Ask a Biologist Vol 006 (Guest Andrew Smith)

Keystone Species -

Travel with us to the Tibetan plateau in China and the field site of conservation biologist Andrew Smith. There we will learn about some cute furry animals called Pikas and why they are considered a keystone species. Hey just what is a keystone species - that's something we will also learn about..

Transcript

Dr. Biology: This is Ask-A-Biologist, a program about the living world, and I am Dr. Biology. Today we're going to travel to the other side of the world, to the Tibetan Plateau. That's in China. The reason for our trip is to catch up with conservation biologist Andrew Smith. Dr. Smith is a professor in the School of Life Sciences at Arizona State University, and an expert on some furry animals called picas. As you will learn in our show today, picas are what biologists call a "keystone species." We'll learn more about these animals and why they are called keystone species, but right now let's journey to China and listen to what Dr. Smith is doing at his research field site.

Dr. Andrew Smith: It is now 7:30. I'm beginning another 15-minute session, again sitting under the territory of Large Orange Orange and Large Blue Blue. Everybody in the family is active in what is considered many frequent social interactions in the past. It is absolutely still.

[animal noises]

Those two calls were given respectively by Large Yellow Red, Large Orange Green, neither of which are animals at risk.

[animal noises]

At the beginning of the session I just missed recording a long call by Silver Silver, after which he was approached by Large Orange Red, and they had a vigorous fight.

Dr. Biology: Now that you've had a small taste of what it's like to be in the field with Dr. Smith, let's meet our guest scientist. Welcome, Professor Smith.

Andrew: Welcome.

Dr. Biology: Let me begin with one question which many of our visitors to the Ask-A-Biologist web site ask: what is a conservation biologist and what do they do?

Andrew: Conservation biologists are generally interested in the biological diversity of ecosystems and species, and even the genetics within species, of all the forms of life on Earth. Conservation biologists do many things. They are very interested in preserving all

of the biodiversity on Earth--biodiversity being the short term for biological diversity--and they do it in many ways, by conducting field studies to determine how many animals are found in the world and where they are found. They also deal a lot with the impacts on these species, whether or not the populations are declining and what we can do to save these populations.

So ultimately conservation biologists work at many different levels, from being scientists, gathering data, working in the field, and also working very much more, in today's world, in the socio-biological, political and economic world, because economics help people think and work, and this really impinges on why things are endangered and what we can do to keep them from being endangered, and to bring some species back that may be rare in the world today.

Dr. Biology: So when you talk about biodiversity, we are actually talking about keeping the breadth of many types of animals.

Andrew: That's correct.

Dr. Biology: The issue about money is really important because, for example, the rainforest. The deforestation down there has caused a huge impact on biodiversity down there, but it was mainly a money issue at the time.

Andrew: That's right; but we use money in many different ways. Money can actually be one of the things that leads to the decline of species on Earth, but finding that certain species on Earth are indeed valuable might even be responsible for saving these species, by making people realize how connected they are to the real world.

Dr. Biology: Right, and in particular, medicines have come from plants.

Andrew: Maybe as many as 50 percent of all the medicines that you would find in your local drugstore, at one time or another were part of cultural tradition among local peoples, and have now found their way into our stores, but really were a part of the natural world and were used by native peoples when they didn't even realize what it was that they were doing.

Dr. Biology: One of the points to make here is that we want to be careful that we don't lose something that we're going to need later.

Andrew: That's correct.

Dr. Biology: Another thing that's interesting, even though you are a professor at Arizona State University, your research takes you to literally the other side of the world. What first got you interested in picas, and later your studies in China?

Andrew: Well, I work on these small animals called "picas, " which are mammals. They are actually related to rabbits. They are shaped like an egg, about six inches long, with little round ears, a cute little nose, and no visible tail. They sort of hunch up. There are actually two kinds of picas in the world: picas that live in rocks, and picas that live in

meadows and that make burrows. I became familiar early on, when I was a boy, with the picas that live in rocks, because both of the kinds of picas that live in North America are rock-dwelling picas. I grew up hiking in the Sierra Nevada Mountains in California, when I was in ninth grade I was going on three-week backpack trips with just a friend of mine, and hearing the picas--because they are very vocal--calling from the rocks, got me interested in this animal.

