"SCIENCE IN PARADISE -- SPECIAL FROM THE CARIBBEAN" -

SHOW 901

EPISODE OPEN

ALAN ALDA: It's not all fun and games down here, you know. There's some serious stuff going on. On this edition of Scientific American Frontiers, we're cruising the Caribbean.

ALAN ALDA: (Narration) First stop -- Buck Island, where the turtles are coming home. Then Montserrat -- living with a live volcano. At Arecibo, we'll listen for extraterrestrials and watch for deadly asteroids. And on St. John we'll work out what's wrong with the coral.

ALAN ALDA: Ha, ha, ha. I love it. Science! I'm

ALAN ALDA:, join me now as we explore Science in Paradise.

ALAN ALDA: We all know about the Caribbean. It's that sleepy backwater with palm trees, blue ocean and gorgeous beaches. Good for lazy vacations. But dig a little deeper, and your ideas about this place may change. For science, the Caribbean is nothing like a backwater. Here in the Virgin Islands, for example, biologists have just made a major breakthrough in understanding the diseases that are threatening coral worldwide. Over in Puerto Rico we'll be visiting the largest radio telescope in the world. It's one of the most important tools astronomers have for exploring the universe. For geologists, the erupting volcano on the island of Montserrat is the place to be -- and that's where our cameras will

be, too. And when we head down to Trinidad, we'll meet scientists who are learning the secrets of the steel drum. Just about everywhere you look in the Caribbean there's science going on. Right under my feet is a turtle-nesting beach. Here in St. Croix is one of the world's longest-running turtle conservation efforts. And it has recently turned out to be one of the world's greatest conservation success stories...

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TURTLE TRAVELS

ALAN ALDA: (Narration) We're heading for Buck Island, just off St. Croix.

ALAN ALDA: How big is Buck Island?

SKIPPER: It's a little over a mile long.

ALAN ALDA: (Narration) Like many Caribbean islands, this one's ringed with coral reefs -- always good to avoid if you're a human in a boat... But if you're a turtle they're great places to hang out. Now we're inside the reef, on our way to meet

ZANDY HILLIS: and her team. They're out here most days, hanging out with the turtles.

ZANDY HILLIS: Morning, Alan.

ALAN ALDA: Morning.

ZANDY HILLIS: How you doing?

ALAN ALDA: Great. What's the best way to get in?

ZANDY HILLIS: The best way to get in here is carefully. CREW MEMBER: Make your move.

ZANDY HILLIS: There you go. Well done, well done.

ALAN ALDA: (Narration) The team works with hawksbill turtles. They've been so ruthlessly hunted for their valuable "tortoiseshell" that they're now endangered. There are only a few thousand breeding females left in the entire Caribbean. Pressures have built steadily on all sea turtles. The development of nesting beaches, increased hunting and losses in fishing nets have all taken their toll. Yet Columbus observed you couldn't sail here without hitting a turtle. You can get an idea of how abundant they were from this historic film of ridley turtles on their nesting beach in Mexico, taken in the 1940s. Turtles are now protected here... As they are in American waters. Here at Buck Island, it's biologists like Zandy and her Park Service team who are in the front line of protection. Many aspects of turtles' lives are still a mystery. Young hawksbills, for example, just appear on the reefs at about age five. Zandy uses a spectacular free-diving technique to catch a ten-year-old male. He seems a lot less excited than I am. We'll take him back to the boat for a checkup.

ZANDY HILLIS: Push, Alan, push. There we go. Alright.

ALAN ALDA: Is he OK?

ZANDY HILLIS: Oh yeah.

ALAN ALDA: I did that with a leak in my mask the whole time.

ALAN ALDA: (Narration) He looks a little like a bird of prey - and so the name hawksbill.

ZANDY HILLIS: There are not too many places in the world where people do free diving captures on sea turtles.

ALAN ALDA: Yeah, I bet.

ZANDY HILLIS: In Australia they jump off fast moving boats and catch them.

ALAN ALDA: I'm so glad we're not in Australia. Because that's what they would have me do.

ZANDY HILLIS: Most likely. It's called a rodeo.

ALAN ALDA: These guys. Not the Australians. These... I bring them with me. They make me jump off of things.

ALAN ALDA: (Narration) Number six thirty five is an old friend.

ZANDY HILLIS: The animal was first caught in September of '94, and the next time we caught it was April of '95. We caught it again in July of 96.

ALAN ALDA: (Narration) Now the part he doesn't like. But within a few seconds, Brendalee Phillips puts him into a deep, relaxed trance.

ALAN ALDA: How did you figure out how to do that?

BRENDALEE PHILLIPS: Well I've done some work with alligators, and it's known that alligators can be put in this somewhat hypnotic trance by rubbing down the seam of their stomachs. And so I thought I would try it with the sea turtles, since they're also reptiles. Seems to work, little bit anyway.

