TRANSCRIPT
INTERVIEWEE: Alexander “Sasha” Karatayev
INTERVIEWER: David Todd
DATE: February 1, 2024
LOCATION: Buffalo, New York
SOURCE MEDIA: MP3 audio file, Zoom MP4A recording
TRANSCRIPTION: Trint, David Todd
REEL: 4189
FILE: TexasHornshell_Karatayev_Alexander_BuffaloNY_1February2024_Reel4189.mp3

David Todd [00:00:02] All right. Well, good morning.

David Todd [00:00:04] I am David Todd, and I have the great privilege of being here with Doctor Alexander "Sasha" Karatayev. And, with his permission, we plan on recording this interview for research and educational work on behalf of a non-profit group, the Conservation History Association of Texas, and for a book and a website for Texas A&M University Press, and finally for an archive at the Briscoe Center for American History, which is at the University of Texas at Austin.

David Todd [00:00:32] And he would have all equal rights to use the recording as he sees fit.

David Todd [00:00:37] And I wanted to make sure before we went any further that that's acceptable with him.

Alexander Karatayev [00:00:42] Absolutely. And thank you very much for having me. It's a pleasure. And of course, good morning.

David Todd [00:00:48] Good morning to you. And thank you for joining us. This is great. Well, let's get started.

David Todd [00:00:53] It is, Thursday, February 1st, 2024. It's about 9:00. Let's see a little bit later, 9:15 now, Central Time or 1015, Eastern Time.

David Todd [00:01:07] My name, as I said, is David Todd, and I am representing the Conservation History Association of Texas. And I am in Austin, and we are fortunate to be doing a remote interview with Dr. Alexander Karatayev, who's based in the Buffalo, New York area.

David Todd [00:01:24] Dr. Karatayev is a professor and the director at the Great Lakes Center, which is a research foundation at SUNY Buffalo State College in Buffalo, New York. Previously he was a professor at Stephen F. Austin State University in Nacogdoches, Texas, and has also had prior positions at the State of New York Museum Field Research Lab, University of Wisconsin in Madison, and Belarusian State University.

David Todd [00:01:51] Dr. Karatayev is interested in the ecology and diversity of freshwater benthic communities, among other topics, and for a number of years was heavily engaged in efforts to survey, study and protect, the Texas hornshell, which is a rare mussel that's native to the Rio Grande and its tributaries.

David Todd [00:02:10] So today, we're looking forward to talking to Dr. Karatayev about his life and career so far, and especially focus on what he can tell us about the Texas hornshell mussel.

David Todd [00:02:22] So, with that little introduction, I wanted to thank him again for visiting with us. And, I thought maybe we could start with just a opening question about your childhood and early years, and if there might have been some sort of experience or people that introduced you to an interest in nature and science.

Alexander Karatayev [00:02:42] Thank you. And please call me Sasha.

Alexander Karatayev [00:02:46] So I was born. I just celebrated my seventieth birthday. So, I was born 70 years ago in Batumi, Georgia, at the time part of Soviet Union, in 1954. And, Batumi is a harbor on the Black Sea. So, from our house where I lived was about ten minutes' walk to the shore of the Black Sea. And, Batumi is a subtropical place and a climate very similar to East Texas.

Alexander Karatayev [00:03:17] When we moved to Texas in 2000, people were asking me, "Oh, it's probably so cold in Russia." So, no, Russia is big. And the climate in East Texas is so similar to my childhood. So, I remember there's bananas, camellias, azaleas. And it was so nice.

Alexander Karatayev [00:03:38] And when I was seven, when my family moved to Belarus, which is a country between Russia and Poland, with a climate very similar to Midwest. So, very, very different.

Alexander Karatayev [00:03:54] So, early in my life, my grandfather had the largest impact on me. He was an architect, but he also was very interested in nature, and he knew very well local plants, animals. He taught me to swim when I was six, and soon I got my first snorkel and mask and fell in love with the underwater world.

David Todd [00:04:21] Would he go swimming with you?

Alexander Karatayev [00:04:24] Absolutely. Yes. He was swimming, starting like early May until December 1st - every day, every day.

David Todd [00:04:35] Right. I might take a just a moment out and suggest that you close out an app on your computer, which I think maybe reminding you of things to do.

Alexander Karatayev [00:04:49] This is actually notification that ... okay, I'll just close email. These are emails that come in. I think, it's just notification of my emails come in. So, hopefully I turned it off.

David Todd [00:05:09] Okay, great. Yeah, that always helps.

David Todd [00:05:12] Well, good. So we were just talking about your introduction to swimming and the underwater world, and, I was wondering if you could, remember, recall some experiences with your grandfather, who I gather was a hardy swimmer, a sort of a polar bear.

Alexander Karatayev [00:05:30] Yeah. Well, it was, the water temperature was like in Galveston, so it wasn't too bad. But, you know, he was an excellent swimmer and always taught me that it's so important to be able to swim for, you know, a very, very long time. So, we swam together a lot.

Alexander Karatayev [00:05:55] And he also was a very, very interesting person. He was an officer during the First World War, but spent 60 years, in Batumi. So, he knew local history very well. And he traveled a lot in the area, building different residential and industrial houses. So, it was, very interesting to travel him around with him and look on different landscapes. There was an excellent botanical garden, and he knew the history of the garden. So, it was very interesting.

David Todd [00:06:40] Was there anybody who spoke to you about fish or shellfish or aquatic creatures?

Alexander Karatayev [00:06:48] Yeah, there was, a nice aquarium, in this city, open to the public. This is the first aquarium: it's nothing to aquariums like in, I don't know, in Chicago or in Boston. But, this was the first, and the first aquarium always give you the largest impression. So, when I looked at it, I went there and then I figured out that I need to study my own collection.

Alexander Karatayev [00:07:22] So, I started snorkeling, collecting shells. And then I when I became a student, I learned all these different techniques how to preserve these creatures. And I still have a very large collection of shells here in my basement and much larger in our college.

David Todd [00:07:43] And were you largely self-taught in those early years or, of course, your grandfather was introducing you to some of this, but were there other family members or friends that were interested in these things?

Alexander Karatayev [00:07:57] Not much in early years. But, I read a lot of books, especially about expeditions, field work, like, literally everything that I was able to find. And also later I started watching when TV became more sophisticated, I started watching all these movies. Especially, I remember there was a TV shows by Jacques Cousteau on marine life. And this was absolutely spectacular.

David Todd [00:08:36] So it sounds like there was interest in just the drama and excitement of field work and expeditions, explorations, sort of like what Cousteau might be involved in.

