Ingrid Wood interviews
Warren E. Johnson, PhD

Mapping the Genome of Our "Speechless Brothers"

Dr. Warren Johnson

The Alpaca Research Foundation (ARF), in conjunction with Morris Animal Foundation (MAF) and other groups in the llama and alpaca communities, provides funding grants to veterinarians and scientists engaged in research that has the potential to improve the health and well-being of our animals. *Alpacas Magazine* is pleased to bring you another in a series of interviews with the researchers carrying on this important work.

The baby boy was born in Thailand to American parents who traveled the world with their offspring. The Johnsons' professions took them to South America. The family spent five years in Peru, exploring the country and absorbing its culture.

Living in the shadows of ancient Incan history, the boy had no premonition that, years later, his professional path would cross with the "ships of the Andes" and their smaller cousins, the alpacas.

That little traveler grew up to become Warren E. Johnson, PhD, staff scientist at the Laboratory of Genomic Diversity (National Cancer Institute) in Frederick, Maryland. Dr. Johnson is the principal investigator of a small group of scientists developing An Integrated (Coding Gene and Microsatellite Marker) Radiation Hybrid Map of the Alpaca.

Dr. Johnson's extensive educational credentials include DNA research on the Andean Mountain Cat. It is certainly fitting that the man who will put camelids on the scientific "map" (pun intended) is married to a native of Chile. The couple has three children. The family speaks Spanish at home. Dr. Johnson's hobbies include playing soccer, running marathons, traveling, and enjoying the company of an affectionate "Labradoodle" named Kodiak.

In Chile, Dr. Johnson had observed and studied wild camelids – guanacos and vicuñas. It wasn't until 2001 that Stephen J. O'Brien, PhD introduced him to members of the North American alpaca community and his scientific interest expanded to domesticated camelids.

The Alpaca Research Foundation (www.alpacaresearch.com) and Morris Animal Foundation are funding the three-year project of mapping the alpaca genome at an approximate cost of $287,000. The latter is actually administering the grant. It is an extremely modest investment, when we consider the short- and long-range far reaching benefits of such a study.

Sharing Research

After interviewing Dr. Johnson in July of 2003, I realized quickly that alpaca breeders owe a huge financial and moral debt to the breeders of other species. "7,500 genetic sequences have been established for the horse, 18,000 for the dog, 22,500 for the cat, 115,000 for the pig, and 240,000 for the cow," Dr. Johnson shared with me during an hour-long phone conversation. This information immediately explained the relatively low cost of the alpaca project. "In other words," I asked, in an attempt to confirm the validity of my conclusion, "the alpaca community is piggy-backing on research funded by owners and breeders of other agricultural and companion animals?"

"Absolutely," Dr. Johnson replied. "Right now, genetic information on camelids is virtually zero. You have to realize that the field of molecular genetics is fairly new. However, our laboratory has already demonstrated ability in creating a whole-genome genetic map of the domestic cat. We are currently constructing a macaque genetic map and an African Elephant radiation hybrid panel."

"The techniques used on those studies will be applied to mapping the alpaca genome?" I inquired. "Yes," was Dr. Johnson's immediate response.

"The alpaca map will be constructed much more quickly due to work done on the maps of other species. Of course, not all alpaca traits will have candidate genes (those derived from other) studies."

While I allowed that bit of interesting information to sink in, Dr. Johnson continued, "Alpaca breeders also benefit from necessary, highly-trained personnel, experience, and already existing infrastructure at our laboratory – everything is in place to complete the project efficiently and within the proposed time frame."

Camelids and Cancer

While we talked, I glanced briefly at Dr. Johnson's biographical sketch. My eyes focused on the words, "National Cancer Institute." "Why does a facility specializing in cancer research support construction of the radiation hybrid map of the alpaca?" I asked. The answer to this candid question will surely meet with the full approval of the South American pastoralists. For centuries, the original breeders and caretakers of llamas and alpacas have reverently and respectfully referred to the camelids as their "speechless brothers." They intuitively grasped a genetic concept the average "educated" person in this country is not aware of.

To understand it we must appreciate the fact that four links (nucleotides), the scientific names for their differing bases abbreviated to A, T, C, and G (memory bridge: All Ticks Carry Genes – sorry, I couldn't think of a more catchy phrase), are the only "letters" used in the genetic "book" called DNA, whether they describe a llama, a pig, a hamster, or a human being. What accounts for the uniqueness of each individual? The difference is how the bases of these four nucleotides are sequentially arranged.

Mapping the alpaca genome therefore will give scientists more information on human defects and diseases. Once the project has been completed, man as well as other species will benefit from the knowledge gleaned by Dr. Johnson and his co-workers.