ZANDY HILLIS: 1... 2... 3...

ALAN ALDA: (Narration) The young turtle's about 70 pounds right now, but he'll be twice that when he's mature, at about twenty years old.

ZANDY HILLIS: Alan if you grab that right flipper there. Brendalee's gonna take the blood.

ALAN ALDA: (Narration) By analyzing blood samples, the team has discovered that young turtles here are related to adults found all over the Caribbean. So turtles use the entire region as their backyard. It's an important conclusion, and it makes conservation more of a challenge.

ZANDY HILLIS: See if I can pick this guy up myself, and Alan if you'll just sort of actually put your hand up on the shoulder there. Put your left hand up on the shoulder. Woohoo, ready to go. Now we're going to try and very carefully lift him over. Here we go. Woohoo, oh man, he's got a little bit of air on board. OK.

ALAN ALDA: I thought he'd zip off, but he sort of lingered.

ZANDY HILLIS: He was a little bit full of air, he had to sort of...

ALAN ALDA: He was full of air?

ZANDY HILLIS: He had to burp!

ALAN ALDA: The first thing he does is burp?

ZANDY HILLIS: Well he was on the boat for a good period of time, so he was really sucking in air, and so all of a sudden here he was back in the sea again and you know like a submarine he had blow ballast before he could go down.

ALAN ALDA: (Narration) When he's mature this guy will simply leave the reef, maybe never to be seen again. But mature females will show up on one of the region's remaining nesting beaches.

ZANDY HILLIS: A lot of foot traffic today.

ALAN ALDA: (Narration) Lucky ones come to Buck Island, where their tracks will be picked up by one of Zandy's beach patrols.

ZANDY HILLIS: Think we've got something on the beach. It looks like she's behind that little manchineel tree. Let's go look. There we go, how are we doing? It's PPB 179.

ALAN ALDA: (Narration) They've been expecting her. She was here two seasons ago, in the very same week.

ZANDY HILLIS: This turtle I think is on her second nest of the season. The average is 140 per clutch. Right now hers is about filling to the top and might be coming over.

ALAN ALDA: (Narration) She'll make three nests on three nights, and then she'll disappear for another two years.

ZANDY HILLIS: She's compacting the sand on top of the clutch of eggs, making a nice firm cap, keeping the eggs and the air trapped around the eggs. And she's using both her flippers -- just like our hands, she has five bones in her hind flipper -- and pushing the sand down using both the flipper and her knees.

ALAN ALDA: (Narration) A total of just 105 females nest on Buck Island, one of only 3 hawksbill concentrations in the Caribbean that we know about. Every nest is precious, and Zandy is worried about tonight's.

ZANDY HILLIS: It's too close to the sea. And we always have the potential for a hurricane any time during the latter part of the summer. And at this point at this exposure on Buck Island we will get storm surge washing right in over this area.

ALAN ALDA: (Narration) This was hurricane Hugo, in 1989. It cut a swath of devastation from the Virgin Islands to South Carolina. Buck Island was hit hard, losing most of the mature trees along the beach. So last night's nest is doubly vulnerable -- it could be washed out by a storm, and without shade trees it could overheat.

ZANDY HILLIS: OK Brendalee, let's see if we can find this nest again.

ALAN ALDA: (Narration) The following night, Zandy and Brendalee return to start the job over. With a healthy turtle population, losing a few nests wouldn't matter. But now every animal, every nest, every egg counts.

ZANDY HILLIS: We'll pick a spot further up the beach and reconstruct the nest as exact to the measurements that we found in this nest right here. And pray that we've picked better than the turtle. Watch your step.

ALAN ALDA: (Narration) They set about meticulously reconstructing the nest. It's essential to get the temperature in the nest right. As with all reptiles, the eventual mix of male and female hatchlings depends on it. This thermometer will keep a record of nest temperature.

ZANDY HILLIS: If the temperature is warmer then they'll be predominantly female. If it's cooler predominantly male. His legs are awfully long. We're going to have to find a good spot to push him way down.

ALAN ALDA: (Narration) Here's their latest nesting aid. A simple replacement for the missing shade trees. All goes well in the nest. About 60 days later, the hatchlings emerge and head for the water. They'll disappear for about 5 years, then hang out on a reef for maybe 15 years, and only then will the females return to this very beach to nest. So you have to wait at least 20 years for results. And that's how long the program's been running.

ALAN ALDA: Since you've been doing this project, are there more turtles now than there were before?

ZANDY HILLIS: In the last 2 year we've seen the numbers of new nesters from 2 to 3, jump up to 10 and 15. And what that may be indicating to me knowing that it takes about 20 to 25 years for a hawksbill turtle to mature, to get to the breeding size, that by protecting the nesting beach on Buck Island, maybe we're actually seeing young from Buck Island, that have matured, are coming back here to nest.

