

Science Studio Vol 013 (Guest Dale DeNardo)

Monsters of the Desert

Herpetologist Dale Denardo has been pulling back the veil shrouding the habits and adaptations of one of our Sonoran desert denizens: the Gila monster. Find out what makes the Sonoran unlike any other area in the world and its wildlife perfectly suited to life here - but nowhere else.

Transcript

Peggy Coulombe: Hi. This is Peggy Coulombe, with the School of Life Sciences at Arizona State University, and welcome to Science Studio.

There's a monster in the Sonoran Desert, a reptile found nowhere else in the world. Do you know what it is? Today's guest, Dale DeNardo, will tell us about how and why the Gila monster can only be found in the Sonoran and some things about some other reptiles that live in the Southwest. Dale is an assistant professor in the School of Life Sciences and the ASU veterinarian. Welcome, Dale.

Dale DeNardo: It's good to be here.

Peggy: Tell me first, before we start talking about specifics, let's talk about the Sonoran Desert. What are its geographic boundaries?

Dale: The Sonoran Desert is something that Arizona, at least in the United States, can consider its own. The Sonoran Desert is the lower elevation parts of Arizona and extends down south into Mexico--the western side of Sonora, Mexico, and much of Baja.

Peggy: And what characteristics make the Sonoran Desert unique and, say, distinctly different from the Mojave or other deserts found in the Southwest?

Dale: The Sonoran Desert is indeed different. The two things that it has is a relatively low elevation: so we don't have much freeze at all in the Sonoran Desert--maybe a few days a year. And the other thing is the weather patterns: we have that summer monsoon that comes in the latter half of the year, and the difference is dramatic when you start looking at the animals and plants that exist in this desert.

Peggy: Part of what you study is the interplay between the environment and how creatures have physiologically evolved to meet the constraints of that environment. I understand you don't like to call those constraints stresses. Why is that?

Dale: Yeah. A lot of people like saying, "The desert is a real stressful place to live." Maybe if you just move here from Wisconsin or Alaska, or any human, but for these animals, they've adapted to be here. Yes, it's very challenging. It's hot. There's not a lot of water. There's not a lot of food, because it's dry and hot. But these animals have adapted to be here, and therefore, they've adapted to cope with challenges. And stress is something that you're not expecting; it's dealing with the unknown or the unexpected.

Peggy: Why did the Gila monster capture your interest? Now, for those of you who can't see a picture right now, a Gila monster is about how long?

Dale: Without its tail, it's a little over a foot long.

Peggy: OK. And with its tail? [laughs]

Dale: Tail is another, probably, about the same length of its body, maybe a little shorter.

Peggy: OK. And they have a really bumpy texture, and tend to be black and orange. Is that typical?

Dale: Yeah. Black and orange. Black and salmon pattern.

Peggy: And why did it capture your interest?

Dale: I've always been interested in reptiles, and the Gila monster is the largest lizard in the United States, and it's also one of only two venomous lizards in the world. That alone made it, of course, interesting and curious.

But the big interest is when you start not thinking about what it looks like, but what it does. This animal eats and offspring of other vertebrates, such as small rabbits or quail eggs. And the idea that you can survive in a desert that has very few animals in it, and be specialized on that, is just extremely intriguing to me.

Peggy: What kinds of unique adaptations have you found that the Gila monsters use to meet the challenges of the Sonoran environment?

Dale: Gila monsters use both behavioral and physiological adjustments. Like many animals--they're not unique, necessarily--is that they're nocturnal. They like mainly being out at night, especially during the warmer months.

And also, they tend to use underground refuges. They go hide during the hotter temperatures, underground, which in many ways, is relatively cool. And in fact, they choose special refuges, based on the temperature. They like using woodrat middens, piles of cholla balls, and cactus pads that you see out there--if you're lucky enough to ever step in one, you won't forget that.

