How Does a Mole View the World?

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I remember longing as a child to experience, even just once, how an animal actually sees the world — to slip inside an ant and wander through the passages of the anthill, to see with the eyes of a squirrel. This longing has not, in a straightforward way, been fulfilled. I can't get inside my cat — at least directly. And, if *I* were inside the cat, would I be seeing as me, or as the cat? It seems like an unsolvable problem; we can't get inside the animal.

Twentieth-century behaviorism brought one neat solution to this problem by simply eradicating the animal's inside. On this view, all we know is external behaviors. We can observe sequences of movement and also, through our own behavior, manipulate the animal's behavior. This is a modern version of Descartes' idea that animals are machines without souls. Untold harm has been done to animals on the basis of our ability to objectify them — to make them into things that we can treat as mere objects.

Any human being who has not been totally blinded by dogma knows that cats, squirrels, mice and deer are all creatures that experience the world. This knowing is not intellectual; it is a kind of felt-knowing based on the direct interactions we have with animals. The cat looks at us when we walk by and purrs when we stroke it; it raises its tail, arches it back, hisses and focuses intently on the little puppy trying to come near. The gaze, the utterances, and the movements of the body are all gestures. They are expressive of the animal itself.

To use the phrase of philosopher Thomas Nagel, "there is something that it is like to *be* that organism" (Reference #8, Nagel's emphasis). Each animal has a perspective, a point of view through which it lives in the world. When we observe an animal, we observe how it is living out this perspective, how it is living its unique way-of-being.

We may never be able to take on this perspective as a first-person ("first-animal") experience. But that doesn't mean the inwardness of the animal is an impenetrable black box. It is true that we create a problem for ourselves when we imagine the inwardness of the animal as totally distinct and other from what we call the body. But what we actually confront in our experience of animals is the ensouled living body. We can't talk meaningfully about the animal's behavior, for example, if we don't include how it actively and selectively relates to the world around it. This we can call the animal's intentionality. My cat reacts very differently to me than it does to our little puppy. That's its perspective, its way of relating, how it shapes its existence by interacting in different ways with different things.

What we can do is to carefully observe an animal's behavior and the concrete context of different kinds of behavior to gain an understanding of its specific intentionality. But we can't fully penetrate this behavior without attending to *how* it moves and the way this movement is shaped through the form and function of its various organs. We can discover how the shape of the wings and the configuration of muscles determine how a bird flies. The wings and muscles, with their specific form, are the bodily expressions of the eagle's or the chickadee's whole style of existence, which includes its intentionality and behavior.

The point is to build up vivid pictures of the animal from as many sides as possible. By continually immersing ourselves in concrete observation and then connecting our observations to vivid inner images, we enter into a conversation with the animal. The animal begins to show itself.

The Star-Nosed Mole

A mole is a highly specialized creature. Its limbs hardly seem to protrude from its barrel-shaped, compact body, and externally one doesn't see a neck; the head appears as a tapered extension of the trunk (see Figure 1). Noting, as he always did, the relations *between* the parts of an organism, Johann Wolfgang von Goethe, the German writer and phenomenological scientist, remarked that "the neck and extremities are favored in the giraffe at the expense of the body, but the reverse is the case in the mole" (Reference #5, p. 121).

Figure 1. The star-nosed mole (*Condylura cristata*). The adult mole's body, without tail, is about four-and-one-half inches long (11-12cm). (Drawing by C. Holdrege.)

The cylindrical form is ideal for moving through the soil. And the dark fur — in star-nosed moles, virtually black — can bend in all directions, so that it will lay flat whether the mole is moving forward or backward through its tunnels. When you look at the mole's forelimbs more closely, you see the proportionately enormous clawed paws used for digging subterranean tunnels. The paws are held with the large, broad palm turned outward and next to the head. When the mole digs, it stretches the paw forward, digs into the soil, and then scoops it away to the side. It's the kind of motion we make in swimming the breaststroke.

Just as the form of its body and the form and function of its limbs express the mole's subterranean habitat and manner of digging — how it interacts with and shapes its environment — so do its senses and sense organs. Moles have very small eyes that are functional, but in many species, they are not discernible until one pushes aside the fur. Moles also have no external ears (enhancing the smooth, barrel-shaped form of the body).

Through field and experimental observations, it's evident that neither sight nor hearing are its primary senses, which isn't terribly surprising for an animal that spends most of its life in the earth in dark tunnels.

Interestingly, the star-nosed mole's eyes are usually visible and its forepaws are proportionally not as large as in many other moles. The star-nosed mole spends at least some time foraging above ground. But it also spends a good deal of time in water, using its limbs as paddles. Often its tunnels lead into ponds, streams, or wetlands. (This species is found in the northeastern United States and southeastern Canada.) One finds the tunnels of star-nosed moles near and around wet areas, so that they are often digging through mucky soil.

But what makes the star-nosed mole stand out most is the star at the front of its snout. The star, which is less than half an inch in diameter, consists of twenty-two rays that surround the nostrils just above the mouth (see Figure 2). Since no other animal has such a star-like appendage, it has intrigued researchers.

I will draw below primarily on the fascinating work that Kenneth Catania at the University of Vanderbilt has carried out. (See references 1-4).

