

Art of darkness

By Shaun Johnston, see shaunjohnston.org. 2013.

The passage they're taking has suddenly widened, and they can tell from the way their voices echo that they're coming to a large cavern. They've been expecting this; the large cavern was to have been the highlight of the journey. Now, it's pitch dark, and they can see nothing of its splendors.

Not only that, but their way across the cavern is blocked by a lake, and they know they can only cross it by walking along a causeway that begins just a few feet from the shore they're on and snakes all the way across the lake to the other side. Now they have to figure out how to find the causeway, and follow it, in the dark.

Walking slowly forward, pausing every so often to feel the ground in front of them, they find the water edge. They follow it a little way in each direction, telling each other what they're finding. "Runs right along in front of us," Jodi hears Fred say. "I've got an idea. Give me a few minutes."

In the relative silence of the cavern, she hears Fred gather pebbles from the ground, a sudden energetic rustling of his clothing, then a distant "splash." She waits while he throws more stones, each rewarded with a distant splash.

"Tell me the idea, Fred?" she says. "What are you trying to do?"

"I'm trying to form an image of the lake, like a television camera," she hears him say, already breathless from his exertions. Oh, yes, she thinks, he's an electronic engineer. He's trying to scan the lake in a number of lines, starting in the distance all the way to the left and aiming a bit further to the right each time, then starting at the left again and throwing a little closer in, telling from whether each pebble returns a splash or a clatter where the causeway runs. Remembering which of his throws resulted in clatters, he'll try to reconstruct a two-dimensional map of the lake's surface.

"I think you'll be exhausted before you've finished," she says into the darkness. "You're having to invest too much energy on each stone. Let me try." She feels around on the ground with her hands and collects a handful of small stones. Standing, she tosses them up in the air in the general direction of the shoreline.

The stones land in a profusion of splashes and clatters. Jodi is able to pick out from the directions of the sounds where the shoreline begins. But there's no clatter from further out that would indicate the causeway.

"Hey, that was neat," Fred calls out. "Dirty, but effective... I mean, not dirty, exactly, but crude. Practical—how's that?"

Jodi smiled. "I'll take it," she says. "Now I'll scan around, see if I can find that causeway."

A handful of stones tossed up and to the right reveals no causeway, but another handful to the left returns an island of clattering starting several feet from the shore and extending out into the lake. "I got it," she says, "I'm going to wade out to it. Follow my voice."

Once they've dry land beneath their feet again, Jodi hears Fred shuffle his feet, turning around in a circle. "I've no idea where we are," he says. "I'm on an island in the middle of a lake, in pitch darkness, with no instruments. This is really eerie. Do you know how to get out of here?"

"Sure, don't worry," she says. "Follow me. I'll keep talking, so you can follow my voice."

She bends down to gather more pebbles, but finds only an occasional stone. Feeling around, she gathers a small handful. She tosses one in front of her; it lands with a clatter. She walks forward. In this way, tossing stones one at a time, walking forward if she hears it clatter, tossing stones in other directions if the first one returns a splash, she continues walking forward in whichever direction yields her a clatter. Soon it becomes a routine, and she can concentrate on talking.

"I feel like the back half of a pantomime horse, following you blindly like this" Fred says. "You're a biologist aren't you? What's your field of study?"

"Evolution," Jodi says. She's feeling quite at home in the dark, and enjoying the prospect of talking about her studies. "Actually, I study trial and error methods of forming images."

She trudges on. No response from Fred. Then:

"You mean, like that handful of stones trick back there?" she hears him ask, with a hint of sharpness in his voice. "How did you come up with that?"

Uh, oh, she thinks. Mustn't try to one-up the electronics engineer when it comes to forming images. "It's just something I've picked up from animals," she says. "When I'm underground and I encounter a difficult situation like this, I try to think of an animal that's already evolved to cope with it, and I borrow its tricks.

"Right now, for example, I'm forming images like certain single-celled creatures that have a pit at their front end, with a single light receptor at the bottom of it. All they can tell is, is there light ahead of me? If there isn't, then they turn from side to side until light shines into the pit and onto the receptor. Then they know there's light ahead, and can move towards it or away from it, whatever they're programmed to do. That's like what I'm doing each time I toss a single stone.

"Back there on the shore, I came up with another kind of organism that has a deeper pit that's almost closed, leaving just a small opening. Light shines in through this opening, and forms a crude image on the bottom of the pit. Like a pinhole camera, you know?"

She hears Fred grunt a yes. An electronics engineer is going to know how a pinhole camera works. It's a black box with a piece of film in it, and a pinhole in the opposite side. Light rays pass in through the pinhole in straight lines and form an image on the film. Because there's no lens to gather light and focus it on the film, only a simple pinhole, the image is very faint. But it can be quite sharp.

"At the bottom of that pit, there're several light sensitive receptors. Now if there's a point of light ahead, there's a good chance rays of light from it will fall on a receptor. From which receptor is getting the light the creature knows what direction the light's in, and it can turn that way. That's what I did on the shore. The dozen or so pebbles I tossed were like the dozen or so light receptors in this primitive eye. Because my ears can place where sounds come from, that gave me a very crude image of the scene ahead of me."

"That's trial and error image-making?"

"Yes. You're sending out simple probes, each one being a trial of what's out there. You can send them one by one, as I'm doing now, or several at a time, as I did on the shore. Or you can send them out in the hundreds, or the millions. The more individual trial-and-error probes you send out, the sharper the image you can form."

Jodi is barely aware of gathering and tossing the stones by now. She's striding confidently in the directions the stones tell her. "At one extreme, there's Noah, who used only two probes, one at a time. Lost on an ocean, he releases a bird, knowing the bird will be able to see much further than he can. When the bird returns to the ark, Noah knows there's no land nearby. A few days later, he releases another bird, and this one takes off. Noah therefore knows that land lies in the direction the bird's taken, and he can steer towards it.

