

“Taming Foxes Explained” with Lee Alan Dugatkin

Transcript of Cerebrum Podcast



Guest: Lee Alan Dugatkin, Ph.D., is a professor of biology and a College of Arts & Sciences Distinguished Scholar at the University of Louisville. He has studied the evolution of cooperation, the evolution of aggression, the interaction between genetic and cultural evolution, the evolution of antibiotic resistance, the evolution of senescence, and the evolution of risk-taking. He has been a contributing author to *Slate Magazine*, *Scientific American*, and *The New Scientist*, and author of *The Altruism Equation* (Princeton University Press, 2006), *Mr. Jefferson and the Giant Moose* (The University of Chicago Press, 2009) and co-author, with Lyudmila Trut, of *How to Tame a Fox and Build a Dog* (The University of Chicago Press, 2017).

Host: Bill Glovin serves as editor of *Cerebrum* and as executive editor of the Dana Foundation. He was formerly senior editor of *Rutgers Magazine*, managing editor of *New Jersey Success*, editor of *New Jersey Business* magazine, and a staff writer at *The Record* newspaper in Hackensack, NJ. Glovin has won 20 writing awards from the Society of Professional Journalists of New Jersey and the Council for Advancement and Support of Education. He has a B.A. in Journalism from George Washington University.

Bill Glovin: Hi, I'm Dana Foundation Executive Editor, Bill Glovin, and welcome to the *Cerebrum* Podcast where we explore topics about brain science with the authors of our *Cerebrum* magazine articles. On the phone with us today is Lee Alan Dugatkin, professor of biology in the College of Arts and Sciences, distinguished scholar at the University of Louisville. Lee is the author of *How to Tame a Fox (and Build a Dog)*, which was published in 2017 by the University of Chicago Press. In reviewing the book, the *New York Times* called it part science, part Russian fairy tale and part spy thriller. It's a fascinating exploration of how genes evolution and then environments shape behavior.

Before we get started, I just wanted to tell you that we recently posted our second online magazine, which you can find at Dana.org. There you can read Lee's article called “Jump-Starting Evolution,” and get yourself free *Cerebrum* subscription by simply going to Dana.org and typing in your email address. Lee's article includes some of the findings that have emerged since the book was published. So first of all, for people who are listening to this, I think most people may have heard of the Soviet fox experiment, but can you just briefly explain what it was all about?

Lee Alan Dugatkin: Absolutely. It's a pleasure to chat with you. I should just start by saying that the book is coauthored with my colleague Lyudmila Trut, who has actually been leading this

experiment for 60 years, and so she was absolutely critical in the development of all the things that we're going to talk about. But sure, a brief overview. The experiment has been going on since about 1959, 1960. Essentially it started when a Soviet geneticist by the name of Dmitry Belyaev was interested in this process of domestication. How do we get domesticated animals that play such a fundamental role in our life? He was particularly interested in domestication of dogs because, of course, this is something that people, including scientists, are fascinated by.

So he comes up with this experiment, and the basic idea is that he has come to think from his reading of Darwin and from his own research that the key thing in the process of domestication, when our ancestors began domesticating dogs, for example, about 15,000 years ago, was that they selected the calmest, friendliest, most pro-social towards human wolves to start the domestication process. Then they continually did this year after year, and Belyaev thought that that alone would lead to not only calm animals that worked well with humans, but produce all of the other sorts of traits that we tend to see in domesticated animals.

So in dogs, for example, you tend to see floppy ears in some breeds, and curly tails and really varied fur patterns and lots of other things that we tend to see in domesticated species.

Belyaev thought they were all driven by initially choosing the animals that were friendliest towards humans. So he decided to test this idea in real time and he did it working with foxes that he had been researching for more than a decade at that point, and that's how it started.

Bill Glovin: Why foxes and not wolves, you think?