Peggy: [laughs]

Dale: But those don't serve as much as a defense as they're serving as insulation and keeping airflow from varying--it actually keeps it much cooler, under those piles, than just underground naturally. So, they use those basic behavioral adjustments.

But they also have some really unique physiological adaptations that we've discovered. One is, when we get hot, we sweat--we just sweat all over our skin and everywhere--but reptiles don't have sweat glands. They can't lose a lot of water across their skin, even though Gila monsters, relative to other lizards, lose more water than most across their skin.

They've evolved to actually lose water across their cloaca, which is the vent where they urinate and defecate through. They're not urinating, but they'll just expose that, like a dog that pants will open its mouth. They're exposing that moist tissue, and actually, they can decrease their body temperature a couple degrees when they're challenged with an extremely high temperature.

The problem with that: it uses water. And again, this place is water limited. So, they've also adapted to use their urinary bladder, which we store urine in, and we hold it until there's one thing to do with that--and that's get rid of it.

Peggy: [laughs]

Dale: But they can actually recycle it. They can pull the water component back out of that urine and actually use it. So basically, they're carrying a large canteen around with them, which allows them to lose water, if they have to, in order to cool.

Peggy: Now, how large is this canteen?

Dale: This canteen, for a Gila monster, can be about two ounces or so--60 mls (milliliters). And they weigh about 300 or so grams, because this can be up to a quarter, 20-30 percent, of their body weight. So, it's a large canteen.

Peggy: In comparison to human beings, that would be like carrying around...

Dale: It's like carrying around, not just a gallon container, but a five-gallon jug, maybe a 10-gallon jug, of water.

Peggy: Every step that you take.

Dale: Pretty much.

Peggy: Since Gila monsters are protected, how do you make the kinds of measurements you need to do?

Dale: That's a good point. We respect what they are; they are restricted in what we can do with them. But also, we want to learn about them; it's the only way we can make sure that they last long-term. We take advantage of what they call nuisance animals--which, it's unbelievable that a Gila monster can be considered a nuisance...

Peggy: [laughs]

Dale: Animals that end up in people's backyard, people's pools. As they develop houses, there's no place for these animals. The Game and Fish gets these, and we get animals from them to establish lab colonies so we can do laboratory experiments.

And, in the field, we do experiments with using radiotelemetry, where we can do measurements and manipulations that have no long-term negative impact on them. But they're volunteering for some good experiments, so we can get a lot of data of what they're doing out there.

Peggy: I understand one of the stranger ways you estimate their body weight is by taking them and sticking their tail in a cylinder filled with water and look at displacement?

Dale: Yeah. It's not estimating their body weight...

Peggy: OK.

Dale: It's estimating their body condition--how good are their energy stores, or how fat? In humans, we have similar things, where they take little calipers and measure the thickness of your skin, because humans have a lot of subcutaneous fat.

But these guys, when they eat a meal or take a drink, they can gain a lot of calories. And it's hard to tell whether they've taken a drink or they have to go to the bathroom or whatever, and it can make a big, dramatic change, without really changing their condition.

Gila monsters store a lot of their energy in their tail. They also store it in their abdomen. And we've shown that, proportionally, if we know the volume of the tail, we can get a good idea of how much energy is stored in that tail. The question is, how do you measure a volume of a tail? You can use math and do all these measurements. Well, mathematics--I'm not bad at it, but I'm a biologist; I try and stay away from some of those calculations.

Peggy: [laughs]

Dale: It's much easier to just fill a cylinder with water, dip the tail in it, and see how much water gets kicked out; and that's how much the tail volume is.

Peggy: And then you can estimate condition versus...

Dale: And that changes across the year, yeah. Early in the year, in spring, the tail's very big. As we go through the drier summer months, and there's no food out there for these guys--or very little food--the tail will get much thinner and much smaller in volume. And then, when the monsoons come, they get more food, and the tail will swell.

Peggy: Now, I understand that Gila monsters can consume a lot of water in one sitting, and that's one way that they refresh their canteen during the monsoons.