ALAN ALDA: (Narration) That in itself is a terrific success. But the team's going further.

ZANDY HILLIS: You going over me, guys?

ALAN ALDA: (Narration) This female is ready to leave the nesting beach. But before she goes, there'll be a short delay.

ZANDY HILLIS: Ready... down... Oh, they are strong when they get going.

ALAN ALDA: (Narration) A dab of epoxy will secure a transmitter that can be tracked by satellite. The aim is to study where adult hawksbills hang out, during their 100-year lifetimes. In the past Buck Island animals have been found in Cuba, Nicaragua and Belize. This particular female settled 150 miles away, near St. Maarten. So turtles from all over the region use Buck Island.

ALAN ALDA: They left here and they went to places like Belize. What does that mean to you as a turtle person? What do you learn from that?

ZANDY HILLIS: What we're learning is that our management area for these animals is not something that we can say, if we're conserving and protecting sea turtles here at Buck Island while they're nesting, our responsibilities are not over. We have to co-manage these with other island nations, other nations in general. Sea turtle conservation is really resting on cooperation from multiple, multiple nations.

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PARADISE POSTPONED

ALAN ALDA: (Narration) Like many Caribbean islands, Montserrat was formed millions of years ago by a volcano. This fiery origin never much bothered the residents. Then in 1995… After lying dormant for nearly 400 years, Montserrat's volcano burst into life. This type of volcano doesn't produce much red-hot lava, but something much deadlier -- a mixture of ash, rock and gas called "pyroclastic flow", traveling over a hundred miles an hour with temperatures over a thousand degrees. Dozens of eruptions over the next 2 years devastated nearly all the major towns on this island paradise. Intense heat from the pyroclastic flows had literally melted steel frames of buildings. Most residents and vacationers abandoned the island. But about 3000 people decided to hang on, like taxi driver Willy Morson.

WILLY MORSON: I don't want to leave Montserrat. I prefer to stay here, I prefer to die here. This is anything, everything and anything that I have I own it here in Montserrat and I decide to just weather it out. If I die, I die, but y'know with God's

grace I know that Montserrat is going to bounce back and when it bounce back some of us will be very happy.

ALAN ALDA: (Narration) The northern third of Montserrat is far enough away from the volcano to be relatively safe, so all the "stay behinds" have moved here to rebuild and get on with life. They talk about returning to the evacuated area -- locally known as the "exclusion zone". And they constantly listen to the radio for encouragement and hopeful news.

RADIO ANNOUNCER: At this time we bring to you this morning's volcano report from the Montserrat Volcano Observatory. Overnight the volcano has been relatively quiet with a few rockfall signals being the only seismic activity. It can be assumed that the dome is continuing to grow in the crater formed by the Boxing Day collapse.

ALAN ALDA: (Narration) Early on Boxing Day -- the day after Christmas, 1997 -- Montserrat's volcano erupted with unusual fury. The event was closely followed 8 miles away at the Montserrat Volcano Observatory, where scientists from around the world try to predict new eruptions. They watch for ground tremors picked up by seismic stations buried all around the volcano. Usually tremors mean there's an eruption coming -- but not always.

RICH LUCKETT: This station is right on the very edge of the exclusion zone. And they're actually digging a landfill site so that is a bulldozer, which is digging right near the station.

ALAN ALDA: (Narration) On Boxing Day all the seismic stations were picking up tremors. These lasted for hours, and then…

RICH LUCKETT: What actually happened was a big pyroclastic flow at 3 o'clock in the morning the day after Christmas, which is actually the biggest we've seen so far.

ALAN ALDA: (Narration) It's now a few days after that eruption and scientists Simon Young and Barry Voigt are heading out to survey the damage for the first time. Near the top of the volcano, the ground is still smoldering. And you can see where the rock and ash flowed into the ocean down below. Our crew was only allowed to come on this mission if we stayed near the helicopter at all times. So we attached miniature cameras to Barry and Simon's helmets to follow the action. Their first task is to collect rocks, which were blown out of the volcano and went for miles. The rock barrage was devastating.

BARRY VOIGT: Anything which stood above the ground here got knocked over. Some of the things like the trees that got bent over pretty low managed to

survive. But the houses which were standing in this location beforehand are now out in the Caribbean sea.

ALAN ALDA: (Narration) Because the volcano could erupt again without warning, the helicopter is left running, ready for a quick getaway. Barry and Simon work quickly. Their trench reveals three layers of ash, indicating the eruption occurred in three waves. The first wave was traveling almost 200 miles an hour, they calculate.

BARRY VOIGT: There was a seismometer operating here. And we know what time the explosion started at the top. And we know what time the seismometer got killed at this location. So we haven't been back to visit it but we now want to see just what kind of damage has occurred - whether just the antenna got knocked over or whatever. But in any case, this is important information from the point of view of determining velocity of the flowage.