Lee Alan Dugatkin: Yeah, it's a great question. I think there's a couple of things. First of all, wolves would have been extremely more difficult to work with, right? I mean just to get them, to put them in some sort of experimental situation where you could read them, much, much harder. But the bigger reason was that Belyaev had been working at a number of institutes where they specialized in understanding the genetics of foxes because at this time exporting fox furs was one of the main ways that the Soviet Union was getting Western funds coming into the country, the funds that they desperately needed.

So, Belyaev already was working in a system that he understood and that many people understood very well. So it was unnatural for him to use the foxes. Of course, they're canids just like wolves, and so they're a bit more distant and immune related to dogs than wolves are, yes, but they're in the same family. So he just began working with people he knew in the fox breeding industry. He wasn't interested in breeding them for their furs to sell to the West, but this gave him an opening.

Bill Glovin: I'm curious about silver foxes. Is there a difference between silver foxes and other types of foxes?

Lee Alan Dugatkin: Well, silver foxes are technically red foxes. If you look up *Vulpes vulpes*, which is the scientific name of the red fox, silver foxes are a breed of red foxes. Basically about the late 1800s, various people began breeding foxes for this kind of blackish silvery fur that was very attractive on the fur market. So that's where we get the name silver foxes from.

Bill Glovin: Can you explain to folks how you got involved?

Lee Alan Dugatkin: Oh sure. Well, I am an evolutionary biologist and a historian of science by training. So I've known about basic science here since I was in grad school because within evolutionary biology, this is a very famous experiment. It's one of the longest ongoing experiments in evolution ever done. So I knew a little bit about it from early on in the graduate school. Then about 10 years ago, my interests really turned fairly strongly towards history of science questions, and I was thinking about projects and the silver fox experiment came back to my mind. I had done some other work on Russian Soviet evolutionary biology and I knew that there were a number of aspects about this study that is particularly interesting as a kind of history of science project, but also a project that could reach the general public, people who are just generally interested in science.

First of all, the experiment itself is fantastic. It's cutting edge, looking at all sorts of interesting things. Second of all, when this experiment began in the late 1950s, there was a political backdrop to this that makes it very fascinating for a story in a science, which is that at this time, it was essentially illegal to do what we would've called time monitoring genetics, also, what was typically called Mundelein genetics after the famous geneticists Mendel. It was illegal to do that in the Soviet Union because of a charlatan by the name of Trofim Lysenko who had convinced, personally convinced, Stalin that that sort of science was bourgeois Western science. So he basically single-handedly produced an environment where it was illegal to do modern genetics.

The experiment that Belyaev, and then, Lyudmila Trut, my coauthor, eventually got involved with was classic genetics, and so I thought there would be an interesting political dimension to the story. Also, while the basic science was out there, you wouldn't experiment for 60 years in the Soviet Union/Russia and there are going to no doubt be all sorts of fascinating behind the scenes stories of the people who work with the foxes, both the scientists and the people who were doing everything from feeding them to cleaning their cages there. There had to be 60-year's worth of interesting tales that were going on behind the scenes. So I was interested, I reached out to Lyudmila, I wrote her an email and told her who I was, what I had done, and we started talking.

We exchange many, many, many, many emails. I asked her if she might be interested in writing something, a book that would be for the general public. She was. This has been a dream of Belyaev that he never got to see come to fruition. He died in the mid '80s, and she was interested. We talked more, we decided we would do this, and then about a year and a half, two years after we did that, I began going there and visiting, spending time with Lyudmila, the whole fox research team and of course the amazing domesticated foxes themselves.

Bill Glovin: With all the political interference, especially early on, how were they able to stay under the radar, get funding to continue? And was your involvement, or her agreement for you to get involved and do a book related to funding at all?

Lee Alan Dugatkin: So in terms of how they kept themselves under the radar, there were a couple of things in play. First of all, because there was so much Western money tied to both fox fur and also mink fur. This fellow Lysenko, who had made it illegal to do Western genetics, and

really had an entire apparatus in place to do that. He and his henchman, they turned their back a little bit and pretended people weren't doing modern genetics when it came to foxes. Just because there was so much money involved, they didn't want to tinker with it. The other thing is that Belyaev and Lyudmila began the experiment after he had moved from Moscow where he had done most of his work up to that point in the late '50s to Novosibirsk, Siberia, and so they were pretty far away from the seat of power that Lysenko had, and so it was more difficult to control those sorts of things, although there were issues within the first six months.