Then I ultimately went to university and began to read about these animals, and it was always that nothing much was known about the pica. Well this certainly piqued my interest. I went to graduate school, decided that I would work on picas, and--for two things. One, it was very interesting to sort of explore the unknown, and here, many, many, many years later I am still working on picas because the questions that keep coming up scientifically are still interesting to me. But at that time I got to study the animals that I thought were very interesting, and do serious trout fishing in high-altitude Sierra Lakes when I wasn't gathering my data. But I worked on these rock-dwelling picas in North America.

Then, I completed those studies. I did more studies when I came to Arizona State University. Then I began going to the library, reading that there were other picas, and that they lived in China and throughout Asia. There were many species there, and lots of the species that lived in Asia didn't live in the rocks, like I was familiar with, but lived in these open, flat meadows. And yet these animals were six inches long, shaped like an egg, no tail, little round ears, just like my picas in North America. So from a scientific point of view, what drew me to China was to compare how an animal that looked exactly the same as the picas I was familiar with from my work here, how different they would be, in their ecology and their behavior, by living in a completely different kind of habitat. So that was the initial draw that took me to China.

Dr. Biology: So that's what got you to China. How often do you travel to China to do your research?

Andrew: I have been to China about 20 times. Most of those trips were to conduct research on my picas. Also, as a conservation biologist and because of my familiarity with the ecosystems of Asia, many of the trips have actually been to advise the government of China in dealing with biological diversity, and I actually couple many of my policy trips to China, to talk to the government there, with additional trips to go up to my favorite part of the world, up on the Tibetan plateau, to study my animals.

So I have been there about 20 times.

Dr. Biology: Ooh. Now, 20 times, that's how many years' worth of research now?

Andrew: Well, I began work in 1984, going there. I have a family, so there have been a few years that I haven't gone, but I try to make it almost every year.

Dr. Biology: OK, over 20 years, what has research into picas revealed, and to make it simple, what is the story that's showing up?

Andrew: Well actually, the picas in China turned out to be just completely fascinating. First of all, they haven't read any of the scientific papers published in America, because they did everything wrong, which of course really makes things interesting for a scientist. They were very, very social. Normally, rabbit-like animals are not too social, but these picas were grooming each other much like they were monkeys. They were sitting in contact, they have these six different vocalizations, some of which you heard earlier, which make them communicate with each other.

They live in family systems. They have really, really high reproductive rates; normally the rock-dwelling picas have two babies per year, but these meadow-dwelling picas may have 20 babies per year within a family, and they all stay together, and they groom each other. So it has become increasingly fascinating, from the point of view of understanding their behavior, what was going on, and to compare them then to these almost asocial, or relatively unsocial, picas that live in rocks, such as our picas that we have in our mountains of western North America.

But then, and part of the story that we'll talk about today, it became apparent how important this species was on the ecosystem, that they were in fact a keystone species.

Dr. Biology: Very good. Well, let's take a moment now, and let's return to your field site on a Tibetan plateau, and listen to some of the sounds the picas make.

[audio of picas from Andrew's fieldwork]

Dr. Biology: When I heard all the different sounds the pica made, I was surprised, honestly. Is this common for animals of this type, and how many sounds do they make?

Andrew: Well rabbits are noticeably unvocal. Hares, the big jackrabbits that we have in the United States, they don't make any sounds unless maybe they're being eaten by a weasel at the time, and then they screech their heads off. The small cottontail rabbits make almost no sounds. And in fact it is very rare, among the 91 species of animals in the rabbit family, to make any calls at all. But 30 of those species of rabbit-like animals are picas, and they are noticeably vocal. Most of the picas that live in rocks only make two calls. One of the calls is the song given by males during the mating season, they go, "Eh, eh, eh"--something like that. It lasts for about 20 or 30 seconds. The other is a short call to say, "This is my territory, " or when they repeat it, that a predator is coming.