Dale: Yeah. People who get dehydrated, or get lost in the desert or in the mountains, when they're found, the last thing you want to do is give them a big jug of water and have them guzzle that water, or else it's going to come right back at you. So, you have to give them very slow water. A lot of times, you'll give them a piece of fruit or something.

But Gila monsters have the ability, they can be dehydrated down to about 15% body mass--which would pretty much almost kill a person--and you can put them in front of a bowl of water, they'll stick their head in and they'll drink all the way back to full hydration, so they can consume, they can fill their entire body; and I think we have measurements of 60, 80 mls in a single drink, which again, when you only weigh 300 grams, that's like taking a couple of gallons for us of water.

Peggy: That's a lot of fluid. So, not only can they take a lot of fluid, they can reabsorb it into their system quickly, whereas I think in human beings, it takes, what, 24 hours to re-establish your water balance? Something like that?

Dale: The trick with humans is that you can take it in, but you tend to, the reason why you don't guzzle water, drink a lot of water, as humans, is you have to worry about overcompensating and diluting your blood too much. The Gila monsters tend to change it much quicker.

Again, though, we don't see full compensation --even though they drink all at once -- we don't see it for about a day. So, there is a slower correction of it, but again, it is much quicker in their ability to deal with these challenges.

Peggy: So, what other reptiles do you study?

Dale: Well, we're also interested in rattlesnakes, as well as pythons.

Peggy: And what made you go to snakes? I mean, I understand that you've got a thing for reptiles.

Dale: Yeah. The one thing in common between the rattlesnakes and the Gila monster is that they're venomous; but in reality that's the last thing of interest for me. I don't study the venom, I'd rather they not be venomous just for the simplicity of worrying about injury to myself and my staff. But what's interesting is, similar to the Gila monsters, they have these challenges.

They have to deal with, again, low energy availability out there, and that's really interesting. But they take a different approach. Gila monsters have to look for nests of other animals, so they're always on the move, always looking. Rattlesnakes take the other approach.

Since they eat mostly rodents, they can sit, wait, and wait for a rodent to walk in front of them. And they'll wait, they'll basically stay at the same bush, going below ground during the heat of day and coming up, for weeks at a time, and they'll eat maybe two, three times a year.

Peggy: And how do they deal with things like heat stress?

Dale: There it is! I mean, the same type of approach. They go underground. They tend to be nocturnal, and they will come up during the peak activities, and in the summer, even if they are not out foraging or even ambushing prey, they will still tend to spend their night above ground, because the air is going to cool much faster in the ground, so actually being on the surface is actually a cooler environment to be in.

So, they're going to deal with it mainly shuttling, again. We haven't documented any source of, really, water conservation or water storage, but rattlesnakes don't have a bladder, so they don't even have that option of potentially storing it there.

Peggy: Wow! I had no idea.

Dale: The things you learn.

Peggy: Do other things not have bladders?

Dale: Yeah, there are a variety of animals that don't have bladders. Most of them do, because you do need to store; but snakes, it's not that they can't store anyways--they will store it in their, actually, large intestine, a lot of it.

Peggy: What is it about the study of reptiles that drew you to them?

Dale: As a kid I was, for some reason, one of those kids that was very fascinated with reptiles. Most kids grow out of it, and I think my parents were hoping I would; but as I learned more about them, it was no longer that, "Ooh, those are cool or interesting," it was that I noticed they were doing interesting things, and as I did that just made more questions, and as I addressed those questions I just got more and more excited about it, and realized that studying reptiles is not just to learn about reptiles.

By studying reptiles we can learn about animals as a whole, vertebrates as a whole, and it's nice because we've done things like supplemental water, giving animals in the wild some extra food or extra water; and if you do that with a bird or a small mammal, you'd be out there every day throwing seeds to it or giving water to it.