Lee Alan Dugatkin: He himself had come to where they were doing the experiment in Siberia. It was part of a gigantic scientific city that had been built there recently, and he almost personally shut down the fox experiment within a year from when it began because he was still under Lysenko's spell in 1960. It didn't happen, but it almost happened. In terms of Lyudmila and I's interaction, the only thing about the political backdrop that I would say that might be interesting to our listeners here is that when Lyudmila and I first started interacting, I would ask her things about the experiment, the science, and she would tell me anything I wanted to know. But when I started asking her a little bit about Stalin and what was going on politically, she tended to pull back and say things like, "Well, I don't really think this is that important for the book."

I kept telling her that this would really be the sort of thing that would help readers keep their attention on the story, if we could have a good narrative and explain why this was ... what was going on, why was this so important, she was reluctant and then I began to realize, of course, this is someone who grew up in Stalinist Russia. You don't go around talking about these things to people unless you know them very well. This was one of the reasons I decided I really needed to go there and visit. Once I did and I got to know her and she began to trust me more as a friend, then she was perfectly willing to tell me about the political aspects. But initially, she was reluctant, which is understandable.

Bill Glovin: So who funded the research?

Lee Alan Dugatkin: Their money came primarily from various Soviet agencies early on that were interested in breeding fox fur. So Belyaev would write to them and propose experiments. So they were interested. One of the things that happens with domesticated species is they tend to have lots of variation in their fur, and so Belyaev was able to basically approach the government and say, "We are interested in fur," because it was something that who'd studied domestication would be interested in. He also was able to say that they were interested in fox reproduction because they were. One of the things that happens in domesticated species is they tend to have a longer reproductive period than their ancestors, their wild ancestors.

Belyaev was interested in that, and of course the Soviet government was interested in reproduction in fox, just because the more we understand about reproduction, the quicker we can get them to breed and that means more furs and more money coming in. So he was basically able to use their interest in the economic side, and without lying and just saying, "Look, we're interested in these phenomena as well." He didn't get into the Mendelian modern

genetic side of things. He just said, "We're interested in this. Our experiments will shed light on it," and they were able to get some money that way.

Bill Glovin: Do you believe the experiment will continue once Lyudmila retires?

Lee Alan Dugatkin: I do. I do. I think it's going to be a very difficult period for them. So she turned 86 in November, and she is still running the experiment. Now, she's not the one taking the data on the foxes. There are a whole team of people that she basically manages but she is still in charge of virtually every aspect of it. Of course eventually, she won't be able to. There are a couple of ways that it could play out when she is not working with the project anymore, and I think that will not be until she is no longer with us and I hope that is a long time. But nevertheless, when that happens, I think one of two things might occur. There is a person whose name is Anastasia Kamelia, or I believe that's how you pronounce her last name.

Anastasia has been working with Lyudmila for 30 years ever since Anastasia was an undergraduate. So she's still fairly young. She's I think in her late 40s. She would be the obvious person to take over if the experiments stay doing exactly what it's doing and they often joke around in Novosibirsk about her being Lyudmila's lieutenant. I think that's the most likely scenario. There's another scenario that might happen, and it might happen at this kind of concurrently with Anastasia, which is that it may be that some of these foxes end up in the equivalent of these parks that we have where they are ecological education parks. Right up the road from me in Indiana, there's a wolf park, and there are three breeding packs of wolves, some of whom are in a more controlled situation where people can interact with them and then learn something about wolf biology.

It's possible that some of the foxes end up in the equivalent of that either in the US or Europe or in Russia. But I think that the experiment itself will continue for the foreseeable future, even after Lyudmila is no longer involved. Because essentially what they do is they're just breeding the foxes, they're choosing the calmest, tamest animals, and then they're doing what they've been doing for 60 years. So there's a very well established protocol and apparatus in place that I think will facilitate doing this for at least the medium term.