The multitude of calls that I witnessed when I first got to the Tibetan Plateau was amazing, because there were like six different calls, and they were very, very different. There were whines, and trills, and long calls given by the males, the same mating function as in the rock-dwelling picas. There were alarm calls, but they were very different. They were this faint call that you could almost not hear, just enough to warn immediate family members that a predator might be approaching.

The most interesting calls of them all are these whines [imitates whines] and the trills [imitates trills] that the picas make, because normally these are made by juvenile animals, by animals that have just been weaned from their mother, have just appeared onto the

surface of the meadow for the very first time. First there is one litter, and then three weeks later another litter of babies comes up, and three weeks later another litter of babies comes up. And they don't disperse. They stay right on the family territory with the adults, the male and female, their mother and father.

Well these youngsters come up and give these calls, and when they give one of these whines or trills, all the other, older, brothers and sisters--call them siblings--come running over and they mob each other, groom each other, and then they start these little train-like things, where one animal will walk across the meadow and everybody else will follow. Sometimes they will all follow the father, which are real "dads." Normally males are not too paternal and don't do very much with their children in most mammal families, but the picas are very, very social, and so the father is brought to the attention of the new juvenile when they give these calls, and so they are actively communicating with one another in a very dynamic way.

Dr. Biology: I listened to you out on the Tibetan Plateau and you were whispering, obviously not to disturb the picas. Are you using special equipment, and how close do you have to be, or how far away do you have to be, I should say, so that you don't disturb them but you can still get the recordings?

Andrew: Actually, the picas are really interesting. You can just sit on the meadow and be still, and they'll run all around the meadow in crews, and sometimes over your pant leg. But when I'm recording, you do have to be as still and as quiet as possible so that you get as much natural behavior from the animals, because you want to witness them in their world, not in yours. I use very special equipment, a one-meter-long, one-yard-long, Sennheiser directional microphone, so that I can point it right at the animal and really pick up that call specifically.

Now--and normally we have to use things to muffle the wind, which is always blowing up on the plateau and makes things very difficult. Sometimes in my recordings you can still hear the wind whistling by. Or sometimes you can use a parabolic directional piece of plastic behind the microphone to sort of, again, focus on a particular animal, because remember, this is just a big open meadow. We are generally sitting between 11,000 and 14,000 feet in elevation on the meadow. The wind is blowing, and the world goes on, it's just sort of endless in all directions at this very high plateau, and so you have to use special equipment to make sure that you pick up just the call that you want.

Dr. Biology: Right, and when you talk about parabolic, it is basically a giant dish kind of shape, if you can imagine that.

I often ask our guest scientists if they remember the spark that got them interested in biology. Do you remember when and what the spark was for you?

Andrew: I've always loved the natural world. I think I was one year old when my parents first took me camping up in the Sierra Nevada of California. We went back for our family vacation every single year. A highlight of my annual cycle was getting up to the mountains, being out of doors, camping, learning all the birds and the mammals and

things such as that. Certainly it played out when I ultimately became older and more independent, when I could go backpacking through the Sierra Nevada. I just loved the outside, natural world. So that when I went to university, it was pretty clear that I was going to engage in a field of study that would bring me close to my roots and what I was really interested in.

Dr. Biology: I mentioned we would talk a bit more about keystone species, but I thought before you talk about the picas and their role as a keystone species, it might help to know what "keystone" is, and where the word came from. For that we need to travel back in time thousands of years to the Roman civilization, where architects first began using a keystone. Now a keystone is also called a capstone, so those two words can be used interchangeably. They used a keystone when they were building their arches; this was the centermost top stone that was put in the arch, and what it did was it distributed the weight of the arch all the way down through the columns of the walls so it would stay up. The interesting thing about a keystone is it literally was the key stone. If you pulled it out, the arch would completely fall. Now that we know what a keystone is, the question for you, Dr. Andrew, is how does a pica fit this term, as far as a keystone species, and what is a keystone species?