Alexander Karatayev [00:08:52] Yes, this is true. You know, my dream was always to spend as much time as possible in the field. And I started doing actual real field work in 1974, and I'm still doing it. So, basically this summer I will celebrate 50 years of field work.

David Todd [00:09:17] Well, maybe we should talk a little bit about your start in education. Were there teachers or classmates in grade school or college or graduate school who might have been an influence on you?

Alexander Karatayev [00:09:36] Yes. Absolutely. When I was an undergraduate student at Belarussian State University in 1974, we went to our first fieldwork. We spent 50 days living in tents and sampling lakes in Belarus. So, every day we were sampling a new lake. It was an excellent expedition for me and my classmate, who later became a lifetime friend - Gena

Tischikov. He was ten years older than me, with better experience. So, we spent so much time together sampling and collecting mollusks.

Alexander Karatayev [00:10:18] This was when first time I saw a zebra mussel. And I was fascinated how this tiny creature came from an absolutely different area, colonized lakes and starts impacting the entire ecosystem.

Alexander Karatayev [00:10:38] And then my supervisor, Dr. Vladimir Lynakhnovich, had a huge impact on me. He was an excellent scientist, very intelligent, broadly educated, aquatic ecologist. We became friends. Unfortunately, he died when he was 60. But he had a very strong impact at me.

David Todd [00:11:02] Yeah. Was it sort of his personality or some very specific lessons that that you recall most significantly?

Alexander Karatayev [00:11:15] It was both. He was excellent ecologist. And so I learned a lot about science. But his personality was also fantastic. He told me what kind of novels I should read for my better and very broad education. And we traveled together with him. He introduced me to lots of scientists in the former Soviet Union. And these were his friends, and, of course, much older people than myself. But I was very, very lucky to have met all these famous scientists.

David Todd [00:11:57] Yeah. It sounds like you got sort of inducted into this whole realm of science and scientists maybe through him. Is that fair to say?

Alexander Karatayev [00:12:07] Absolutely.

David Todd [00:12:09] Well. So, one of the things that, of course, we're particularly interested in is how you used this experience as a child, and this training in school to learn about aquatic creatures, and the animal that we're most interested in today is this Texas hornshell.

David Todd [00:12:29] And I was wondering if you could help us get introduced to the life history and ecological niche of the hornshell.

Alexander Karatayev [00:12:39] Well, it's a Unionid bivalve that was first described by Lea in 1857. The Latin name of the Texas hornshell is Popenaias popeii. But, at that time, he called it Unionid popeii, and it was described from the Devils River in Texas and the Rio Salado in Mexico.

Alexander Karatayev [00:13:02] Similar to all Unionid mussels, this Texas hornshell has a very interesting life history. Adult mussels have a limited ability to disperse. They basically spend most of their life, all their life, in a particular place. They can move, but very, very little.

Alexander Karatayev [00:13:22] So, in order to disperse, they developed a very interesting method. Adult males release sperm into the water. Then the sperm goes into a female, fertilize the egg, and then this egg develops into a Glochidia and then female mussels attract fish and insert Glochidia into fish gills.

Alexander Karatayev [00:13:45] So this tiny larva that is like, maybe way less than a millimeter, develops inside fish for a certain period of time. And when they became ready,

they detached from fish, fell into bottom, and spent the rest of their life on the bottom in sediments.

Alexander Karatayev [00:14:08] So, they really rely on fish for reproduction and for dispersal. And there were cases, not with Popenaias popeii, but not with Texas hornshell, but with other species, when fish hosts disappeared and were able to follow for decades, presence of adult mussels was finally they also disappeared, because they can live for maybe two decades, but there is no reproduction.

David Todd [00:14:39] I see. So, these fish form a really critical link in the life cycle of the Texas hornshell.

Alexander Karatayev [00:14:48] Yes, absolutely.

David Todd [00:14:50] Well, when you were surveying in Texas, where did you typically find Texas hornshell? What's their usual habitat?

Alexander Karatayev [00:15:00] Well, that's a very interesting question because usually other bivalves, they live in sediments and it's relatively easy to find them if you know where to look. But Texas hornshell lived under huge rocks, in crevices where sand and clay particles provide substrate for mussels. And this is why ... well, they have to survive in the Rio Grande, for example, during very strong floods. So, they had to withstand this flood. How do they do that? They hide in crevices, under huge boulders.

Alexander Karatayev [00:15:45] And this is, was very ... before we figure out it where they are, it was very difficult to find them. This is why very few mussels were known, in general, for Texas hornshell, very few individuals. And there was even conclusion that they were all gone. And when we found their actual hiding place, the first day we found more than all scientists were able to find in the whole history before this. But we were just lucky that we found this place.

David Todd [00:16:21] That's interesting. So, I guess they'd found a way to wedge themselves into these crevices under large rocks to resist these big flood flows that could come roaring down the Rio Grande.

Alexander Karatayev [00:16:34] Yes, exactly. Sometimes you can lift a huge rock, and it was really difficult to lift them. And you can see them - like 20 or 30 of them in one spot - like sardines in cans. And these are mussels that were so rare. And here there are 20 of them in one spot.

David Todd [00:16:57] So, so very concentrated populations, but maybe scattered in remote spots.

Alexander Karatayev [00:17:04] Yes, yes. Very fragmented population.

David Todd [00:17:07] Well, so that was one of the things I wanted to ask you about. It sounds like the Texas hornshell has dropped in number in its population and has retreated from a large part of its range. Where do we find them now, what river segments? And why do you think they've retreated in such a large degree?

Alexander Karatayev [00:17:31] Well, there were several reasons. First, they can leave only in running water. So, when they built Amistad and Falcon Reservoir on the Rio Grande, in the spots where they used to be, they completely disappeared.

Alexander Karatayev [00:17:48] Another problem is water extraction. Now in the upper reaches of the Rio Grande, there is sometimes there is no water at all. In lower reaches, the water could be very saline. And also, wastewater discharge. In Laredo, we were able to, right in the city, were able to find quite a lot of Texas hornshell, like literally 50 yards upstream from the wastewater discharge. But below wastewater discharge we sampled for 25 miles below, we didn't find a single Texas horseshoe.

David Todd [00:18:31] Hmhm. So, they're very sensitive, I guess, to whether there's flowing water, whether the water quality is good. And I guess they're indicators of those kind of factors?

Alexander Karatayev [00:18:45] Yes. Yeah, they could be excellent indicators of water quality. They stay for a long time in the same place and, as we like to say, they will give you integrated indication of water quality for the last maybe several years or even a decade.

David Todd [00:19:07] So, it sounds like you did a lot of sampling, in, in the Rio Grande and from Laredo and beyond. Did you do any sampling in the Mexico part of the Rio Grande watershed?