"At the other extreme, there are fish and trees that release vast numbers of seeds or eggs that, by whether they live or die, form a kind of pixilated image of where the soil or the sea bottom is favorable. The creature releasing the young doesn't get to see the image, but it's formed nevertheless. If we tagged all the young with fluorescent dyes, we'd be able to see the image at night, by where the surviving creatures were concentrated. Whoops!"

Jodi had felt cold water close over both her feet. Getting careless, she thought. She stepped back a few paces, bumping into Fred who had been following close behind her.

"Hold on for a moment, I've got to backtrack and find where the main path branches off," she utters into the darkness. "Just hang on. I'll let you know when I find it." She gathers up more stones, and uses her "handful" technique, searching for the fork where she took the wrong turning.

Suddenly she hears a cry. "Come here, Jodi," Fred calls out. "You won't believe this, but in an inside pocket of my jacket, I've found an old book of matches. There's just one match left. Let's both face towards the far side of the lake we're aiming at, and I'll see if I can get this to light."

Jodi rejoins him. "OK," she says. "I'm ready." She gazes blankly ahead, trying to relax.

There's a scratch, and a sputter, then a sudden blaze of light that's almost immediately extinguished. "Damn," Fred exclaims. "I didn't have time to scan the image. Where I was focused all I could see was a blank wall. Did you see anything?"

In fact, by maintaining a passive unfocused attention, Jodi had been able to take in the entire scene. "I see the causeway," she said. "It's over here. Follow me."

Once again tossing her probes one by one, she continued to guide them both across the lake. But she found it more difficult to speak, having twice trumped the professional image-engineer behind her. "Say something," she says.

"Now, that was what I call an image," he replies. "No trial and error there, Eh?"

Jodi says nothing.

"Speak to me," he says, "You've got to talk, or I can't follow you. Tell me, do you see trial and error in images like that? Perfect sharp images you see with your eyes?"

"Yes," Jodi replies. "Remember back there I said that as you use more probes, the image get's sharper. Well, that match of yours sent out huge number of probes, zillions and zillions of light rays, so many that when they got reflected back into our eyes, they formed a pretty good image. But it wasn't perfect you know. If you'd enlarged it enough, you'd have found it pretty speckly, something like the images of stones I've been making, only much finer. It only looked perfectly sharp because our eyes can't form images sharp enough to see those speckles. Pretty sharp, but not entirely different from that creature with the pin hole camera for an eye and a few dozen light sensitive receptors."

From behind her she hears another grunt of assent.

They both fall silent. Then "Go on, you've got to talk," Fred says. "Tell me about biology and trial and error, what you're studying."

The invitation made Jodi suddenly self-aware, and she momentarily forgot how to do the stone throwing. Catching herself, she picked up some stones, and continued.

"I study evolution," she says. "I use a computer to study what happens when a species evolves. The computer program I use happens to be meant for image-making, but the same math applies to image-making and evolution. So I can study evolution at both ends of the scale: natural selection of just one or two animals, which is almost entirely a matter of chance, or selection among billions of animals, which gives me something corresponding to a sharp and detailed image. Using one or two probes is like Noah

sending up just two birds a few days apart. Summing the variation-selection cycle of a large number of creatures over thousands of generations is like casting a beam of light on the environment, and forming an almost perfect image of it, like we got with that match. What's special about my computer program is, it shows me how evolution works at every level in between. So, to me, evolution ranges from being almost indistinguishable from pure chance in very small populations of just a few creatures, to being an enormously powerful and creative force when you deal with entire species over millions of years."

She couldn't say any more without some feedback from him. He was silent for a few moments, then acknowledged that it was his turn to speak.

"Hearing you say this helps me understand why you seemed so very much at home here, in this cavern," he said. "Tell me more about how you see the world, with this kind of insight into evolution."

"Well, it's changed how I like to spend my time," she said. "I've developed the habit of spending Sunday mornings in a zoo, wherever I find myself. It's become my form of religious experience. I wander from cage to cage, in a sort of trance, awed by how crisply each species is formed, by the enormous number of transactions required for its evolution. I know those numbers, because I know how many probes would be required to form correspondingly sharp images.

"So I wander around, wondering how evolution manages to form such perfect images of the environment—the bat so perfectly formed to exploit flight through air, the frog so perfectly formed to both leap on land and swim through water. And it gives me a sense of how much there is to learn about evolution, that we don't yet know."

"Like what?"

"You know about a sexual selection?"

"A little. I know a lot of evolution is attributed to the sexes selecting each other for favorable attributes."

"That'll do," Jodi responds. "Well, imagine we knew only about selection through predators and disease. We'd be missing a whole dimension of evolution by not knowing about sexual selection. It's obvious to me that we're still missing a lot of other factors, because evolution is much more efficient than it should be. Understanding genetics helped a lot, because we found that nature can fine tune both how animals vary from one another, and how vulnerable they are to particular aspects of the environment.

"My dream is to discover more of the mechanisms by which evolution works so efficiently, the engines that drive it. So for me, my Sundays at the zoo really are almost a religious experience. I feel the secrets of nature are right there, so close, just behind those bars. Or in front of them, in me. I'm evolved, after all. Why can't I find the answers inside myself."

"Do you try—Oh, look, light!" And sure enough, a faint glimmer showed ahead. They could hear the echo of their voices lessen, signaling they were approaching the wall of the cavern, Soon Jodi's pebbles were landing on rock on all sides, and they could walk freely towards the light, and the tunnel that led them to the surface.

[My wife insisted I couldn't end the story there, I had to have a resolution to their relationship. So let's have them meet at a conference in a year or so, fall in love, and get married.]

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