ALAN ALDA: (Narration) The rock barrage that wiped out the houses completely obliterated the seismometer. This is a piece of someone's fence. But the speed of the flow was a blessing in some other ways.

SIMON YOUNG: You can see right next to this completely devastated charred branch here of a small tree some green shoots already coming through this deposit. What that indicates is this thing firstly is quite thin. But also it suggests that all the heat was very quick and it didn't really penetrate very far down into the earth. So it didn't kill off all the little seedlings resting in the soil. So that fairly soon after they get water again they can start to grow again.

ALAN ALDA: (Narration) After an hour, Barry and Simon have collected dozens of rock and ash samples to be sent off the island for analysis. As part of the Observatory's routine, Rick Heard and Lucy Ritchie keep a constant watch on the volcano's rate of growth. It's one of the best predictors of when it will erupt again. They head out for a point with a good view of the volcano's top -- and that means crossing into territory that's strictly off limits to the public.

RICK HEARD: We're just going to the old observatory site.

GUARD: Okay, no problem.

ALAN ALDA: (Narration) This area hasn't been hit yet by the volcano, but it's dangerously close. As always, Rick backs into the driveway -- just in case. Before the area was evacuated, this was the Montserrat Volcano Observatory. And before the first eruption, it was a luxurious vacation home. Once a week, Rick and Lucy come here to try to measure the volcano's dome. That's the part above

the pre-eruption summit, where lava builds up and eventually explodes. Today is the first time in two weeks that the dome is visible through the smoke and steam.

RICK HEARD: Getting conditions like this is essential. Because if you can't see it, we're a bit stuck.

ALAN ALDA: (Narration) Rick and Lucy measure the precise angles to about a dozen recognizable points on the dome.

LUCY RITCHIE: Okay, right, let's get number one -- Big Spine

ALAN ALDA: (Narration) Big spine is that tombstone-like piece of rock sticking up on the right side of the dome.

LUCY RITCHIE: 3,4,4,4,3

RICK HEARD: 3,4,4,5,2

ALAN ALDA: (Narration) By combining measurements from this and a second location, they work out the latest contours of the dome. Over the last two months the dome has grown rapidly, adding a house-sized volume of lava every ten seconds. For predicting eruptions, it's also crucial to know whether the sides of the volcano are bulging or shifting. After a tricky landing on the roof of an evacuated house, Rick and an assistant don their helmets -- with our helmetcams -- and head for one of six locations around the volcano. Their goal is to figure out the exact distance between the locations, to see if they've moved. They're miles apart, but just the change of an inch would be alarming. At each location, they set up a GPS receiver, which uses satellite signals to pinpoint the position. Risky operations like this allow scientists to keep track of the volcano. But whether the people of Montserrat will ever get most of their island back remains very uncertain.

RICK HEARD: You know, it may settle down for a few years and then, you know, 20, 30, or 50 years later it may erupt again. I'd be hopeful they could develop it for farmland and so on. But I don't think there's much prospect for living up here for a while to a long time to come.

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THE PAN MAN

ALAN ALDA: (Narration) How do you get to be a pannist? As Brian Brumant says -- practice, practice!

ALAN ALDA: Told you I was fast.

BRIAN BRUMANT: I want to see how fast you is after you learn the next few notes, right?

ALAN ALDA: (Narration) Brian is lead tenor player with the Renegades, Trinidad's champion steel band. For big events there can be a hundred players. I've volunteered to help fill in -- if I survive Brian's crash course. Steel bands grew directly out of Trinidad's history. It was a typical Caribbean plantation island. Sugar cane was the main crop, with African laborers doing the hard work. The workers maintained a tradition of drumming, especially for parades. Oil was discovered in 1866, but it was not until the 1930s, when 55-gallon steel barrels became common, that oil and drumming came together. Barrels were cheap and available, and for the poor people of Trinidad, they became a way to make music. Today the top bands are famous around the world. And like many top professionals, Brian has total patience with beginners.

ALAN ALDA: I kept the beat a little.

BRIAN BRUMANT: That's important. You've got to play the right notes.

ALAN ALDA: Well, you know, you're kind of demanding.

BRIAN BRUMANT: 2, 3, 4, 5, 6,7 this is what I do for kids.

ALAN ALDA: I figured that.

BRIAN BRUMANT: Okay, crash course, 1, 2, 3, 4...

ALAN ALDA: (Narration) Transforming oil drums into musical instruments has become a specialized, highly skilled craft. First the "sinker" makes a deep hollow to create the "pan". The hammer blows have to be just right -- enough to stretch but not split the metal. Then the note positions are marked. This tenor pan's going to have 29 notes -- nearly two and a half octaves. Next the magic step that

creates a musical instrument. Each note is outlined with a flat punch, then the spaces between are beaten down. Eventually there'll be twenty-nine separate little domes, with twenty-nine different sounds. Finally, the sinker heats the pan to just the right temperature. This softens the metal and evens out the stresses that all that pounding created.