Alexander Karatayev [00:19:23] Unfortunately, we were not able to go to Mexico. And, while we were there, very, very few people, scientists, went to survey in Mexico in general. We were guessing that the population in Mexico also was badly affected because of the pollution and the water over-extraction in Mexico was at least as bad as in the US. But, I knew that in 2018, a small population of Texas hornshell was discovered in Mexico, in Rio San Diego. And it's really great that they still exist.

David Todd [00:20:14] Well, it sounds like your study, along with your wife and others, discovered mussels in populations that hadn't been known for years. And I'm wondering why it took such a long time between its original discovery back in 1857, I think you mentioned, to over 100 years later to really start to understand the physiology and the habitat and where these mussels might be found.

Alexander Karatayev [00:20:49] For a long period of time, little effort for studying them was done, mostly because of lack of funding, but also there was a belief that various species of Unionids in the Rio Grande are lost. So, what's the point to do anything?

David Todd [00:21:13] I see. So, it felt like it just wasn't worth investing in in the research because the assumption was that they were gone already.

Alexander Karatayev [00:21:23] Yeah. Texas Parks and Wildlife Department in 1998 and 2001 did some study there. I'm afraid it was done during high water. They didn't find not only Texas hornshell, but other endemic Unionid species in the Rio Grande - Mexican fawnsfoot or Salina mucket. And the conclusion was, "There is nothing left".

David Todd [00:21:55] And partly this was because the water was too high, maybe to find some of these crevices where these rare mussels might be?

Alexander Karatayev [00:22:03] Yeah. When we did our surveys, on the Rio Grande with our partner, Tom Miller from the local university, we were always trying to contact him and sad, "What's the water level? What's the water level?" And if the water level dropped, which was absolutely unpredictable, then we can go and be successful. Otherwise, you're just trying to survive in this water. Forget about looking for mussels, but technically, you spent your time. You didn't find anything. You write in the report that nothing was found, which is not necessarily equal to nothing was there.

David Todd [00:22:46] That's a really good point. So, it's hard to prove a negative. All you can say is, didn't find them.

David Todd [00:22:56] Well, you know, one of the things that I think is always interesting for so many of us that don't know enough about freshwater mussels is to maybe, sort of step back and try to look at mussel conservation and uses and industries writ large. And, I was wondering if you could tell us a little bit about this commercial harvest of freshwater mussels, maybe not including the Texas hornshell, but the many kinds of mussels, that happened in the 1890s. I understand that there was a lot of interest in them for buttons. Is that right?

Alexander Karatayev [00:23:36] Yes. There was a huge commercial harvest. There are photos showing gigantic piles of shells, mostly from the Mississippi, but also from other areas. These were buttons that people were using, and it completely stopped with plastic. So, although plastic really created a huge amount of pollution, but for mussels, the discovery of plastic was kind of a good thing.

David Todd [00:24:11] I see. Okay. So, the plastic turned out to be a good replacement for the nacre, the shell, of many of these freshwater mussels.

Alexander Karatayev [00:24:25] Yeah, yeah. But also for buttons, mostly large mussels with thicker shells were harvested. So, mussels like Texas hornshell was thin - its shells were not good for either buttons or nuclei for the pearl industry. So, they never were harvested. But also, the densities were so low, so there was no reason.

David Todd [00:25:03] Well, so you mentioned the nuclei that were used for, as I understand it, for seeding cultured pearls. And I was wondering if you can explain about that sort of second industry that came along later and played a pretty big role in freshwater mussels.

Alexander Karatayev [00:25:28] Yes. After, there was not any more commercial harvest for the button industry then, it was discovered, and I think it first started in Japan when they started importing big shells of mussels, freshwater mussels, to make small beads to implant nuclei for cultural pearls. And again, they were looking for mussels with relatively thick shells because they figured out that this is the best nuclei for pearls - basically the same nature. It doesn't matter if you insert it into a freshwater or marine mussel.

Alexander Karatayev [00:26:18] And then, when it became a problem from the point of view of conservation, Japan stopped importing them. There was, for a while, industry in China. But at this point, I don't think there is any industry going on.

Alexander Karatayev [00:26:37] But I also would like to mention that being in Texas, I met one old lady and she was a professional pearl hunter, so she was, looking for pearls in freshwater mussels in Texas. And she told me that once she found a mussel that had a pearl inside, and the mussel she sold for like 40 grand. But it was only one and she was very

interesting person. She also, because she spent so much time looking for mussels, she'd develop allergies. She wasn't able to touch shells, so she was always wearing gloves.

Alexander Karatayev [00:27:20] So, this also had some impact on mussels, but not on Texas hornshell.

Alexander Karatayev [00:27:29] I see. And where would she typically search for these pearl-bearing mussels?

Alexander Karatayev [00:27:38] Mostly in, I think it was in central Texas, in large rivers, and in reservoirs. She also was moving mussels of live unionids from one area to another, because she was thinking that maybe it will promote unionids, it will have more unionids. And there's one species called Tampico pearl mussel that contains usually more than others.

Alexander Karatayev [00:28:05] But still, you need to kill so many of them to find a pearl or two. So, I think it's a horrible business.

Alexander Karatayev [00:28:16] During our study, we had to form a collection of shells. We always were trying to keep only dead shells. But when we were working on the DNA analysis, we had to, you know, sacrifice a few mussels.

Alexander Karatayev [00:28:39] And for all of my experience, we found only one pearl. So, it's just not something that you could get rich, so. And she also mentioned that this is a very difficult business. So, she was like the only one, but most of the time it was very difficult.

David Todd [00:29:01] Sounds like it takes a lot of patience. So, I guess some mussels are very rare.

David Todd [00:29:09] But then there are others that grow to be very common. I was thinking that you might be able to tell us a little bit about the zebra mussel, which I understand you saw as a child and had a real curiosity about how they, as very small creatures so successful in colonizing foreign spots.

Alexander Karatayev [00:29:31] Yeah, they're very different from all freshwater mussels in the world. They basically are from a brackish water region, and they have features that are typical for marine mussels, like oysters or Mytilus. They don't need fish to complete their lifecycle. They produce a special thread, byssal thread, that they attach themselves to substrate.

Alexander Karatayev [00:29:58] And they have enormous reproduction potential. One female of zebra mussel can produce up to 1 million eggs per year, and one male up to 10 billion sperm. So, they have external fertilization. The larva swim for about two weeks in the water. And this is how they disperse.

Alexander Karatayev [00:30:26] And because of the huge reproduction potential in a lake colonized with zebra mussel, you can have up to a hundred thousand larvae per cubic meter. So, if you will project it to the one square meter of the bottom, and let's say you have ten meters' depth. You have 1 million of larvae for each square meter. And this is like a rain of larvae. That's why they can form density up to 20, 30,000 per square meter.