Bill Glovin: As you point out in your article, you're not the only American scientists that has been involved with this. Brian Hare as a graduate student at Harvard and he's now a professor at Duke, was very involved, as are some others. Is this something that has sparked a collaboration between the countries and scientists?

Lee Alan Dugatkin: Yes, absolutely. There's a timeline there. So in the late 1990s, there was this period, particularly ... Well, there's two periods, in the early '90s and in the late '90s. In the early '90s, when the Soviet Union was collapsing, and then in the late '90s when the ruble took this incredible plunge, where the funding for the fox experiment almost dried up completely. I mean the funding for many scientific experiments in the Soviet Union did, but of course they just needed money that keeps the foxes alive. So it wasn't as if they could just put them in a

freezer and come back to them the way you would with microbes. So they were really in dire straits, and Lyudmila and her team did some remarkable things to get the money to keep going. But one of the things that Lyudmila did was she wrote up these articles with the American scientists, which was essentially a plea to the scientific public that the experiment was really in a very delicate, difficult situation. That article then spurred a New York Times article that occurred again, I think it was '99, and those things together brought the experiment onto the radar of many people in Europe and the United States, many scientists who may not have known about this. So there's also Gordon Lark, who worked on bone shape and bone morphology in dogs who got involved. There was Brian; there were other people who were doing work on hormones.

So those things, all in the late 1990s, reintroduced the fox experiment in a big way to the scientific community. After that, Lyudmila was able with her colleagues to get money from everything ... I believe they got some money from the National Institutes of Health, they got some money from European science agencies and people like Brian and Gordon and others were involved in collaborations with them. So it was a very precarious moment in the history of the experiment, but fortunately, they made it through and in ways that actually at the end made the experiment stronger by building these international collaborations.

Bill Glovin: Let's get into the science a little bit. You pointed out before that initially some of the tamer foxes were chosen in the litters to get started, and so I'm wondering, were there sex differences and was there inbreeding going on? Were there anomalies in the litters, those kinds of things?

Lee Alan Dugatkin: Well, first of all, what they've done from day one is choose, in essence, the ten percent of the friendliest foxes, every generation. So it's not just that they did this at the beginning, this is what they've been doing every year now for 60 years. What they do is they choose the ten percent of the friendliest, calmest males and the ten percent of the friendliest calmest females, and they breed those individuals. Yes, there are sex differences. The females in general are less aggressive and they're calmer, they're smaller, they have slightly different facial and body features.

Now, one interesting component to the experiment is that when you look at both males and females over the course of this experiment where they're constantly every generation selecting for the calmest, what you see is a kind of feminization of males and an emphasis on those kind of traits that make females different from males and females. So you're basically getting both sexes becoming even more feminized, which means that they have lower stress hormone levels, they have lower testosterone levels, they tend to get a little bit smaller and they tend to get facial and body features. They're a little bit more typical both to wild females and to wild younger foxes. There are two kind of simultaneous things are going on here. There's a feminization process and a juvenilization process that's been going on.

Lee Alan Dugatkin: So if you look at the domesticated foxes now, they look much more like juvenilized feminized wild foxes. In terms of the inbreeding, Lyudmila and her own team have been absolutely fanatical to minimize that. They were quite aware that all kinds of anomalies

can occur if you inbreed and that there would be many, many variables to the experiment. So even from the start, when they began the experiment with about 130 or so foxes, they were meticulous about minimizing inbreeding. So when I say that they are choosing the 10 percent of the calmest males and females, the one kind of constraint on that is within not selecting close related individuals to mate. That's how they choose the top 10 percent. So they're very aware of the effects of inbreeding and they've minimize them.

Are there any anomalies? Certainly when you look at a given litter of fox pups, you will see what you see when you look at a group of any animals, which is that there's variation. Some of the pups might be super friendly and calm towards humans, and others might be just moderately so, and some might be skittish. Then of course in the next generation, there'll be the ones that grow up that will be super calm ones that will be the breeders to the next generation.