With our lizards, with the Gila monsters, we can go out and give it water once a month and have a significant impact on how that animal's behavior and his physiology. Rattlesnakes, a meal a month will have a dramatic impact on its body mass, its activity, and also how often it reproduces. So it allows you to do a lot more. It extends your ability to interact with these animals.

Peggy: And they're fantastic models.

Dale: They are fantastic models, they really are, and I think there's a greater appreciation for that.

Peggy: Now, you call your lab "Team DeNardo," and I've talked with some of your students who tell me what a great mentor you are. Where did you learn to be this kind of teacher, and did you have early role models?

Dale: I have a lot of role models, but I think my approach is sort of a potpourri of my experiences. Doing research is very time consuming, it is very detailed work, and therefore there is a tendency there, also, to get frustrated, especially for students who are just starting out and haven't really learned that this happens and you just have to deal with it and keep moving forward.

So, I think it's very important that you get people committed, understanding that it is the number one priority, but also making sure it's fun and enjoyable. There is just too much time and effort being put in to not have fun.

The best thing about my career is I get to do what I think is the most enjoyable thing in the world and make a career out of it. So, my role, I see, is to be there for my students, help them learn, help them deal with the problem situations, and increasingly watch them progress. That's, although I really enjoy my research, I think it's exciting what we discover, my biggest contribution is going to be what my students discover over the next several decades, and not what I discover.

Peggy: I know that going out into the community and doing outreach, and talking about reptiles like pythons and boas and rattlesnakes and Gila monsters is something important to you. In fact, I know you were even requested to come and talk to the NFL owners and their families when they gathered in Phoenix to discuss the Super Bowl. What would you like people to understand about reptiles, particularly those found in the Sonoran Desert?

Dale: Well, a couple of things. First, I want, anytime I give talks or presentations I stress the research side, that this information, that people--a lot of people, even, who watch documentaries on TV, the Discovery Channel--lots of them don't appreciate that someone is out there getting this information.

Some animal didn't walk up and decide to give its life story. It takes a lot of work to get this information, even if it's presented as just the story of some animal and really doesn't show the science. So, I think it's very important to push the science, and I think researchers don't do a good job of that. I think we really are inept, in many ways, of really showing the value of research and what it means, not just medical research but all research.

And in terms of the Sonoran Desert and the animals, this place is unique, these animals have been here, and I think in many ways we have to look at ourselves as stewards of the environment and not necessarily look at, what do we get for it, what's in it for us?

Sometimes we get things that are of great value, and that's a bonus, that's just a plus; but we have a responsibility, I think, to our environment, to try and share this planet, and the more we share it with the other animals, the more, in the long term, we're actually going to be sharing it with our future generations.

Peggy: How do you think development and urbanization in the Sonoran desert may affect Gila monsters and other animals?

Dale: Well, it's sort of two possible outcomes.

The first one is, if it just means clearing the habitat and building a bunch of tract homes on it, or football fields or agricultural fields, clearly we lose what's there. The big question is: what happens when we sort of have these low-density modifications or slight adjustments to the environment, and how does that affect them?

That's one of our questions we're starting to get into now. We're interested in what's happening at some of these large scale golf courses. I can't afford to actually golf at any of these golf courses, but I can afford to go out there and trap animals there, they'll let me do that.

Peggy: And tell me a little bit more about golf courses. I think some of your findings suggest that they are actually good for a lot of the wildlife.

Dale: Yeah, there are both pros and cons there. You just can't guess what the benefits are going to be, and what the overall outcome is going to be, and how it is going to affect different species. Obviously there is habitat destruction, there is loss of corridors, there is human influence, there are feral animals, dogs, cats, people with shovels, that are going to limit the success of animals.

But the one thing that these golf courses--and we're talking the ones that still preserve a lot of natural habitat, not the ones in the middle of the town that are just greens and fairways--but those, they eliminate some of these major constraints. Remember, we talked about it being very hot, and little water, and only a little bit of food? Well, golf courses tend to be green, you don't draw a lot of golfers if it's a brown course.