Alexander Karatayev [00:31:02] Now, in the Great Lakes, one species, quagga mussel, replaces zebra mussel. It represents 95% of all biomass of all living animals in Great Lakes, including fish and plankton... In Lake Michigan, 95% quagga mussel. So basically, it has a huge, huge impact on the entire Great Lakes ecosystem, but also on other ecosystems around the world.

David Todd [00:31:38] That's interesting. I mean, I've heard that they can clog pipes and infrastructure. But I didn't realize the extent to which they really come to dominate the whole natural ecosystem as well.

Alexander Karatayev [00:31:54] Yeah. Water clarity in Lake Michigan before the introduction was around seven meters - now 18 meters. Lakes became so much clearer, which divers really love. But the clear water also indicates that there is not much production going on in the water column. So, fishery that relies on fish that stay in water column ... really drop.

David Todd [00:32:28] And my understanding is that these zebra mussels have and quagga mussels have used human commerce and even amateur fishermen to move from one spot to another. Can you help us understand the human role in their spread?

Alexander Karatayev [00:32:51] Yeah. They came to America in the middle of the 1980s with ballast water that was released that came from the port of ... on the Black Sea, which is almost a fresh water port and the boat dropped the, discharged the ballast water into Lake Erie. And this is where we got our first both zebra and quagga mussels, Dreissena polymorpha and Dreissena bugensis.

Alexander Karatayev [00:33:24] And then, so this was a method to allow them to cross the ocean. But from lake to lake, the local dispersal was because they can attach themselves to any kind of hard object. In the late '80s, early '90s, boats in Lake Erie were, and they still are, but at the beginning they were covered much more. The entire boat was covered. The hull of boat was covered by zebra mussels, even to reduce the speed of the boat. And when you moved a boat from one lake to another, they drop and start a colony in a new lake. And this is how they spread. By now, we have about 800 lakes in North America colonized by zebra mussel.

David Todd [00:34:24] And I understand that they've come to colonize bodies of water in Texas, too. Is that right?

Alexander Karatayev [00:34:31] Yes, yes. When we came to Texas because of, well, we already had some experience working on the zebra mussel, so we suggested that we can make predictions how they will spread in Texas. And unfortunately, we were told, "Oh, Texas is too hot. They will never live in Texas."

Alexander Karatayev [00:34:50] And we said, "No, they will." And now they are.

David Todd [00:34:56] So, they managed to adapt to the Texas climate?

Alexander Karatayev [00:35:02] Yeah.

David Todd [00:35:02] And they've spread here. Is that right?

Alexander Karatayev [00:35:05] Yeah. But the spread is not as fast as in the Midwest, for example. But, because they are still on the edge of the distribution range, the water is still ...

they won't survive when water gets higher than 33, 34 degrees Celsius. And this might happen in many rivers in Texas.

Alexander Karatayev [00:35:35] They also are doing much better in stagnant water - in lakes, reservoirs - but not in running water. And they need hard substrate for attachment.

Alexander Karatayev [00:35:46] So, when also if water level dropped in reservoirs, then of course they will die from desiccation, especially in Texas heat.

David Todd [00:36:00] I see. So, there are some challenges, even to the fearsome quagga and zebra mussels.

Alexander Karatayev [00:36:06] Yes.

David Todd [00:36:06] There are some situations they can't survive.

David Todd [00:36:11] I thought, while we're talking about invasive problems, we might, visit with you a little bit about some of the macrophytes, hydrilla and others that I think you and your wife have studied over the years. Can you talk about some of those issues?

Alexander Karatayev [00:36:28] Yeah. There are lots of invasive species, including macrophytes, and they spread all over the world, including Texas, like water hyacinth or hydrilla, for example. And sometimes they can be a threat to Unionids. But again, they prefer stagnant water or slowly running water, but not areas like the Rio Grande, where the water level is very unpredictable, or the current is very unpredictable. You can have a huge flood with absolutely, dramatic water current.

Alexander Karatayev [00:37:14] So, I doubt that they may form a sizable density in areas where Texas hornshell exists. They still can be in some backwaters, but these are not areas with Texas hornshell.

Alexander Karatayev [00:37:31] Other invasive species - Asian gold clam or golden mussel, Corbicula fluminea - that's everywhere in Texas. But, and there were some suggestions that they may be a threat to Unionids, but we found that in some areas with huge amount of Corbicula, but also we found very diverse and very dense community of Unionids. So, there is not any negative effect that we found.

Alexander Karatayev [00:38:06] In contrast, zebra and quagga mussel can have devastating effect of Unionids like this. Most of Unionids disappeared from the Great Lakes, because they were overgrown by the zebra mussel.

David Todd [00:38:25] I see. They out competed the Unionids? Is that is the case?

Alexander Karatayev [00:38:30] No. They simply attached themselves to the shell. And sometimes the weight of attached zebra mussel could be ten times more than the weight of the Unionid itself.

Alexander Karatayev [00:38:43] And if it's in sediment, they simply can sink Unionid into the mud. And they have just died. And this was shown in many, many lakes and reservoirs around the world.

Alexander Karatayev [00:39:00] And it's funny that in areas with hard substrate where the Unionid is still hanging very dense - sand, for example, or rocks - they can still survive in a smaller quantity, but not in, areas with soft substrate.

Alexander Karatayev [00:39:20] So we still have them in the Great Lakes, in marshland and flowing rivers, in very shallow areas, but not in deeper areas of the Great Lakes. We snorkel and we SCUBA a lot, and all that we found was lots and lots of dead shells, but not a lot of Unionids in the deeper part of the Great Lakes.

David Todd [00:39:46] I see. Okay.

Alexander Karatayev [00:39:48] Well, you know, when you think about the zebra and quagga and Asian gold clam and the apple snail, and then some of these plants - the hydrilla and water hyacinth - is there something that you think these invasive, really aggressive, non-native animals and plants have in common, that they share that makes them so successful?

Alexander Karatayev [00:40:18] In science, we call it a million dollar question. And this is what so many people were trying to answer. What are the common features among them? Several papers were published. Several theories. But we still cannot find any very definite generalization that we can say, "Okay, this species will be invasive, this will never be."

Alexander Karatayev [00:40:48] In general, we might say that this probably if we want to draw a portrait of an invasive species, we'll say that it's a generalist, something, a creature, that can live in many different types of environment, capable of feeding on a large spectrum of food items. Because if a species adapts to live, to feed on only one particular species, it's very unlikely that in a new area it will flourish and also be able to live in wide variety of habitats.