Bill Glovin: What do you think is the most interesting scientific findings from the study?

Lee Alan Dugatkin: I think it shows how quickly this process can occur. I mean, of course they are speeding it up. But keep in mind that we began domesticating dogs 15,000 years ago, about. There's some controversy, but about 15,000 years ago, and it took our ancestors thousands and thousands of years to produce dogs from wolves. This experiment's been going on six years and they have dog-like foxes. Now again, they're speeding it up intentionally. That's one thing that's incredible about the experiment. The other thing I think that is just absolutely remarkable is that they found so many changes in the domesticated foxes. So they have, generally speaking, floppier ears, they have curlier tails in wild foxes, they have more very fur patterns, they have lower stress hormone levels. They have a different body shape. They're chunkier and they don't have that pronounced snout.

There's an endless list of things that are different about the foxes that are very much what we tend to see in domesticated species. The thing to keep in mind is that what drove Belyaev initially and why he brought Lyudmila in right from the start to work on the experiment is that he thought the just selecting on behavior would produce all those other changes, and the only thing they ever select on is behavior. They test the animals to see how friendly they are, they breed the friendliest ones and they've gotten all of these other things emerge. They never choose a fox based on whether it has floppy ears or a curly tail or a round or less pronounced snouts. Only on behavior, and yet you get the changes that Belyaev thought would occur.

Bill Glovin: What does this teach us about humans?

Lee Alan Dugatkin: What I can tell you is that Belyaev was interested in this. He made the argument long ago that humans had done the equivalent of self domesticating themselves, and what he meant by that was that we, by selecting the calmest friendliest mates and group mates, have created an environment that's essentially the same as the environment that humans create when we choose our domesticated animals, right? We choose the calmest friendliest ones. Belyaev said we did that with our own mates and group mates, and that we domesticated ourselves, and if you look at humans compared to other primates, we tend to

show the characteristics of a domesticated species. Other people have taken this up more recently, so there's a fantastic book that I would recommend to people by Richard Wrangham, one of the world's leading evolutionary primatologists, and it's called *The Goodness Paradox*. It's all about this notion of humans self domesticating themselves. It also talks a little bit about the idea that another species of primates, bonobos, have also self domesticated themselves. So I think it gives us hints about our own evolutionary background.

Bill Glovin: Just to get into the brain-science weeds for a second, you talk in your article about neural crest cells. Can you explain how they fit into the experiment?

Lee Alan Dugatkin: Sure, and this is definitely an ongoing area of research. People are still sorting it out. There are debates and arguments and all of this, and they're all important. But the basic idea here is this: there are these neuro crest cells. They're like stem-like cells; that is they're totally potent and they can develop into almost any other kind of cell, like a muscle cell or a melanocyte, or many, many other different types of cells. The key thing is that very, very early on in development, they migrate from this area called the neuro crest to all sorts of different parts of the body. Now, what people know from developmental biology is that when you choose animals and breed them preferentially on low stress friendliness characteristics, like they've been doing with the foxes, you're also selecting for animals that have on average fewer neuro crest cells.

Now, that means that when these neural crest cells migrate to different parts of the body, they'll be nests of them. Well, if you look at where they migrate, for example in dogs and other canids, including foxes, they tend to end up in places like the ears, the tail, the skull. Well, these are places where some of the key domestication things have happened. So for example, if you want to understand floppy ears, well, if there are less neuro crest cells developing into cartilage in ears, then you're much more likely to get floppy ears. If there are fewer neuro crest cells migrating to the tail, again for cartilage in this case, you're more likely to end up with a curly tail. If there are fewer neural crest cells migrating into what eventually becomes the melanocytes, the things that create the color in fur, if you have fewer of them, then you're going to end up with sort of more patches of whiteness, which is classic for what you see in the foxes.

Almost all of the characteristics that we see in the domesticated foxes that make them different from wild foxes, almost all of them can be argued to be the result of having fewer neuro crest cells migrates early on in development, and people believe that this neuro crest cell idea might also explain these domestication traits in many, many different animals, not just the foxes. Again, there's contention over that, but it's a working hypothesis that people are looking at in depth now.

