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The Truth About Dogs

Recent explorations into the field of canine genetics are changing the way we think about man's best friend -- "man's best parasite" may be more like it -- and could help us repair the damage done by a century of inbreeding

by Stephen Budiansky

(*The online version of this article appears in three parts. Click here to go to parts two and three.*)

IF some advertiser or political consultant could figure out just what it is in human psychology that makes us willing to believe that dogs are loyal, trustworthy, selfless, loving, courageous, noble, and obedient, he could retire to his own island in the Caribbean in about a week with what he would make peddling that secret. Dogs belong to that select group of con artists at the very top of the profession, the ones who pick our pockets clean and leave us smiling about it. Dogs take from the rich, they take from the poor, and they keep it all. They lie on top of the air-conditioning vent in the summer; they curl up by the fireplace in the winter; they commit outrages against our property too varied and unspeakable to name. They decide when we may go to bed at night and when we must rise in the morning, where we may go on vacation and for how long, whom we may invite over to dinner, and how we should decorate our living rooms. They steal the very bread from our plates (I'm thinking here of a collie I used to have whose specialty actually was toast). If we had roommates who behaved like this, we'd be calling a lawyer, or the police.

Biologists, if they weren't victims of the same blindness that afflicts us all, wouldn't hesitate to classify dogs as

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social parasites. This is the class of manipulative creatures exemplified by the cuckoo, which lays its eggs in the nest of some poor unsuspecting dupe of a bird of another species. The befuddled parents see a big mouth crying out for food and stuff it full of worms at the expense of their own offspring. Every time they turn their backs, the cuckoo hatchling shoves another of their own flesh and blood overboard. The parents never seem to notice.

Dogs have not quite reached that point in their parasitism of human society. Still, it is sobering that the No. 1 behavioral problem that drives dog owners to seek professional help is aggression. And canine aggression is most often directed at children. In 1996 dog attacks cost U.S. insurance companies $250 million in claims paid out, with total costs to society estimated at $1 billion a year. By dog standards, though, a billion is nothing when it comes to diverting the wealth of one's best friends; Americans spend more than $5 billion a year on dog food and $7 billion on canine veterinary care.

Add up all the benefits that dogs provide us and compare that sum with the costs, and it is not a rational bargain on our part. Dogs are extraordinarily beautiful animals; they are extraordinarily interesting animals too, and as a devoted student of animal behavior, if nothing else, I certainly find the rewards of living with dogs worth the cost. But I am also keenly aware that the conventional explanations of where dogs come from, how they ended up in our homes, and why they do what they do for us have to be all wrong.

In the past couple of years new scientific evidence has started to confirm just how weird the relationship between dogs and human beings is -- and how different it is from what we tend to think it is. What truly defines the differences between breeds of dogs, what motivates dogs to be protective or helpful to us, what causes aggressive behavior by dogs toward human beings, why dogs started hanging around us in the first place -- when it comes to dogs, almost nothing is what it seems.

Canine Genetics

THE starting point for this scientific reconsideration of matters canine is an extremely modest effort, colloquially known as the Dog Genome Project. In scale it is nothing like the Human Genome Project, a $3 billion federally sponsored program to map every gene in the human body. The dog project will cost a few million dollars, with a lot of the funding coming from private

breed clubs that want to develop genetic tests for inborn diseases that their particular breeds are susceptible to.

Finding genes that cause this or that ailment is what most people think of when they think about gene mapping and genetic research, and pinpointing the causes of inborn diseases is certainly one of the obvious and direct payoffs that will come from a better understanding of the dog genome. But the genes an individual carries are more than a personal health chart; they are also a logbook of the evolutionary voyage of the species. The dog's journey through the past 100,000 years in the company of man has left distinctive markers in the genes of the dog population. Just as an archaeologist can deduce nonmaterial attributes of a long-vanished civilization -- its social hierarchies, superstitious beliefs, trading patterns -- from its material remains, so geneticists can deduce much about the history, evolution, and social ecology of a species from the patterns that all those forces have etched into its genes.

Merely getting to the point where scientists can make a serious study of the dog genome has required something of a breakthrough in the culture of science. For years science has maintained a rather aloof stance toward domestic animals in general, and toward dogs in particular. Traditionally, zoologists have considered domestic animals to be uninteresting, and have generally classed them as "degenerates" -- unworthy of ecological scrutiny because they have lost their adaptive behaviors. Veterinary medicine aside, it is as if molecular genetics and the other great advances of twentieth-century science had simply bypassed the dog.