So, by watering these courses, you are eliminating that water constraint, which also means that not only the animal has access to the water, that you're focused on, but the plants and all other animals have it.

So, for a Gila monster, not only does it have water to drink, which we have shown giving it water, specifically benefits it. But also, its prey species have more food, because the plants are always blooming, and we see activity differences. We see density differences in these animals.

Peggy: How often, if you were out walking in the desert, would you be likely to see a Gila monster?

Dale: During the spring--during March, and April. In March they'll be out during the day, and April it's sort of first thing in the morning, and then it shifts to right around sunset. By right now, we're over 100 degrees everyday, they're pretty much limited to only being out at night. The same is true with a lot of rattlesnake patterns.

There are people who are herpetologists looking for Gila monsters who have spent years, and have failed finding one of these animals. So, we do a little better, because we have little radio transmitters beeping. So, these animals are like shocked at how well we are at finding them, because they've never seen a human probably for 10 years, and all of a sudden they see a human every week. It's like--I think they just get really impressed, because they have no idea that they're sending out some signal.

Peggy: [laughs]

Dale: But if you come across one, and you're just walking, or hiking--realize that is a privilege--that is a real special event. Stop, enjoy it, appreciate that this animal's there, and it's not something that many people see.

Peggy: What can people do to protect Gila monsters? I mean, people may not realize for example that relocating a Gila monster more than a 1,000 meters from its home range will probably kill it, or that moving it less than 1,000 meters will just make it come back.

Dale: Yeah, and that's been shown. Brian Sullivan at ASU West has studied looking at that, and it's sort of the result that Game & Fish, and people didn't want to find. People have this nice thing, "Oh, we get this animal out of someone's yard. We move it to this pristine desert, let it go." Then you hear the little music in your head, they lived happily ever after.

When in reality Brian showed that it slowly died a miserable death probably, since it doesn't know where the food resources are, it doesn't know where the refuges are. Therefore it just searches aimlessly trying to find its way back, but it's too far to use any of its homing mechanisms.

So, the key thing is "learn to share." There are no documented evidence from Gila monster bites. In fact, there's only a couple possible questionable, actually accidental bites from Gila monsters. Most people who get bit by a Gila Monster are bitten on the hand.

Gila Monsters can't jump, they're on the ground. So, if you're bitten by a hand, you're bending over trying to pick it up.

Peggy: [laughs]

Dale: Therefore it's your own fault, and don't blame the Gila monster. So, the key is, share it. If it's in your yard, it's going to go, it's going to walk off. It's not going to do anything, it's just again--appreciate that opportunity to see it. If you see it hiking, again watch it, it's not going to come racing at you. It's going to do the exact opposite, it's going to go away. Try not to scare it, you'll get to enjoy it longer.

Then the other thing, the most important thing you can do, is respect the desert. If you leave the desert intact, the animals know how to survive in that desert. If you litter the desert, if we throw toxins on this desert, or if we destroy it and knock it down--it doesn't matter what we do for the animals, how much work we do to learn what these animals need, if we destroy the resources they don't have a chance.

Peggy: Now, switching gears, and sort of looking at a larger issue, like global warming--how do you think global warming could affect the Southwest?

Dale: Well, believe it or not, global warming suggests we're going to get a little warmer here. But, that's not going to be the challenge. I don't think getting warmer for these species is going to be a problem, because these species have adapted to get very hot, and they avoid the hot times of the day.

What the problem is going to be, is probably the changes in weather patterns. Sonoran Desert again, remember, it's special because we have that summer rain. How global warming, which their models predict different things, but if global warming changes either the amount of rain we get, or the timing of it, we could see animals drastically affected.

Gila monsters have this bladder to store water, and that bladder allows them to survive about three months without water resources. Well, that's about the length of our dry summer. That's why Gila monsters live in the Sonoran Desert, and not in the Mojave. Mojave is dry the whole summer, typically Gila monsters can't survive five to six months of no water.