Andrew: OK, the best definition of a keystone species is a species that, if it was lost from an ecosystem, there would be a cascade or a reduced biodiversity. Other species would go extinct; other species that relied on the keystone species would be lost from the ecosystem as well. So to lose a keystone species, much like losing the rock that Dr. Biology was telling you about, the arch falls down. Well in an ecosystem, the ecosystem in part collapses because other species depend upon the keystone species.

So this term has been picked up--keystone--by conservation biologists, because some species really are extremely vital in ecosystems. Up in the high, 14,000-foot meadows of the Tibetan Plateau, where I work, there aren't that many species, because it is so high and the environment is so harsh. But the species I work on, this plateau pica, lives at very high densities, sometimes up to 300 animals per hectare.

Dr. Biology: And what's a hectare?

Andrew: A hectare is, the length of a football field, and make it square, is approximately what a hectare would be. You can fit 300 picas on that. So they are very much an important part, because they are numerically quite dominant in the ecosystem. In this regard they are very similar to prairie dogs in North America, and in fact the plateau pica really occupies the same kind of environment, and is a keystone species much in the same way that the prairie dog is in North America. But in North America, when people have actually poisoned prairie dogs, considering them to be a pest, there are sometimes other species that sort of can fill in; but up on the Tibetan Plateau there really aren't any other species that fill in. The Chinese government considers the picas a pest, and poisons them over huge areas, and when they disappear almost everything else in the environment disappears as well.

First of all, I'll tell you the reason why people consider prairie dogs and picas a pest is because they think that they eat the grass that would otherwise be eaten by livestock--that would be cattle in North America, and up on the Tibetan Plateau it would be yaks and sheep, which are basically grazing animals that the local Tibetan pastoralists herd up in that particular area. They think that poisoning the picas basically will increase the productivity of the grass so that they can have higher densities, higher stocking densities, more yak and more sheep.

They also think that the picas--and even in North America, the prairie dogs--degrade the ecosystem, because they make these burrows and they seem to be very destructive.

But I take a very different point of view by calling the plateau pica a keystone species, because up in this area, at 14,000 feet, there are no trees. So all the birds that evolved up in the Tibetan Plateau didn't evolve to nest in trees, because there weren't any. What was there to protect them? Pica burrows, the burrows that go down into the deep alpine sod soil. The picas make the burrows in which several different species of snow finch, which is found only in the Tibetan Plateau, a really interesting bird related to our jays that we have in North America--it hops along on two feet, it's called Hume's Ground Jay--and nests only in pica burrows. The only native lizard on the Tibetan Plateau only nests in pica burrows.

When you poison the picas and the burrows collapse, there are no holes, and these birds disappear and are gone. So there's one aspect of the pica being a keystone, because the native species of birds and lizards that depend upon them to dig their holes, their burrows, are gone.

Second, the picas are the food resource for almost every bird and mammal that eats meat. We call them "raptors" if they're birds--these are your hawks and your eagles.

Dr. Biology: Birds of prey, right.

Andrew: Birds of prey. There are little owls that are out there, and saker falcons. If you drive across the plateau in the areas that have been poisoned, there are none of these birds. None. You get to an area that hasn't been poisoned yet and there are incredible densities. You can tell by looking at the sky whether an area has been poisoned or not.

But the mammals too, from smaller mammals like weasels to slightly smaller weasel-like animals that are called steppe polecats, to a really shaggy cat-like animal called "palace's cat", which is an endangered species, all the way up to wolves, foxes, and even big brown bears. Big brown bears are the same species as our grizzly bear. A famous Russian explorer named Prisvalsky, over 100 years ago, was doing work on the Tibetan plateau and shot a big brown bear, and opened its stomach to see what it was eating, and it had 53 picas inside.

Dr. Biology: Whoa!

Andrew: So these big bears, that's what they eat. And it is true today, in the areas where there are still picas, and some of the remote areas where the bears have not been shot out, they still are. They are eating the picas. So if you poison the picas, all the carnivores, birds and mammals, disappear.