BRIAN BRUMANT: You got to be just relax.

ALAN ALDA: Let me see you do that.

ALAN ALDA: (Narration) Yeah well, talk about relaxing. I think Brian's getting worried his new band member might not make it.

BRIAN BRUMANT: You look better that way. Play like you know what you're doing.

ALAN ALDA: Oh that's different. I have to act in that case. It was a creative thing I did.

ALAN ALDA: (Narration) Like any instrument, steel pans have to be tuned -- a job for an expert.

LINCOLN NOEL: tunes for the Desperados, big rivals of the Renegades.

ALAN ALDA: It's a little flat...

LINCOLN NOEL: Yes... She's ready to talk.

ALAN ALDA: (Narration) Lincoln gently coaxes each little dome until it rings true, using a simple reference tone to stay on pitch. He has to constantly jump back and forth between notes. This is what makes steel pans unique -- all the notes are connected, so adjusting one changes others. As Lincoln says, he has to wake up all the notes before they can talk together.

ALAN ALDA: It looks to me as though you're seeing how the sound is affected by the other notes, not just how this note sounds.

LINCOLN NOEL: Yeah, you have to get everything exact together.

ALAN ALDA: You have to sort of tune it to the other notes, as well?

LINCOLN NOEL: That's why first you're supposed to wake all these, wake them up.

ALAN ALDA: Wake them up.

ALAN ALDA: (Narration) I've graduated from scales to the one phrase of a calypso tune that I'm supposed to play with the band.

BRIAN BRUMANT: I think you're ready...

ALAN ALDA: No, wait, but I haven't got the...

BRIAN BRUMANT: Your heart is beating.

ALAN ALDA: (Narration) OK. More practice.

ALAN ALDA: How long have you been working on steel drums?

CLEMENT IMBERT: On and off about fifteen years.

ALAN ALDA: (Narration) Meantime, meet Clement Imbert, engineering professor at the University of the West Indies. He makes steel pans the easy way.

ALAN ALDA: This already has the notes in it, then?

CLEMENT IMBERT: This has the notes, the outline of the notes, yes.

ALAN ALDA: After you press this you could play it?

CLEMENT IMBERT: No it has to be tuned.

ALAN ALDA: Oh, I see.

CLEMENT IMBERT: All pans have to be tuned and they have to be tuned by an expert tuner.

ALAN ALDA: (Narration) The massive hydraulic press is a far cry from the backyard pan sinker. But it's research that has to be done, says Clement, against the day when someone in Europe or America decides to get into the steel pan business.

ALAN ALDA: How long would it take doing this by hand to get it to this point?

CLEMENT IMBERT: This would take almost a day.

ALAN ALDA: I think it might be surprising for people to see that universities are studying the steel pan. Why, why is so much effort going into this?

CLEMENT IMBERT: There's a bit of a fear that we may lose some of that fame, that excellence that we have as the best steel pan producers and players in the world.

ALAN ALDA: (Narration) Trinidadians are fiercely proud of their steel bands -- they're so much more than fun at Carnival time. They're about African roots... island history... about creativity emerging from poverty. So the professors are worried. Maybe rival makers will emerge. And even here in Trinidad there's a threat. Believe it or not, steel bands aren't loud enough. They're losing popularity to rock groups that use super-powerful amplifiers.

BRIAN COPELAND: So I'm going to strike this note which is a D just above middle C on a piano.

ALAN ALDA: Oh, bang, there it comes.

BRIAN COPELAND: Okay, there it is.

ALAN ALDA: (Narration) At the University,

BRIAN COPELAND: is figuring out how to amplify steel pans. For really high power a regular microphone can't get in close enough. So he tried an electric pickup -- like what's used on guitars. Here's the result. The pickup sound is shown in the bottom panel. It has an unpleasant extra component -- a kind of "boing" and "thud" -- which sounds like this when isolated electronically.

ALAN ALDA: Is that the sound literally of the hammer hitting the metal?

BRIAN COPELAND: Actually, you know, it isn't. We thought it was up to a few months ago. What it is, is the hammer strikes the note and the energy from your striking the note goes into the pan itself and it starts exciting the pan and the pan starts actually to dance, it starts vibrating.

ALAN ALDA: The pan dancing and vibrating is the thud you hear?

BRIAN COPELAND: Yes, and if you take a look at the underside of this pan, see our new sensor?

ALAN ALDA: This thing sticks out here.

BRIAN COPELAND: Basically, yes.

ALAN ALDA: (Narration) They've worked out an ingenious solution. The sideways pickup only responds to side-to-side vibrations of the pan... Not vertical, which is what the normal pickup detects. It's the vertical vibrations that turn out to contain the annoying thud. Here's the same note, heard through the new sideways pickup. No thud.

BRIAN BRUMANT: One... two... three... four.