When I shared this aspect of the research with a fellow alpaca breeder, she looked amazed. "You mean the alpaca genome map might help to find a cure for cancer for people?" she asked. "Yes, that's exactly right," I answered. "That's so unbelievable… and so beautiful!" my friend exclaimed. Well, believe it. No species exists in a vacuum.

Dr. Johnson's love of all animals, great and small, motivates him to better understand their genetic make-up through genome research.

Practical Applications

Alpaca breeders and their animals will reap immediate and practical benefits from the work done at the Laboratory of Genomic Diversity. "Once the alpaca genome is mapped and integrated with those of other species," Dr. Johnson stressed, "tests for genetic defects, immune problems, and infectious disease will all become readily available to the camelid community." "Give me an example," I requested. "Well, the marker for choanal atresia will be one of the first we'll be looking for," Dr. Johnson explained.

"This interview will be read by non-scientists," I reminded Dr. Johnson. "Can you explain the difference between mapping and sequencing a genome so lay people can understand it?" Luckily, Dr. Johnson proved no exception to my theory that scientists are unusually patient individuals and often make great teachers. "Think of the alpaca genome as a book," he directed me. "A genetic map would be like finding the headings of chapters and sub-sections – sort of like an outline. Sequencing the genome would be the equivalent to locating each letter in that book." The contract with the National Cancer Institute only calls for mapping the genome. Hmm… this did not sound promising to me. "Don't worry," Dr. Johnson assured me firmly when I voiced my concern, "finding specific genes coding for, let's say fiber quality or heart disease, will be entirely possible after our project has been completed."

By the way, owners and breeders can rest assured that not one alpaca's life will have to be sacrificed to bring the work to fruition. Following the plan outlined by the initial research proposal submitted to ARF, the starting material for the RH hybrid panel and map was obtained from a fully pedigreed alpaca male. A licensed veterinarian used standard anesthesia methods to perform a skin biopsy to harvest a donor cell line. No harm done! Why a male? Only male cells carry a Y chromosome. Although it has fewer genes located on it than other chromosomes, it is nevertheless an important component of the alpaca genome.

"What is the meaning of the word hybrid in the context of the alpaca genome map, and what does radiation

have to do with it?" I finally wanted to know. "In order to map a genome, chromosomes are fragmented or "cut" into pieces using x-ray techniques", Dr. Johnson explained. "Eventually, alpaca cells are fused to mix with hamster cell lines… " "Whoa, hold it," I shouted, "Hamster cells?" Dr. Johnson good-naturedly laughed at my surprised outburst. "Yes, you see, hamster cells are very robust," he explained. "Their fast growth helps to copy genetic material very quickly and thereby speeds up the research process. The combination of alpaca-and-hamster genetic material makes the cells hybrid."

Who would suspect that the lowly, common hamster plays such an important role in helping us breed healthier, more productive alpacas?

According to Dr. Johnson, "the opportunities to apply mapping technologies to some of the traits segregating in many of the intensely managed herds of camelids (wild, semi-wild, captive, and domestic) around the world are extensive." In practical terms, this means that llama breeders will benefit equally from mapping the alpaca genome.

Dr. Johnson, who works with five co-investigators on the project, feels strongly that the completion of the alpaca genome will attract world-wide scientific interest and research to camelids. For starters, Dr. Johnson will travel to Chile in June 2004 to collaborate on camelid research with South American scientists.

The work performed by the Laboratory of Genomic Diversity in Fredrick, Maryland is undoubtedly the most ambitious and important camelid scientific research project to date.

Sometimes alpaca breeders express the fear that such work will lead to the discovery of genetic defects in their herds. Breeders of other species experienced that fear as well. However, many of the latter have taken their collective heads out of the sand and squarely faced the fact that no creature is perfect.

Many breeders paint, sculpt, weave, spin – in short, they are creative individuals. Breeding animals also satisfies the urge to create something unique and wonderful.

We should not lose sight of the fact that animals, unlike paintings or sculptures, are living creatures. We share much of our genome with them (close to an amazing 99% in the case of the chimpanzee) and have the responsibility to approach breeding any species with as much knowledge, wisdom, and decency as possible. Animals have served mankind well over the millennia and continue to do so in increasingly complex ways. They are living beings and are entitled to be treated with thoughtful kindness.

Mapping the alpaca genome will assist us in doing so.

Ingrid Wood of Stormwind Alpacas has been breeding huacaya alpacas in Springfield Township, New Jersey, since 1997. Her articles on genetics have been published in A.M.*, several North American camelid newsletters, and publications abroad. Ingrid, along with well-known sighthound author Denise Como, has recently completed a helpful and insightful book,* A Breeder's Guide to Genetics – Relax, It's Not Rocket Science. *Ingrid may be reached at alpacas@uscom.com or (609) 261-0696.*