Dr. Biology: It literally, just like the arch, it collapses.

Andrew: It collapses.

Dr. Biology: The system, all of it collapses.

Andrew: But what's interesting is, there is even more than that. The kinds of plants that make up the alpine meadow are really thick. Actually, to try to dig in them is almost impossible because the mat of roots is so thick. But the picas, burrowing through this and nibbling through the roots as they make their burrows, bring soil up to the surface and recycle nutrients--nitrogen, phosphorus, other kinds of nutrients. So they actually act like fertilizer for the gardens on the surface. So actually, the meadows, we believe, are actually richer in areas where there are picas because of nutrient recycling. The very reason that they kill the picas...

Dr. Biology: Back to the grass.

Andrew: ... which is because they think they hurt the grass, they are probably making the grass better. And the disturbance that they make with their burrows actually means that kinds of wildflowers grow, so that if you actually look at areas where there are picas, and where picas have been poisoned, there are many more species of plants, many more wildflowers and things such as that, in areas where there are picas. They increase the diversity, not just of carnivores, they increase the diversity of different kinds of plant species, and they even may be responsible for the overall health of the meadow. And yet these animals are being poisoned by governmental decree in very much the same way that we poison prairie dogs in North America.

It is very short-sighted, and it is one of the things that conservation biologists try to do, is that we do the science to basically determine these relationships. But then it really goes into the hands of politicians and policy makers to effect the kinds of change that we really need to stop the poisoning campaigns such as this, so that we can basically enhance biodiversity and bring these ecosystems back to their full health.

Dr. Biology: Are there other animals and plants that are considered keystone species? Just a few?

Andrew: I've talked about a couple. I've talked about the prairie dogs. There are other ways in which keystone species might be defined, such as a tiger. You can consider some of the top carnivores keystone species, because if they are lost, the ecosystem below them collapses because maybe the animals that they prey on become too abundant, and they overeat their vegetation and then they starve to death, and ecosystems can sort of go out of whack.

Dr. Biology: The wolves, actually, wasn't it some of the wolves at, was it Yellowstone? Isn't there a big debate on that also?

Andrew: Very much so. Now the wolves have been reintroduced to Yellowstone, where they were probably very important. The coyote populations are half the size they were before, and the coyotes basically--because they ate other things--some of the smaller animals that the coyotes ate, basically are coming back, and as a result of these animals coming back, some of the aspen groves are healthier. Everything is related to everything else. It's one of the key things you learn as an ecologist. And so if you sort of play with Mother Nature and remove species, you will often get these sort of domino effects, and that's really the keystone species concept.

Dr. Biology: It gets into this issue of the food web, which a lot of people learn about while they're in school. It all holds together. It's not simple, it's not a direct line. There is a lot of entwined relationships that become very critical.

In your travels, and your passion for these keystone species, you have come in contact with some pretty influential people. I believe you've met Queen Noor.

Andrew: That's correct.

Dr. Biology: And other people that have common interests in wildlife, and something called the Red List.

Andrew: Right.

Dr. Biology: Can you tell us about the Red List?

Andrew: We must have a currency, a way of talking that is equal among all conservation biologists, so that we know how to prioritize what it is that we want to say. So one of the ways to do that, for endangered species, is to have a clear mechanism for telling us whether a species, from the data that we have available, whether a species is critically endangered--in other words, very, very rare--endangered, or maybe threatened with extinction. Those are the three critical threatened categories that are found in what is the IUCN, or World Conservation Union, Red List. In theory, anyone in the world, given the same data on a particular species, would come up with the same Red List classification for any given species, so that we have a common currency for talking.

We take the Red List extremely seriously. We are continually trying to gather improved data on every species so that we can understand what its Red List status is. For example, right now all the mammals in the world have been assessed using the criteria for the Red List, and 24 percent of all the species of mammals in the world are threatened with extinction.

Dr. Biology: One quarter?