ALAN ALDA: (Narration) OK, now it's my turn. I'm going to be very happy not to have my pan too well amplified today. I lost it... Wait -- how does it go?

ALAN ALDA: What are you doing to me here, you're throwing me to the lions!

BRIAN BRUMANT: You did good.

ALAN ALDA: I did good? I managed to find the drum. That was all I did.

ALAN ALDA: (Narration) I'd only been a pan man for a few hours and already I was losing my touch.

ALAN ALDA: They're getting mad at me, they don't know that I've just started. They don't look too happy, I mean they have to play with an amateur like this. One more time... I did it!

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BIG DISH

ALAN ALDA: (Narration): Nestled deep in the mountains of Puerto Rico is the Arecibo Observatory, the world's largest and most powerful radio telescope.

ALAN ALDA: How long have you been using this telescope?

JIM CORDES: This is my 26th year.

ALAN ALDA: (Narration) Astronomer Jim Cordes and I are on our way to explore the telescope from a perspective few people ever get.

JIM CORDES: And can we get in? No. I'll have to pick the lock.

ALAN ALDA: What is this?

JIM CORDES: I know it's doable because I did it yesterday.

ALAN ALDA: (Narration) For a minute it looks as if our journey is going to end right here at the gate. But fortunately, aside from being an accomplished astronomer who hunts for collapsed stars called pulsars, Jim's not a bad lock picker.

JIM CORDES: There we go.

ALAN ALDA: Well, if you can open up this gate, then I guess you can find a pulsar.

JIM CORDES: I hope so.

ALAN ALDA: You know I've seen pictures of this but I never knew it was so big. It's gigantic.

JIM CORDES: Yeah, it's big.

ALAN ALDA: (Narration) There's a catwalk that leads out to the top of the telescope. Oh boy -- another fun trip.

JIM CORDES: So you see here it says maximum capacity 5 people at any given time. When light is on, verify. The light's not on. I think that means when there are people walking in the opposite direction.

ALAN ALDA: So two of you guys have to stay where you are.

ALAN ALDA: (Narration) Actually the catwalk turns out not so bad, and looking down I can't help being impressed by the enormous dish below.

ALAN ALDA: What's the diameter of this?

JIM CORDES: The diameter is 1000 feet.

ALAN ALDA: 1000 feet across.

JIM CORDES: 305 meters. And when we get to the top of the platform here, we'll be about 500 feet above the bottom part of the dish.

ALAN ALDA: (Narration) Unlike optical telescopes, which detect the light given off by stars and galaxies, radio telescopes tune in to their radio waves. But the stars aren't broadcasting Beethoven's Fifth or the Rolling Stones -- almost every object in the universe naturally gives off radio noise. Because it's so big, Arecibo can pick up objects which are extremely faint or far away, tracking them day and night as they pass through the sky overhead.

ALAN ALDA: This is gorgeous up here. It's so funny to look at one of the most beautiful places on Earth, and from there you're looking at the rest of the universe.

JIM CORDES: Yup.

ALAN ALDA: It's gorgeous.

JIM CORDES: It is gorgeous.

ALAN ALDA: (Narration) From this vantage point, astronomers have discovered countless new objects all over the universe.

ALAN ALDA: How far up do you see?

JIM CORDES: We see all the way.

ALAN ALDA: All the way to what, to the edge of the universe?

JIM CORDES: To the edge of the universe.

ALAN ALDA: (Narration) Speaking of being on the edge...

ALAN ALDA: You know, Vesuvius is beginning to look good to me.

ALAN ALDA: (Narration) Now we're on our way to see how the telescope has had a major upgrade over the past few years.

JIM CORDES: So we like to mix athletics with astronomy.

ALAN ALDA: (Narration) Back when it was built in the 1960s, Arecibo was set up to focus radio signals from space onto that long spiny antenna you see on the left. But now with the upgrade, when signals come in and bounce off the dish below, they're aimed into a three-story white dome -- which is where Jim and I are heading.

JIM CORDES: Here we are.

ALAN ALDA: Fantastic

JIM CORDES: This is the Gregorian dome.

ALAN ALDA: Wow. What a sight.

JIM CORDES: The radio waves come through the hole here, reflect off this secondary reflector - that's about 80 feet across. The radio waves then are focused towards this tertiary reflector.

ALAN ALDA: (Narration) The extra reflectors concentrate the radio waves so that by the time they reach the receiver, the signal is ten times stronger than before. So there'll be a lot more discoveries made at Arecibo in future years.

ALAN ALDA: Is this part of the control room?

STU BOWYER: Yeah, this is the major control room.

ALAN ALDA: (Narration) Stu Bowyer runs a small private project here that will also benefit from the upgrade.

STU BOWYER: Right here is a raw signal. Buried in that may be a signal that signifies intelligent life somewhere else in our galaxy.

ALAN ALDA: How would you know?