And then there is the fact that scientists can be as sentimental and uncritical about dogs as the rest of

humanity seems to be. "Most scientists who talk about dogs have their scientist hat and their dumb hat," says Gustavo Aguirre, a veterinary ophthalmologist at Cornell University's Baker Institute for Animal Health. "And whenever they start talking about dogs, they put on their dumb hat. They say things that as scientists they have to know can't possibly be right." The upshot is that scientists know infinitely more about the genome of the mouse or the sheep or the fruit fly than they know about the genome of the dog; they know infinitely more about the social ecology of the ant or even the wolf than they know about the social ecology of the dog.

A few years ago Aguirre and several others decided to put on their scientists' hats and apply the tools of modern biology to the study of the dog genome. Their motivation was to try to understand the genetic roots of the particularly devastating inborn degenerative diseases that cause certain breeds -- notably, miniature poodles, Norwegian elkhounds, Irish setters, collies, and cocker spaniels -- to go blind. These diseases, characterized by night blindness followed by progressive deterioration of daytime vision, bear a striking similarity to the human condition known as retinitis pigmentosa.

Studying the causes of canine genetic diseases remains a central aim of their work, but over time the project acquired a broader objective: to construct a rough but comprehensive map of the entire dog genome, and with that to begin to understand what makes a dog be what it is and do what it does.

Aguirre likes to show visitors to his lab the "kennel." This consists of four large stainless-steel chests containing row upon row of frozen blood samples chilled to -80 degrees Celsius. For the genome map the researchers collected samples from 212 dogs representing three generations, all the products of crosses between dogs about as different as possible -- poodles, Doberman pinschers, Irish setters, Norwegian elkhounds, and beagles. Fortunately for Aguirre and others in the field, dogs are particularly good for genetic studies. Unlike human beings, who tend to intermarry widely, dog breeds have been kept separate through inbreeding. Norwegian elkhounds, for example, are very different from beagles not only in the way they look and in the inborn diseases they get (beagles almost never suffer from degenerative blindness, for instance) but also in the many random bits of "junk" DNA that are found on every one of their chromosomes. Genes are the sequences of DNA on a chromosome that actually direct the body to do something. But long stretches of DNA

between genes have simply accumulated over the course of evolution. Mutations in parts of the genome that do something important are often harmful, and tend to get weeded out of the population quickly, whereas mutations in the junk DNA just pile up, in random variations that can be used to distinguish one family line from another. As far as researchers are concerned, junk DNA sequences have another useful property: they tend to possess distinctive patterns that make it easy to construct a molecular "probe" that zeroes in on them.

What all this means is that researchers can use junk DNA sequences as flags or markers to help them find their way around the genome. If a beagle is crossed with an elkhound and then their offspring are crossed, some of those dogs will suffer from retinal degeneration and some won't. They will also almost certainly have many differences in the easy-to-measure genetic markers they carry. If all disease carriers have marker A at a particular spot on a chromosome whereas no noncarriers do, the disease gene must be close by.

Using this technique, Aguirre's lab and a group led by Elaine Ostrander, at the Fred Hutchinson Cancer Research Center, in Seattle, created the first "linkage" map of the dog genome, which was published in late 1997. The map is made up of about 150 mileposts along the dog genome; each milepost consists of a bit of junk DNA anchored to a gene that remains constant. The gene allows researchers to know where on the genome they are; the variable bits allow them to search for genetic differences between individuals, and so to tie a disease or other physical characteristic to a specific marker.

Another thing that dogs have going for them in terms of genetic mapping is that they produce a lot of offspring -- litters of ten are not uncommon. Standard statistical calculations reveal that diseases that are all but impossible to map in human families can readily be mapped in the typical canine family. Already several genes responsible for canine disorders have been pinpointed, and screening tests have been developed for them. The Irish Setter Club of America, which was one of the first to support genetic research on its breed's problems, now has a blood test that it requires for all purebred Irish setters to determine if they are carrying a gene for retinal degeneration.

More-conventional sponsors of scientific research, such as the National Institutes of Health and the American Cancer Society, have begun to fund the study of canine genetics, because dog disease and human disease are turning out to

be closely linked. More than twenty inborn diseases in dogs have been traced to specific defective genes; in every case the same defective gene has been found in human beings. Dogs even carry the *brca 1*gene, which was identified a few years ago as causing a significantly increased risk of breast cancer in women. Probably 90 to 95 percent of the dog genome and the human genome are identical.

From the start dog-genome researchers realized that along the way they might also discover a lot about the history of dogs and their innate behavior -- the sorts of things that people who like dogs have always wondered about. No one expects to find a gene for loyalty, but maybe there are genes for herding behavior or retrieving or guarding. And although there is almost certainly not *a*gene, or even a handful of genes, that accounts for the transformation from the wolf to the dog, a study of the population genetics of the two species could potentially speak volumes about the origin and history of domestication.

Continued...

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