Alexander Karatayev [00:41:25] Like Corbicula in Texas, you can find that from very large reservoirs to tiny ditches. And there were even reports that they were found in discarded tires. So, they can live anywhere.

Alexander Karatayev [00:41:40] And they also have a pretty high tolerance that they can live in almost freezing water. And can survive probably the hottest part of areas in Texas lakes because they were everywhere. So, their tolerance to high temperature is much higher than zebra and quagga mussel. And they colonize way more lakes, streams and reservoirs.

David Todd [00:42:18] It's impressive. It engenders a lot of respect, and maybe a lot of disgust and frustration. But, these invasive seem to have great survival skills.

Alexander Karatayev [00:42:32] Yeah. Because of them, there is a belief that from, let's say, out of a thousand species that potentially can introduce into new, let's say from Europe to America, or the other way, only a hundred will escape. Only ten will form a population and only one will become invasive and cause some problems.

Alexander Karatayev [00:42:59] We call it "the tenths rule". And we think it's ten because we simply don't have better quantitative data.

Alexander Karatayev [00:43:09] So, there are many more species that probably were transported from one continent to another that now we know became invasive. Some of them simply disappeared, died because of conditions that were not favorable, and there are some

species that survive in a tiny quantity and never create any problems. And that's why they never draw any attention. Nobody studied.

David Todd [00:43:42] That's interesting. So there really is a winnowing effect, I guess a culling, that happens and only a very few are invasive and aggressively so.

Alexander Karatayev [00:43:54] Yeah. But the interesting thing that we never could predict which one will be aggressive or invasive species. And sometimes there is a, we call it a "lag time", between when the species is introduced and when it became invasive. And sometimes it could be decades. It could be 50 years.

Alexander Karatayev [00:44:14] So, it's not a good idea to introduce any species, especially in Texas, where the water is so warm.

Alexander Karatayev [00:44:26] So, basically the aquarium trade is a very strong vector of spreading species. I always told my students that if you have a fish tank and you don't want to kill them, you dump it into a stream in Alaska. They probably will be save - they won't survive winter.

Alexander Karatayev [00:44:49] If you do it in Texas, it will be horrible because they all will very likely adapt to local streams. In San Antonio, you walk in on this River Walk, and most of the creatures that are now visible in the river are invasive, non-native.

David Todd [00:45:16] Gosh. It's interesting when, you know, our little part of Texas may have more in common with Asia, in terms of the kind of biota that's there.

David Todd [00:45:30] Well, so we talked a little bit about invasive issues. I thought this might be a good time to segue to talk about hydrology and the impacts of drawdowns and droughts, which I think you've written about and studied in how they can affect Texas hornshell.

Alexander Karatayev [00:45:53] Yeah. According to predictions, the American Southwest could experience strong increases in temperature and drought that will cause a decrease in water level and oxygen content, and this will affect not only Texas hornshell, but also their fish hosts.

Alexander Karatayev [00:46:11] So, for them, it's critically important to maintain appropriate water flow. If there is no water flow, Texas hornshell will disappear, as happened in parts of Rio Grande that were regulated, like Amistad Reservoir or Falcon Reservoir.

Alexander Karatayev [00:46:34] It also created fragmentation in the population. They cannot really exchange their genes anymore because there is no much movement of mussels from above reservoir to below reservoir, but it also affects the migration of fish.

David Todd [00:47:01] I see. So, they could really remain caught in one area and then eventually die out if they don't have the ability for their Glochidia to attach to a fish.

Alexander Karatayev [00:47:09] Yeah.

David Todd [00:47:10] And continue to reproduce.

David Todd [00:47:15] Well, so, one of the things I thought was interesting that I think you and your wife have pointed out was that, if you have drawdowns or drought conditions and streams and reservoir starts to dewater, it exposes a lot of these mussels, and I guess the Texas hornshell as well, to predators and birds and muskrats and raccoons and so on. And is that a significant factor?

Alexander Karatayev [00:47:48] Yes, it is a significant factor. We have done studies that shows what kind of, what part of the population could be removed by predators. But as soon as there's still part of the reservoir or a stream will be left with water, there is a hope that these areas eventually will be recolonize. But if the entire lake or river will be completely dewatered, then the situation will be way, way worse and it may take decades to recolonize.

David Todd [00:48:36] So, I think you mentioned earlier that, you know, there have been difficulties with dewatering Texas streams and lakes in the past, just, you know, for human uses and maybe hot summers. But that looking forward, climate change, may have a significant impact. And can you help sort of map out what scientists like yourself are foreseeing?

Alexander Karatayev [00:49:08] Yeah, unfortunately, it looks like the water consumption won't decline. More people will live in Texas, including areas with, Texas hornshell. There is fracking going on that required lots of water. There are other industries.

Alexander Karatayev [00:49:32] ... We have this prediction on drought and climate change, including temperature increase. So, they may definitely have a very negative impact on Texas hornshell. And this should be, we should predict this. And we should be able to somehow minimize the negative effect. We should be able to maintain an appropriate minimal water discharge. And maybe do other activities to minimize its negative effect.

Alexander Karatayev [00:50:15] But again, it requires lots of funding, lots of research, and lots of actual implication of this research.

David Todd [00:50:26] So I guess part of the ability to predict what might happen as climate change, really, comes home to Texas. It sounds like a lot of this experience is based on what happened with dams that were installed and, you know, the impacts on downriver segments of rivers that were dried up, or the areas, I guess, above where colonies were submerged. Can you help us understand the past impacts of some of these big dams? I think you mentioned Amistad and Falcon, but I guess there's McMillan and Brantley and Avalon and and even Elephant Butte, way up in New Mexico.

Alexander Karatayev [00:51:19] Yeah, well, different species require different hydrology. There are species that could be fine in stagnant water - lakes, reservoirs. But these are more mostly species that have pretty large distribution range, like, for example, Pyganodon grandis, they lived, these mussels lived in Texas and by the entire North America and can survive in like fish ponds, as well as in huge lakes and reservoirs and in streams.

Alexander Karatayev [00:52:01] But, species like Texas hornshell, they can live only in running water. So, when you build a dam and, above the dam, you have stagnant water. They will disappear.

Alexander Karatayev [00:52:25] But as I already mentioned, this reservoir not only would cause local extirpation from this particular place where there is no running water anymore. It

will disconnect populations above the reservoir where there is still running water, and below the reservoir. And it's also not good for mussels, for the gene exchange, and for recolonization, for example.

Alexander Karatayev [00:52:54] And if you will have quite a few of these reservoirs on the entire river, the whole population could disappear, because there will simply be no place for them to live.