STU BOWYER: Ah!

ALAN ALDA: What would it look like if it were? Wait, there's all these big spikes. What's that? I think we got something here.

ALAN ALDA: (Narration) Next door a specialized computer breaks down the raw signal into millions of channels and analyzes them instantaneously.

STU BOWYER: It's as if you had your regular radio dial and you were twirling the knob and moving through each of the different radio stations. What this does, instead of twirling the knob it does all of it at the same time -- a hundred and sixty eight million of them simultaneously.

ALAN ALDA: (Narration) Every two seconds, the computer sorts the signals -- rejecting nearby strong ones like cell phones, but keeping faint distant ones you have to focus the telescope on.

STU BOWYER: As we're looking at it kind of off it's kind of dim. And then we look at it full on it gets brighter. And then we look at it off it gets dimmer. If it has that profile, that's a good hint...

ALAN ALDA: That it's pretty far away.

STU BOWYER: That it's consistent with it being far away.

ALAN ALDA: (Narration) Other tests include: not coming from a satellite in orbit... being there a second time... and not being a natural object like a star. After years of listening, no signal has passed every test.

ALAN ALDA: Why is it important to you to make this kind of contact?

STU BOWYER: Well, certainly I and a lot of other people think this would be the biggest event in human history.

ALAN ALDA: (Narration) In recent movies like "Deep Impact", the big event has been depicted as something very different. Here, it's a six mile-wide chunk of rock heading for Earth, threatening the survival of humanity. A nightmare like this is not at all far-fetched in the eyes of astronomer Steve Ostro.

STEVE OSTRO: The possibility that an asteroid can smash into the earth is absolutely real. A kilometer-sized object colliding with the Earth would effectively destroy civilization and the odds of this happening are almost one part in a thousand during the next century.

ALAN ALDA: (Narration) Our best tool for studying asteroids is Arecibo, because up in that new dome is the world's most powerful radar transmitter. Its beam is bounced off the dish to reach objects that are millions of miles out in space. With a quick adjustment in the dome, the telescope picks up the returning radar signals.

ASTRONOMER: Ready, go ahead move. All frequencies...

ALAN ALDA: (Narration) Work has just now begun at Arecibo to catalog by radar all the asteroids - they're invisible to optical telescopes. This is the kind of remarkable image you can get of a 3 mile-long asteroid 4 million miles away -- about 20 times farther than the moon. From these images you can produce three-dimensional models. If we ever have to knock an asteroid off course, knowing its exact shape will be crucial for determining exactly how to hit it. So one day we may all be very happy that Arecibo exists. Not a bad place for a hike either.

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DUST BUSTING

ALAN ALDA: (Narration) The Virgin Islands. From here down to Venezuela it's a five hundred-mile loop of beautiful, small islands set in a sparkling sea. They're some of the world's most popular tourist destinations -- to find the sun... or catch a wave. Below the surface things get even better. Coral reefs -- the rain forests of the ocean -- delight the eye and the imagination. But in the winter of '98 there were obvious problems with the health of the reefs. And that's when I found myself being thrown around in a small boat, in the company of three coral experts -- Gene Shinn and Ginger Garrison of the US Geological Survey... And Garriet Smith from the University of South Carolina. We're off St. John -- and this is no vacation.

ALAN ALDA: Caribbean, they said, we're going to shoot in the Caribbean. Nice. All these great stories, sun, surf...

ALAN ALDA: (Narration) We found a spot that was sheltered and got ready to check out the reef. The scientists and I are going to be free-diving, while our underwater camera crew will be using scuba. Free diving's a lot simpler than scuba, and just fine for seeing shallow reefs like these, ten or twenty feet deep. The bad weather has stirred up sediment, so it's not as clear as it could be. But it's more than enough for Ginger to point out the problems. Here comes the free dive... And here's the problem. On this boulder coral, large white patches where the living surface has died off.

GINGER GARRISON: Looking pretty slick there.

ALAN ALDA: (Narration) As we head back down, I realize that white patches of different sizes are everywhere on the boulder coral. It's one of the Caribbean's principle reef-building corals, so this is a disturbing sight, to say the least.

ALAN ALDA: When I see the white stuff down there, what am I looking at?

GINGER GARRISON: Well, the white area that's surrounded by the normal looking coral tissue that's brown is actually just the skeleton. What's happened is the disease, whatever the pathogen is, has evidently killed the polyp and that tissue has sloughed off. So it's like if we lost everything except our bones so that we wouldn't have any flesh on them.