Andrew: One quarter. For birds it's about 12 percent, for reptiles--actually, for amphibians, which have been completely assessed, the percentage is much higher, maybe as high as 50 percent.

We can also, now that we're sort of assessing these things over time, can begin to understand how the Red List categories will change over time for, say, all mammals, or for all birds, so that we can begin to look at assessments to understand how, with the burgeoning human population, but also with our increased attention that we are giving to these species, what's happening--whether we are actually making a difference and how we can basically save these species and preserve the biodiversity on Earth.

Dr. Biology: So did you go through school always thinking you were going to be a conservation biologist?

Andrew: Well actually, I think most of us go through school not thinking at all. But you're developing your own personality, even if you don't know that you are at that particular point in time. Finally, I think it was around my junior or senior year when I was an undergraduate university student that it became really clear that--at that time, because I'm an old guy, people didn't think about their professions very much in advance, and so this was probably much later than a lot of the people listening to this broadcast are going to be thinking about their careers. But anyway, it was maybe between my junior and senior years of university that I realized that being able to do research, and to do fieldwork, and to follow my passions was really fantastic.

And being a professor is, I think, the best job in the world, because you get to do so many different kinds of things, from teaching to research to writing and things, and interacting with people, and going neat places.

Dr. Biology: Very much so. If you were not a biologist what would you be?

Andrew: Oh, I actually toyed, when I was an undergraduate student, at maybe become maybe sort of a biologist, but maybe becoming a National Park Ranger or maybe a naturalist. I always loved the naturalists in Yosemite National Park. There was an incredibly wonderful person named Carl Sharsmith that I think I first met around the campfire when I was one or two years old, and then when I was a graduate student, and he was very old and still driving the same car, which was a classic, from his home in San Jose up to Yosemite National Park.

I found him with a bag of plants, once, just to identify wildflowers for me for my study area where I was working on picas; and he looked at the tallest mountain, which was Mount Conness, a glacier-covered mountain, and he said, "Yes, we've been here a long time, Mount Conness and I." And he identified every plant for me perfectly. Just the fact that he was such a wonderful naturalist, I thought that would have been a fabulous profession, where I would have been able to sort of keep who I was as a person intact, and had a lot of fun and done some good, too.

Dr. Biology: What advice would you have for a young scientist?

Andrew: Well obviously, just follow your heart. There are so many interesting and fabulous things to do in the world that, just don't let anyone push you into anything that you don't want to do. You will excel at any career you have that you are passionate about, and probably the reverse, unless you are really talented and end up in a job that you don't like at all. You might be able to pull that off for a little while, but you'll still never have a full conscience for yourself. Do what you like to do whether, if you love being in the lab and doing molecular biology, or if you love fighting the elements and sitting out in 1600-mile-an-hour winds on the Tibetan Plateau, freezing to death and saying, "Hey, this is cool." It's not for everybody. But you should do what you like to do, that's what I would suggest.

Dr. Biology: I have just one more question. How's your Chinese coming?

Andrew: It's horrible. I'm not a linguist, and all the tones in China just leave me lost, from "ma, " "ma, " "ma, " and "ma"--if I got those four tones right. One is "hemp, " one is "mother, " one is a horse, so I'm always in danger of calling someone's mother either marijuana or a horse. So I can't go there. Some people have much better musical sense than do I, and Chinese is a lot easier to pick up.

Dr. Biology: Well, Andrew Andrew, thank you for visiting with us.

Andrew: Thank you very much.

Dr. Biology: You have been listening to Ask-A-Biologist, and my guest has been Professor Andrew Andrew from the ASU School of Life Sciences. You can read more about Dr. Andrew on the Ask-A-Biologist web site, just click on the Profiles link to see his and other biologists' profiles. The Ask-A-Biologist podcast is produced on the campus of Arizona State University, and even though our program is not broadcast live, you can still send us your questions about biology using our companion web site. The address is AskABiologist.asu.edu, or you can just Google the words "Ask A Biologist." I'm Dr. Biology.