David Todd [00:53:15] Well, so, I think there have been a number of discussions in recent years about not a huge dam, but a, you know, relatively low-water weir that was proposed for the Laredo area. And, I think that some, mussel experts have been concerned about that. And I was wondering if you can explain your own feelings about that proposal.

Alexander Karatayev [00:53:44] I don't know what will be the exact effect of a weir near Laredo, but I know that, in Laredo, near the La Bota ranch, we found the largest population of Texas hornshell. So, if for some reason this dam, even if it's a little water dam, will reduce water flow in this area, which I don't know if it may affect the whole area, then we definitely will lose the largest population of Texas hornshell known so far.

David Todd [00:54:26] All right. So, another area that I'd like to hear your thoughts about. We've talked about the main stems, such as the Laredo section of the river. But what about tributaries like the Pecos? I think that I have heard that female and young Texas hornshells seem to have disappeared from the Pecos. And I was wondering if you have some insights about why that might be happening.

Alexander Karatayev [00:55:03] They do disappear from most of the Pecos. We found only dead shells in the Pecos, but some of these dead shells were very, very recently dead. And as I recall, later, a few individuals were found in the Pecos, but not to the extent as that used to be in the past.

Alexander Karatayev [00:55:32] And one of the reason why they disappeared in most of the Pecos was salinization. Water became very saline. Texas hornshell, they could survive some salinity. But when salinity exceeds seven parts per thousand, it goes through physiological stress and death.

Alexander Karatayev [00:55:56] And this is the major factor limiting Texas hornshell in the Pecos River. In some areas, we found salinity way higher than seven parts per thousand.

David Todd [00:56:08] And is that just a feature of the local geology and sediments that causes the salinity to rise, or is that a problem of water extraction?

Alexander Karatayev [00:56:20] I think it's a water extraction and water that is returning from, after being used in agriculture.

David Todd [00:56:31] I see. So, both extraction and return flows.

David Todd [00:56:36] Okay, while we're talking about quality issues, I think that one of the concerns about these Texas hornshell was a spill. I think there was a well line that ruptured, about 7 or 8 years ago, in the Delaware River and that it had, you know, drew concern about the effect on the hornshell. How do you think that came about, and what sort of effect would you expect?

Alexander Karatayev [00:57:07] Oil spills could be devastating for Texas hornshell as well as for other aquatic organisms. And, yeah, this will be really, really bad. We have data on other parts of the United States where Unionid fauna was completely extirpated. And it started recovering, but it's so slow and we don't know if the community that will eventually recover will be absolutely similar. Some species may be much more strongly affected than others, and some species that had already been on the edge of extinction may completely disappear.

David Todd [00:58:01] And the problem is that these are filter-feeders and they just absorb a lot of the contaminants. Is that right?

Alexander Karatayev [00:58:09] Yes, yes, they are filter-feeders. They stay for a long period of time. They cannot move anywhere like a fish can. But also, it will take so long for them to recolonize. And also, there should be a source of mollusk for recolonization somewhere nearby, because dispersal is not very fast. And if an oil spill will affect a large area (of course, it depends on how much oil is spilled), then the restoration becomes more and more problematic.

David Todd [00:58:55] So, while we're talking about water quality, I think you had mentioned this in passing before, that you found large populations of Texas hornshell above Laredo, but then below Laredo and below, I guess, Laredo and Nuevo Laredo's sewage discharges, you found very few, if any. What is going on there? Can you talk in a little bit more detail about the sort of sewage effects on Texas hornshell?

Alexander Karatayev [00:59:29] Yes. We were assembling, after we figured out where they can live while looking on any signs of bedrocks with rocks on the top of them, and we became very successful. As soon as we see this environment, we were sure that we can find them.

Alexander Karatayev [00:59:47] So we started going downstream from the La Bota ranch, and, right before the sewage plant in Laredo, there was a place that was typical habitat for Texas hornshell. We found lots of them, and it was literally 50 meters above the discharge from the wastewater plant. And there was nothing in there of discharge. But we also started feeling that all the rocks that were supposed to leave, they all became very slimy. And the smell was horrible. But we still were sampling and sampling and sampling.

Alexander Karatayev [01:00:34] Then we hired an airboat and we sampled areas about 40 kilometers, like roughly 25 miles, downstream from Laredo. By the end of our search, we started finding some Unionids, but no Texas hornshell. For the whole stretch, we didn't find a single life Texas hornshell, although we checked tons of typical habitats.

Alexander Karatayev [01:01:02] Above this wastewater discharge, on every habitat that we knew was typical for Texas hornshell, there were some live mussels, none on the habitats below. And this was a very strong message for us.

David Todd [01:01:19] Well, do you think that it's ammonia, or what is it that is in the sewage that might harm the Unionids in general, or the Texas hornshells in particular?

Alexander Karatayev [01:01:34] We don't know the exact mechanism. It could be ammonia. It could be periodical decline in oxygen. But it requires special study to understand. But it was a clear message that this discharge from this sewage plant is the main reason. But the exact mechanism, again, we need to do a special study.

David Todd [01:02:04] Okay. Well, so, I think you've given us some ideas of the factors that are affecting the Texas hornshell, whether it's the dam construction or water extractions or return flows or sewage flows.

David Todd [01:02:24] Maybe you can help us get a picture of how the listing that's kind of recognized the dilemma facing the Texas hornshell came about. I think it was in 2018. How did this shellfish first get recognized for endangered status.

Alexander Karatayev [01:02:44] Yeah. There were attempts to do it much earlier. But what actually happened is that, in general, listing is a very long process. Yes. And it was first proposed in 1989, but then additional populations were found by Tom Miller from Laredo Community College and later by us.

Alexander Karatayev [01:03:20] And then there was a conference when people from New Mexico approached us and say, "Okay, you guys found, Texas hornshell in Texas. And this basically disrupts the process of listing them because we need more data. Let's write a grant together and do this exploration."

Alexander Karatayev [01:03:42] And this is what we did. We conducted very detailed survey. And we also looked at all literature data, data in museum collections. And we were able to restore or reconstruct the former range of Texas hornshell in America, including both New Mexico and Texas.

Alexander Karatayev [01:04:04] And we estimated this Texas hornshell range has declined by roughly 75% and total population by 72%.

Alexander Karatayev [01:04:14] And this was a strong argument to show, "Yes, they still exist, but the decline is so dramatic that we need to list them now. We need to start protecting while there is still something to protect."

David Todd [01:04:34] I think you you mentioned that these listing efforts can take a long time. And I am curious if there's any particular reason why the listing for the Texas hornshell took, gosh, about 30 years, I mean, starting in '89 and then not finally being listed until 2018.