ALAN ALDA: (Narration) Next Ginger takes me down to check out the sea fans. There are clumps of them all around, waving lazily in the swells. Sea fans are one of the soft corals -- not reef-builders, but an important part of reef ecology, providing shelter for many inhabitants. But the sea fans are in bad shape. This is a typical example -- chunks of the fan rotted away, with bright purple patches. Once you know the symptoms you notice them everywhere. Garriet Smith outlines a light purple infected area. Eventually it'll die off, leaving a gaping hole in the fan. Here the process has already started. This is not just a local problem -- sea fans all over the Caribbean are affected. On the reef there are fans at every stage of deterioration. This one's lost almost all its living tissue. So out we came -- cold, wet, tired, depressed at the state of the reef. And as if that weren't enough...

ALAN ALDA: I have a blister from my flipper.

ALAN ALDA: (Narration) Then I realized that my companions don't care about working conditions. It's knowledge they're after.

ALAN ALDA: Ha ha ha, I love it. Science!

ALAN ALDA: (Narration) This is a diseased Caribbean sea fan in Garriet Smith's lab at the University of South Carolina. You can see the skeleton from which the living white tissue has died back. The brown growth is some kind of secondary infection, and the purple is an immune reaction that shows the coral is trying to fight whatever is attacking it. So what is attacking it? The team's now pretty certain they've nailed it down. Here's what they did. Samples were taken from diseased sea fans from six different islands. After culturing for a few days, this is what they got... A whole mix of about a dozen fungi and bacteria. It looked to Garriet that only one was common to all the sea fans. It had the typical threadlike appearance of a fungus. Garriet confirmed that it caused the disease, by deliberately infecting healthy sea fans. So now it was time to identify the fungus. It's routine nowadays to map out the DNA of organisms.

KIM RITCHIE: A - G - T - A - A...

ALAN ALDA: (Narration) Garriet and Kim Ritchie mapped out the fungus' DNA, looked it up in the databases -- and got a big surprise. Sea fan disease was caused by a common soil fungus called Aspergillus. You could find it in any

backyard. But how was Aspergillus getting to coral reefs in the Caribbean? Take a look at this. This picture was shot from the space shuttle over the Atlantic. The brown stain is dust -- millions of tons of it -- coming from new farmland in Africa. In drought years, when there are often dust-bowl conditions, huge quantities are swept across the ocean on the trade winds, to settle on the Caribbean. Gene Shinn suspected that the dust could be delivering a constant dose of damaging material to the water, and to the coral. And it could explain why coral diseases appear all over the Caribbean at the same time. Gene takes up the story.

GENE SHINN: I got talked into presenting this as a hypotheses at the Oceanographic Society annual meeting last year on April Fool's Day, by the way, and a lot of people took it that way...

ALAN ALDA: They didn't go along with this idea.

GENE SHINN: I had discovered that everyone who studied dust in the past, the one common denominator is they all got laughed at one time or another. And they were studying dust in the late 60s and early 70s and there wasn't that much dust. But it's a hundred fold greater now.

ALAN ALDA: Is it pretty clear to you therefore that this rise in disease here in the coral is because of the desertification effect?

GENE SHINN: Well, it was just an observation that the peak years for the dust, like '83 or '87, these were big years for the coral reefs and things changed. It seemed like there was a link.

ALAN ALDA: (Narration): To find out what the Caribbean winds contain,

GINGER GARRISON: sampled the air above St. John. The filter papers went to Garriet Smith in South Carolina. And along with dust particles, he saw thousands of tiny fungal spores. So next step -- culture the spores. A few days later -- another mix of organisms. And among them -- you guessed it -- Aspergillus. So Aspergillus spores are definitely in the air in the Caribbean, but how the grown fungus actually gets into the coral is still a puzzle. Aspergillus usually needs soil to germinate. A little could then wash off into the water, but not much. Or maybe Aspergillus is behaving in some new way, germinating in the water itself. While the basic idea seems pretty solid, there's still a lot of detail to figure out.

GENE SHINN: The gods are with us.

ALAN ALDA: (Narration) I'm getting to be a real pro at this now. Gene Shinn's moving on to the next phase of the investigation. He's drilling a deep core sample from a large boulder coral. The aim is to look at the recent history of the reef, to

see if what happened from year to year can somehow be matched up with dust conditions.

GENE SHINN: There you go, that's about thirty to forty years of growth. Not as easy as it used to be.

ALAN ALDA: Do you see anything on this? Can you read this in any way now without taking it to the lab?

GENE SHINN: Well, you can see this is the growth axis, these lines pointing this way, and that's each individual polyp and you can see the little polyps. It's like a little jellyfish that secretes calcium carbonate and so our plan is to take the segments, cut them out with a diamond saw, dissolve them in hydrochloric acid and then we get a residue, and that residue will be, hopefully will be, African dust.

ALAN ALDA: (Narration) The unexpected story of dust and fungus is an important breakthrough in understanding coral disease, but it's just the beginning. There are many other coral diseases around the world, and as for the dust itself maybe a billion tons a year fall on a huge area, from the Amazon rain forest to the southern United States. We're going to be hearing a lot more about dust in years to come. That's all for our Caribbean special. See you next time.

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