“The Star-Nosed Mole Takes Adaptation To The Extreme” Excerpt Transcript

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IRA FLATOW: This is science Friday. I'm Ira Flatow. You can say that my next guest is an expert in extreme animal behavior. He's researched the snap of a crocodile's jaw, he has studied the voltage discharge of electric eels, he even knows about something called worm grunting. But among his favorite research subjects, the star-nosed mole takes the prize for most extreme adaptations. It's eponymous nose, like a fleshy pink starfish sticking out of its head. You have to look at this to see it. And it's the most sensitive organ of any mammal ever, and studying them has given us a peek into the way the human nervous system is mapped in the brain.

Ken Catania is Stevenson Professor of Biological Sciences at Vanderbilt University. Welcome back to Science Friday, Ken.

KEN CATANIA: Hi, it's great to be here again.

FLATOW: This is one of the more odd-looking creatures. Describe to our listeners what they look like.

CATANIA: Sure. So this is about a mouse-sized little mammal, so it's not all that big, but the front of its face has these 22 appendages on it, so that gives it this really bizarre look. And since it's a mole, it's also got these big clawed forelimbs. So those two things put together really give it a bizarre appearance.

FLATOW: But a lot of moles have tiny eyes. They rely on touch. How did the star-nosed mole come to have this specific adaptation?

CATANIA: Yeah, that's a really interesting story, and it has two sides to it. One would be how did this thing evolve, and the other is why did this thing evolve. The how did it evolve is really interesting, because it looks like the evolutionary sequence is played out in the development. So if you look at the embryos, they are amazing-looking morphology, where the star unfolds off the face almost like a sort of a flower petal coming off the sides. And that suggests, and we have other evidence for this, that this thing evolved from sensory strips on the side of the face rather than growing out as straight appendages.

The how it evolved is, in the wetlands, there are a huge resource of little soft-bodied things that this animal can eat, and in order to do that, because these things are small, it has to have high sensitivity, high acuity, and be really, really fast.

FLATOW: We know that its nose, as I said before, is the most sensitive organ of any mammal. Give us an idea of how sensitive it is.

CATANIA: Well, that's interesting, because we actually have not been able to measure the lower threshold for force that will cause activation of these nerve endings, so they are extremely sensitive. There's a couple of ways you can think of sensitivity. One is compression that would cause a nerve to fire. Another way is to look at the receptive field size, and they have microscopic receptive fields. And receptive field is basically what's the size of the skin region that one nerve will respond to. So that's sort of like the pixels in a camera. It's an incredibly high-resolution touch organ, so it gives them a great picture of what's going on in their world.

FLATOW: How much resolution is it? Can you give us an idea?

CATANIA: Well, there's 25,000 of these little tiny touch domes on the star, and there are 100,000 nerve fibers that are supplying these things. So to give you a good comparison, a human hand, which we know is a very sensitive thing, has about 17,000 touch fibers. And the star is only the size of your fingertips. So imagine five times the acuity and sensitivity of your hand compressed to the size of one fingertip.

FLATOW: Wow, wow. So it's like your retina? Close to that kind of sensitivity?

CATANIA: Yeah, I think that's--

FLATOW: So it's like a retina at the front of its face.

CATANIA: Absolutely, I think that's a great analogy. The star is just completely made of sensory organs stuck out there on the nose. I use the word amazing probably too much when I talk about this animal.

FLATOW: When you look at the animal, there's nothing short of amazing about it. And then the other thing they use these special noses for is they can smell underwater. Isn't that unique, too?

CATANIA: Yeah. It's just one surprise after another with this animal. So we filmed them underwater, thinking maybe they wouldn't be as-- because they dive, they live in wetlands. And so we thought maybe this would be sort of less efficient underwater. Well, it was completely the opposite. We discovered that they're actually sniffing by pushing out air bubbles onto things, and re-inhaling these air bubbles as a way to collect odorants, as a sort of a workaround to use olfaction underwater, which nobody had believed was possible for a mammal, so really interesting discovery.

FLATOW: What other things would you like to know? I mean, you're looking at it because I'm sure the nerve fibers are interesting to you, and how the brain works, right?

CATANIA: Yeah. So the brain is a really interesting area in this species, because one of the big goals of looking at how brains are organized is to look at how these sensory maps are laid out. And usually that's a pretty difficult thing to determine, even though we have a lot of technology to do this now these days.

In star-nosed moles you can actually see a star in the neocortex. So where the star information projects into the neocortical layers, there's a star pattern there. And as soon as we saw that, we realized there's one part of the star pattern that's disproportionately large. And that turned out to be a touch fovea. So they use the star the way we use our eyes, moving around this little sensitive area for high resolution and scanning with the other parts of the star. It's very analogous to a visual system in that behavior, so kind of a unique animal in that sense as well.

FLATOW: Are you always-- do you think there's stuff yet to be discovered underground?

CATANIA: There's always something new to discover. And I have to say, I can never predict what it's going to be. I usually discover something completely unexpected, in whether it's a star-nosed mole, an electric eel, worm grunting, and so forth.

FLATOW: There's more to come. Can't wait. Ken Catania is Stevenson Professor of Biological Sciences at Vanderbilt University. If you see a guy on the ground looking for stuff, that will be him. Thank you, Ken.

CATANIA: Thanks so much.