Alexander Karatayev [01:05:00] In general, it's a very long process, but it also depends on ... I don't want to get into the details, but I think there was a time when it was almost impossible to list any species, not only mollusks, because of the Administration approach to this, because listing species basically can cause some problems for industry, agriculture and there was not much support for doing this.

Alexander Karatayev [01:05:40] Actually it happened! I was very pleasantly surprised that it finally happened because it was such a long time. You know, we're going to the point where it probably never would happen. Then we got a call: "No, it's actually happening".

David Todd [01:05:58] That's interesting. So, I guess the science might have been there, but the politics were not ripe for listing.

Alexander Karatayev [01:06:07] Yeah, because it's one thing to do science. And you can do it in a more continuous way. Yeah. There is nothing to prevent you (maybe like with funding to some extent). But at listing it's largely a bureaucratic process that requires lots of will in

administration, on the part of agencies, because then it became affecting lots of people, industries, agriculture or other things. There should be a will to do this, and an understanding that it may cause some problems.

David Todd [01:07:03] Do you see the Texas hornshell listing as being a kind of a recognition of the problems facing other rare freshwater mussels in Texas, and maybe, you know, sort of cascading into the listing of other species?

Alexander Karatayev [01:07:22] Yes, I hope so. It's really great that it happened. And I hope it's only the beginning.

Alexander Karatayev [01:07:33] But we also need to have a pretty strong public support for that. We should, not "we", but a large portion of our public should understand that this is not because of some, you know, mad scientists who want to create problems for certain industries or agriculture, but this is something that really helps us save our environment for generations to come. It's important, it's necessary.

Alexander Karatayev [01:08:09] We cannot endlessly use our resources. We have so little, for example, water resources in Texas. We need to protect what we have rather than think that, "Okay, we can use it and who knows what will happen next?"

David Todd [01:08:31] Well, that's a good segue to just talk about, what you think might be effective, productive ways to help conserve and restore Texas hornshell. Do you have some thoughts there?

Alexander Karatayev [01:08:50] Well, I think just the fact that now it's officially recognized it will help. But I think it's very important to bring, to increase people's awareness. And there are lots of really ... we found really many wonderful people like Charlie Grantstaff that were very much interested in mussel conservation. He was a farmer, just with not much science background, but he understood that it's like an umbrella species. If Texas hornshell is doing well, it means the stream or the river is healthy. Protecting one species will protect the entire ecosystem, not just for Texas hornshell, but for all other creatures, including fish that people like, including water that people want to drink. They want to swim there. They want to keep water usable, drinkable, fishable, swimmable, whatever.

David Todd [01:10:01] Yeah. So, sort of a keystone, umbrella-type species ...

Alexander Karatayev [01:10:05] Yes.

David Todd [01:10:05] You protect the Texas hornshell, there are all these wonderful repercussions.

David Todd [01:10:11] So, do you think that, you know, some of the core efforts would involve trying to keep water in free-flowing streams or, what would be some of the other ideas that might work for protecting the Texas hornshell?

Alexander Karatayev [01:10:28] Other ideas will be also to protect watershed, to be sure that nothing really bad is coming from the watershed to the river. Stop pollution. Prevent oil spills. These are critically important.

David Todd [01:10:49] So I've read somewhere I believe that there are proponents for trying to repopulate and translocate populations of mussels, and perhaps Texas hornshell as well. But I guess there are issues about making sure that their new homes would be supportive. What do you think about that as an option?

Alexander Karatayev [01:11:19] Yeah. I'm not very familiar with the results of reintroduction of Texas hornshell. I read that something was done in New Mexico, but I wasn't sure if this was successful. However, there are several hatcheries in the United States that specialize on hatching Unionids for reintroduction, and this is a well-known technique. So, we could do it.

Alexander Karatayev [01:11:50] But one of the key conditions for the successful reintroduction, as you mentioned, we need to be sure that there is a suitable environment where we want to reintroduce them. If we can be sure that, I don't know, the Black River in New Mexico or the Pecos River became way cleaner and with lower salinity that is acceptable to the Texas hornshell, I think it will be very possible to hatch them in a hatchery, reintroduce them. Maybe we can restore the population in most of the range and delist them, and say, "They're doing great. We don't need to list them anymore."

Alexander Karatayev [01:12:44] That will be my dream, and probably the dream of everybody who is doing conservation. We don't want to list them because we just like it, but we want to protect them and then eventually delist them, and say, "Oh, they doing great."

David Todd [01:13:05] Yeah. So that's the goal.

David Todd [01:13:08] I understand that there's something called a voluntary candidate conservation agreement that's been tried out in New Mexico, and I think it's been used as a way to protect Texas hornshell. And I was curious if that's something you've been exposed to or have some insights about.

Alexander Karatayev [01:13:29] I wasn't exposed much, but I met lots of people that were very interested in doing this, and I think it's an absolutely great initiative. It is important to have both public support and help from the appropriate agencies, but maybe volunteers could be even more efficient in raising awareness. It's not something that the government imposes on us. It's something that we want to do, and it's a very different message. So, I think it's very, very important.

David Todd [01:14:03] And so, this may be a way to sort of engage people, and build support and awareness? Is that what you're thinking?

Alexander Karatayev [01:14:10] Yes. Yes, absolutely.

David Todd [01:14:14] Okay.

David Todd [01:14:15] Well, so, maybe just to pull back a little bit from the situation for the Texas hornshell, and maybe talk about freshwater mussels in general, I understand that a large percentage of the species are rare, maybe threatened or endangered. Why do you think mussels seem to be generally struggling in so many different kinds of species and habitats?

Alexander Karatayev [01:14:46] Well, it's because of, the unique features of mussels: like in North America, in general, there are about 300 species, but 20 species already, we think are extinct, almost 80 species, endangered, and 43 threatened.

Alexander Karatayev [01:15:06] So, and why? Because they have a unique life cycle and life requirements. They are filter-feeders, so they depend on water quality. If water quality is not good, they filter and eventually accumulate all pollutants that can be devastating.

Alexander Karatayev [01:15:29] They are sedentary: they cannot move to avoid disturbance. There is a drought. There is an oil spill. It's not like fish. They cannot swim away.

Alexander Karatayev [01:15:39] Require certain fish species for reproduction. Fish disappear: Unionid disappear.

Alexander Karatayev [01:15:47] They also are long-lived creatures. They cannot recolonize. There are some species like Corbicula, for example: they could die and in a few years later they could recolonize this area and create the same or even higher density. For Unionids, it takes so much longer.

Alexander Karatayev [01:16:07] And the combination of all these four characteristics makes them so vulnerable.

