflects the absorption of bending to overall fibre curvature, and assuming negligible contribution from fibre torsion, fibre shape can be represented as a 2-dimensional "wave-form" as depicted below ...

... To a mathematician there is a precise definition of curvature. The Curvature,  $C$ , of a circle with radius,  $r$ , is:

$$C=1/r \dots\dots\dots(1)"$$

In the example below, the angle subtended by a 1mm length of arc is 80 degrees and the resulting Curvature is 80 degrees/mm. The following drawing illustrates how curvature is measured.

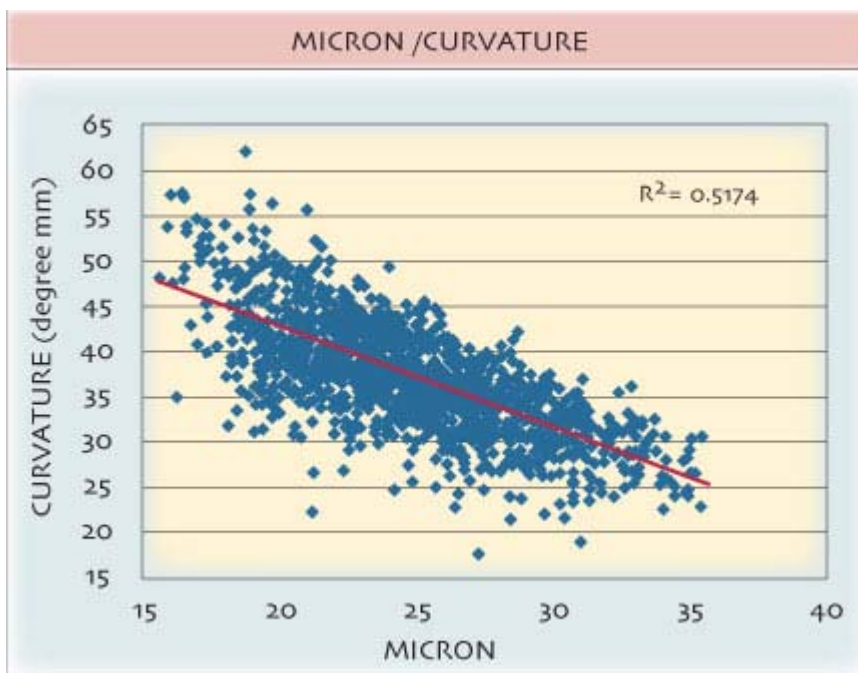


## THE CORRELATION OF CRIMP AND FIBER DIAMETER

Cameron Holt recently shared with me the following test results for 1603 white huacaya alpacas. You can see that average curvature went up as the micron count went down (tested on OFDA100). Cameron indicated to me that when researching curvature on the OFDA and laser equipment, he found that the data was interpreted differently. The laser on average gave a higher reading (curvature) of approximately 17.4 degrees per millimeter.

MICRON GROUP	AVERAGE MICRON	AVERAGE CURVATURE	RANGE CURVATURE	SD CURVATURE
16	16.2	49.4	56.5/33.9	28.5
17	17.1	47.7	53.6/39.0	28.9
18	18.3	43.8	52.9/30.8	26.1
19	19.1	42.9	61.0/29.8	25.3
20	20.1	40.8	55.3/29.9	24.4
21	21.1	39.7	54.6/21.3	24.5
22	22.1	38.8	49.1/25.8	23.9
23	23.1	38.2	47.2/28.6	23.7
24	24.1	37.3	48.4/23.7	22.8
25	25.1	35.8	44.4/24.7	23.0
26	26.1	34.5	43.8/21.7	22.2
27	27.0	32.9	39.4/16.6	21.9
28	28.1	32.6	39.6/20.6	22.1
29	29.0	31.8	41.2/22.9	21.5
30	30.0	30.3	36.4/14.8	20.1
31	31.0	29.5	35.9/18.0	20.0
32	32.0	28.9	34.6/23.1	21.2
33	33.0	28.2	35.2/24.0	20.5
34	34.1	26.1	31.6/21.6	19.9
35	35.1	26.6	29.6/21.8	19.8
TOTAL	24.9	36.1	61.0/14.8	23.0

The following graph illustrates a 0.72 correlation between curvature and fineness. As the average microns increase from 15 to 35, the average curvature decreases from the 50's to the 30's. (Graph courtesy of Cameron Holt)



I think it is indisputable: crimp is related to curvature, resistance to compression and fineness. Textile manufactures value all three. Luis Chaves said it best:

"The breeder needs to know that crimp is an important characteristic, and they can earn more money from crimped fiber. My garment will be lighter and more valuable. Crimp affects, positively, the entire chain of value." (January, 2005)

### **CRIMP VERSUS CRINKLE**

The choice is yours - if you believe crinkle is the best selection marker, then you should select for crinkle. On the other hand, if you believe, as I do, that high frequency crimp is a productive selection marker that suggests fineness, superior fleece weight, uniformity, a lack of guard hair and superior staple length, then you should select for crimp. I suggest that you observe fleeces, both well-crimped with highly defined staples and the crinkly, cotton candy, fluffy ones that Eric writes about. Compare them and decide which you think is most productive. It is really that simple.

*(I want to thank Cameron Holt for his peer review of this article.)*

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