So, even if the water totals the same, if we extend the onset of the rainy season this could lead to death. Not necessarily death to these adults at first, but the offspring, because they're smaller, they have smaller reserves. If there are no offspring surviving, eventually the species is going to die out.

Peggy: Why should we be concerned about diversity, and protecting things like the Gila monster?

Dale: If we lost every animal in the Sonoran Desert, would mankind be affected in terms of ability to survive? Probably not. But again, do we want to serve as stewards in this environment? Do we want to protect these animals? Do we want to provide something to our children, or children's children to see and appreciate what the world is vs. making it a big concrete block, or a concrete bubble?

So, I think a lot of it is just to like anything else, try and share this. Not only with neighbors, other people around, but also future generations.

Peggy: We mentioned that the Gila monster is venomous, and one of only two lizards in the world in fact to be so. But, strangely enough there's something in it's saliva that's greatly improving some people's lives. Can you tell me something about this, and why would the Gila monster need it?

Dale: Yeah, occasionally we do get these bonuses--these are bonuses too. I mean, it's like everyone says, "Why do study, or how is this going...? What's the medical benefit of doing that?" My opinion is, there doesn't have to be a medical benefit. But, in reality we often stumble across these things.

The Gila monster venom actually has a protein in it called, "Exendin-4," currently on the market as "Byetta." This protein is actually currently being used to treat diabetes--Type two Diabetes. It seems to be better than insulin treatments for people. It tends to lower blood glucose when it's highly elevated.

But when it's normal, you don't get these crashes, and these problems where diabetics--where they get hypoglycemic due to having insulin, and not having a constant sugar intake. So, this is really working. It's working very successfully. It's very popular, and this is from a protein in Gila monster spit, basically.

Peggy: [laughs]

Dale: So, are question was, "Well, why do Gila monsters have this?"

Peggy: Sure.

Dale: So, we talked to the company, Amylin, who actually produces the drug. Sort of talked to them and said, "Wouldn't it be nice to know what it does in the Gila Monster? It might give us some insight of what else it might do beneficial for humans, or potentially some side effects that might occur." They've been very supportive, and they basically provide us with not only the synthetic protein, but also antibodies to it, and assaying for that, so they've done a lot for us.

The good news is, we've been able to conduct several studies on this. The bad news is, we still don't know what the big benefit to the Gila monster is. Because when they eat a meal, this protein in their bloodstream goes up dramatically suggesting that, "Wow, this could be just like humans." We have high blood glucose after we eat, if we take Byetta it's going to lower that, it's just this perfect story.

We went to look at it. One, there blood glucose doesn't go very high when they eat. Two, whether they have the protein or not, it doesn't have an impact on how high it goes. So, we've look at several different things, and we're still wondering about it. To have a protein that just lowers your blood sugar from high to normal, doesn't sound like it's going to help you eat an egg.

Peggy: Yeah.

Dale: You don't have to subdue an egg, and wrestle an egg to the ground...

Peggy: [laughs]

Dale: ... and even a baby mouse, or rabbit they're pretty much helpless. So, it doesn't seem to be a need to apprehend prey. Defense, again if a diabetic human is out there, and you get bit by a Gila monster, it's not going to protect the Gila monster. So, we can't even envision the benefit as a defense protein like a venom. But, we also haven't figured out what it might be doing for the Gila monster. So, it's still an "unknown."

Peggy: So, yet another mystery remains about the Gila monster.

Dale: Oh, yeah--still more work.

Peggy: Well, Dale, I want to thank you so much for joining us today, and giving us a window into the life of one of our Sonoran Desert's mysterious denizens.

Dale: Well, thank you for having me. I hope we've increased the knowledge of people out there, and move on, and learn more, and build appreciation.

Peggy: And listener, I guess I take home a message today is, that we're blessed to be living in a unique environment--the Sonoran Desert. That it's up to us as we move forward, and develop our landscapes and communities, to consider how best to protect, and preserve the wildlife and plant life that makes it so special.

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