Alexander Karatayev [01:16:15] And it's going on all over the world, not only in North America. Unfortunately, they're negatively affected by human activities worldwide. Although the specific type of activities can vary from country to country. In Asia, for example, now there is a growing population that simply eats them. You go to local market, and there are thousands and thousands of Unionids with people buying to eat them.

Alexander Karatayev [01:16:50] But, the good news is that in many areas, people finally realize that mussels are important. We start in Western resources in their protection. And I deeply hope that North America, and especially Texas, will be among the most efficient in this activity.

Alexander Karatayev [01:17:11] But this is when we need public support.

David Todd [01:17:21] So the mussel is such an unusual creature. It's so different from ourselves and sort of hard to comprehend. But, as you've pointed out, it has these fabulous features of their life history and they're, you know, important as an indicator for many species. But, when you look at it just in and of itself, do you see some intrinsic value in it? You know, some people try to think of whether animals have souls or they have some sort of ethical value or some sort of functional value. How do you visualize Texas hornshell and other mussels? Why are they important?

Alexander Karatayev [01:18:12] Oh, they definitely have great intrinsic value as living creatures. I'm not sure ... I'm not qualified to discuss the question about their souls. But, you may say that, yeah, they're not as charismatic as tigers or birds, but they provide very important ecosystem services. They clarify streams through filtering. They could be an excellent indicator species of water quality. They have unique biology, and they are simply the largest creatures in our freshwater that may live for decades. And to me, they are more charismatic than many other animals.

Alexander Karatayev [01:19:01] People just simply are not really aware of them. Like many times, many times, I ask local owners of the land in Texas if I can get access to their streams, and they were always very friendly. Access was always granted. And then coming back, I show them these shells that I found. They'd say, "Oh, these are such cool shells. Where did you get them? In the Gulf of Mexico? No, it's in your backyard, the streams that run in your backyard."

Alexander Karatayev [01:19:39] And again, as I mentioned, they're considered an umbrella species. If they flourish, we may be sure that the environment is also good for many other aquatic organisms. So, these are very, very interesting creatures, very to me, very charismatic. And they have absolutely great intrinsic value and provide wonderful ecosystem services.

David Todd [01:20:06] So, I think when we were just starting out, you were talking about how you have worked in this field for nearly a half century as a biologist, an aquatic ecologist. And I'm wondering if there are things that you've valued or learned from having that kind of career. Is there anything that you can tell me about this line of work that you've found so interesting?

Alexander Karatayev [01:20:37] Well, 50 years of this experience convinced me that I made a very wise choice for me as a career. I found that, and I was trying to convince my student that biology, ecology, is not only important to protect nature and provide foundation for smart management of our environment, which is essential for surviving of us as humans. But, it also could be extremely interesting and enjoyable.

Alexander Karatayev [01:21:23] Doing research, both me and my wife, we together did the research in different areas, but many, many times, we were in very remote areas of Rio Grande, or I did a study in remote Siberia or in Russia. I visited pristine areas that very few people been there, and I found that I so liked it. This is the only, or one of a very few professions where you will get experience. You will see all this. You will experience all these adventures that are now very difficult to find. And you will get paid for this. Although sometimes we have had to work for 14 hours straight in a really nasty environment, but we liked it.

David Todd [01:22:29] Well, not only have you, I guess, worked with your wife and your generation of biologists, but, I see that you've worked as a professor at a number of institutions, and I'm curious if there are things that you valued from being a professor and a teacher and a mentor.

Alexander Karatayev [01:22:53] Yeah. It's very rewarding to teach a new generation, even if you are not always successful. But even if you have a few students that really gain something important from you that changes their life, their career, it's so rewarding. And I think it's really worth to invest time in and efforts in this.

David Todd [01:23:24] So, I think that it's become a kind of a part of the English language to discuss who your wife or husband or spouse is, and say they're your "partner". And I think that's true for many people, but it may be that you're a partner in, you know, maintaining a home and raising kids, but you and Luba have been a partner in research as well. And I think that's really unusual to have that kind of combination of home life, but also, your work in research, with, you know, your life partner. And I'm curious what that experience has been like.

Alexander Karatayev [01:24:11] Oh, this was and still is a wonderful experience. And it's interesting, Luba graduated from the physics department, with exceptionally good mathematical background, and then she became a biologist. And in contrast, I got this classical biology college education in the early '70s, which means not much statistics or mathematics. So, both of us brought something unique to our family team and it resulted in a very productive long-term collaboration.

Alexander Karatayev [01:24:46] In 1992, we published our first joint paper. And we wrote over 100 more. We conducted research in Belarus, France, Argentina, Great Lakes and, of course, in Texas.

Alexander Karatayev [01:25:00] And we both enjoyed being in nature. As I already mentioned, we often considered our field work as a family vacation. Although we worked a lot in, for example, rivers below sewage water discharge.

Alexander Karatayev [01:25:20] But over the last 30 years of our collaboration, the two of us had different roles in different projects. But I want to emphasize that in the study of Unionids in Texas, Luba was always the leader.

Alexander Karatayev [01:25:36] Also, our kids - we have two sons, the oldest, Dmitry, is 40, and the youngest, Vadim, he's 31. Dmitry, now he's a manager of a small company. And Vadim last year became an ecology professor at Maryland University. But when they were young, they helped us a lot in our field work.

Alexander Karatayev [01:26:00] We moved to Texas. We were very busy. They started complaining that we don't have family activities. So, "Okay, our field trips will be our family activity". They really enjoyed that. Now, they have very different jobs, very different in their career, but they still remember these expeditions as one of the happiest parts of their life.

David Todd [01:26:25] Well, it's wonderful that you've shared this with your family, and with the rest of us, today. So, thank you for telling us about this experience.

David Todd [01:26:37] Is there, is there anything you might like to add before we wrap up?

Alexander Karatayev [01:26:41] Probably not, thank you very much. It was really interesting to talk to you about this Texas experience. It brought lots of good memories.

David Todd [01:26:52] Well, thank you very much. You're generous to share the time and the memories.

David Todd [01:26:57] So, I want to thank you for that and wish you the best. This has been really interesting and valuable.

Alexander Karatayev [01:27:05] Thank you.

David Todd [01:27:06] All right. Well, I'll cut it off now. And, again, thank you so much.

Alexander Karatayev [01:27:12] Yeah, you're very welcome. And maybe someday we'll meet in person in Texas.

David Todd [01:27:17] I would love that. I hope our paths cross.

Alexander Karatayev [01:27:20] Yeah. And you're welcome to visit us in Buffalo.

David Todd [01:27:24] That's a nice invitation. Thank you so much.

Alexander Karatayev [01:27:27] You're very welcome.

David Todd [01:27:28] All right. Have a good day. Bye now.