Bill Glovin: Can you tell us what happens to the foxes once the experiment is over for them?

Lee Alan Dugatkin: You mean what happens to a given fox in the experiment?

Bill Glovin: Yes.

Lee Alan Dugatkin: It depends. It depends. I mean, one thing to keep in mind is ... I can tell you personally how much the scientists and the workers involved in the experiment care about the foxes. That said, you have to keep in mind that this is an experiment at any given time, based on all the components of it, and we've talked about some, but not all, there could be 700 foxes, right? They're breeding producing litters of five and six foxes. So you've got to be able to control the population at some level. Otherwise, it'll get exponentially large. Some of the foxes, when they're done, unfortunately are terminated and sometimes their furs are sold to the fur industry just to keep the money coming in for the experiment. They're never doing it to produce furs.

Lee Alan Dugatkin: But some of those boxes don't have a pleasant end. On the other hand, some of them do. Some of them live out their natural lives, some of them are used for other things in the experiment that we haven't talked about, some are used for other interest in fox biology in general, some are used as educational tools that the team in Siberia uses to bring students and kids in and teach them about the foxes. Some of them even end up in homes and are sold as domesticated animals, and so you'll find these foxes, not a lot of them, but dozens and dozens of them that have been sold and live in people's houses. They're extraordinarily expensive. Again, the money goes to the experiment. So there's a variety of things that happen to them, from not particularly pleasant to living in people's houses.

Bill Glovin: I mean, over the 60 years, the fox fur industry has probably enormously declined. So that's led to probably less money for these fox breeding farms in Russia.

Lee Alan Dugatkin: Oh, absolutely. Absolutely. When they began the experiment in the late '50s, it was still a huge industry and it was massive in the '30s. There were literally hundreds, perhaps thousands of these places around the Soviet Union where they were breeding for fur, and like you say, that's dramatically declined. The market has decline, the ethical issues have come to the surface a lot more. So yes, absolutely.

Bill Glovin:

So going forward now, you've done the book, you've done some articles like ours. So what's in your future concerning the experiment and your involvement?

Lee Alan Dugatkin:

I think for the most part, the major role that I played was working with Lyudmila to produce this book, and as you say, after that, updating people on what's going on. I keep in touch with Lyudmila, she's a dear friend of mine. I keep in touch with other people involved in the experiment both there and around the world, but I don't envision a lot of direct work with that project for me anymore. I will tell you it was the single greatest experience of my life to be involved in this from about 2010 to right now, but I don't engage in lots of direct work in that project. Lyudmila and her team are of course keeping it going, but my involvement will be mostly on the sidelines now.

Bill Glovin: Are you working on anything else right now that you want to mention?

Lee Alan Dugatkin: Sure. I have these two sides to my work. I've recently started a project where I'm writing a book about the evolution of power in non-human societies, and I also have a different kind of book coming out in the fall. It's actually the history of science book about the first natural history museum in the United States that was built by this guy, Charles Wilson Peale, that was a cultural hub in the early republic, and I'm telling all of the stories that revolved around this combination natural history art museum that Peale built in Philadelphia. It was housed in the State Capitol for a while, above the floor where the Declaration of Independence was signed and below where what we call the Liberty Bell used to ring every day. So it was fundamentally important thing in the early enlightenment scientific development of the US, and I'm telling that story in a book that comes out in the fall.

Bill Glovin: Well, we'll look forward to seeing that.

Lee Alan Dugatkin: Thank you.

Bill Glovin: I think that's a great place to end. I want to thank Lee Dugatkin once again for his great article called "Jump-Starting Evolution," which you can find at Dana.org, part of our second online *Cerebrum* magazine. Hey, great job, and I appreciate you coming on the podcast and going a little bit deeper for us.

Lee Alan Dugatkin:

It's my pleasure. I've always been a huge fan of *Cerebrum*, so I appreciate the opportunity.