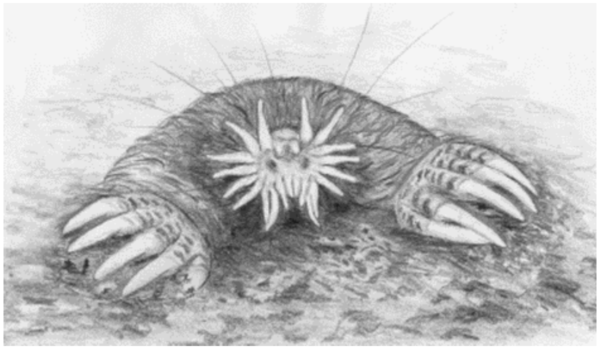

Figure 2. The head and large, clawed forepaws of a star-nosed mole emerging out of the soil. The clearly visible star consists of eleven pairs of rays ordered around the nostrils (dark spots near the center of the star). The top middle pair is very small and inconspicuous, appearing as two knobs. The eleventh pair, which is the center of focal touch sensitivity, is the small pair at the bottom middle of the star. Note also the long tactile whiskers (vibrissae) that radiate out behind the star. (Drawing by C. Holdrege, after a photo by Kenneth Catania in Reference #2, p. 66.)

When the mole is digging, the rays of the star are in constant movement. They contact and probe around, palpating (but not digging into) the earth. While digging through the soil with its paws, the mole lays bare its food, which consists primarily of earthworms, but also insect larvae and other small soil invertebrates. Catania noticed that although the forepaws may touch earthworms during burrowing, the mole doesn't stop, grab, and eat the worms. But when a ray of the star comes into contact with a piece of earthworm, the mole orients the star around the food, touching it rapidly and numerous times with the rays. It then moves its snout so that the small and inconspicuous eleventh pair of rays, which lies just above the mouth, touches the worm, upon which the food is engulfed. The animal always goes through this sequence before it eats anything:

> The star moves so quickly that you can't see it with your naked eye .... Scanning its environment with a rapid series of touches, a star-nosed mole can find and eat five separate prey items, such as pieces of earthworm we feed them in the laboratory, in a single second. (Reference #1, p. 56.)

Although it surrounds the nose, the star is not part of the mole's sense of smell, and the mole doesn't use it as an appendage to grab and handle food. Whether the star helps the mole perceive temperature differences or maybe even detect the electrical properties of its environment is still open to debate (see Reference #6).

The development of this mobile and sensitive appendage is correlated with other changes in the face and jaw. The muscles to move the star are highly developed, while the jaw muscles have weakened and the lower jaw (mandible) is very thin-boned.

This is a telling example of what the great French comparative anatomist Georges Cuvier called the law of the correlation of parts. In Goethe's words, “nothing can be added to one part without subtracting from another, and vice versa” (Reference #5, p. 121).

Living in a Tactile World

When Catania looked at the anatomical fine structure of the rays, he discovered an extraordinary organ of touch. Under a microscope, the star's surface looks like a honeycomb of about 25,000 little dome-like structures called “Eimer's organs.” Each Eimer's organ, in turn, consists of three different types of sensory receptors — for detecting vibrations (such as the wiggling earthworm), pressure on the skin, and the texture of objects. As Catania discovered, the star:

> … is supplied with more than 100,000 large nerve fibers. By comparison, the touch receptors in the human hand are equipped with only about 17,000 of these fibers. Imagine having six times the sensitivity of your entire hand concentrated in a single fingertip. (Reference #2, p. 66.)

So we have to imagine an extremely fine sense of touch concentrated in the star.

In imagining the tactile world of the mole, we must strip away what is so familiar to us—our colorful and airy world of sight and hearing. We can picture ourselves in a dark, quiet, enclosed space where the surface of our body touches myriad objects. Since our sense of touch is most refined in fingertips and tongue, we can imagine concentrating our perceptions of weight, texture, and temperature through these organs. In this way, we can begin to acquaint ourselves with a tactile world, which normally stands in the shadows of our more dominant and focal visual and auditory experiences.

(When I was about thirteen years old, I spent a good deal of time with friends crawling around in the rain catchment pipes that ran under streets of the town I lived in. They got smaller and smaller, to where you couldn't turn around anymore. We'd lie there for a while and then wriggle our way back out. I shudder at the thought of having done this and wouldn't go two feet into such a pipe today. But at that age I lived, evidently, in a different consciousness — I won't say I was more mole-like — that allowed those journeys into a narrow tactile space.)

Experiencing Focus & Background

In his descriptions of the mole's star, Catania makes an illuminating comparison to other senses. When we use our eyes, we are continually active in at least two ways. While reading, for example, we focus on particular words and yet at all times this center of attention is seen within the larger context of sentences and words that come before and after. Or when we're walking through a landscape, we focus on a bird flying through the bushes, but we also see the surroundings as a backdrop.

This contrast between focal attention (foreground) and peripheral background has its anatomical correlate in the fovea of the retina, (which is strongly innervated and used for focusing on objects), and in the periphery of the retina (which helps us see the overall surroundings).

Catania suggests that the way moles use their star reveals a similar two-fold awareness of the environment. Continually moving its outspread rays in all directions, the mole probes its tactile world. It's a bit like us going out with our eyes wide open but without focusing; we're open to what comes. When the mole comes into contact with potential food, it focuses on it by touching it with the eleventh pair of rays. Only then does it eat.

Like with the eye, the contrast between focal sensitivity and more general awareness finds its physical reflection in the anatomy and physiology of the star and the star-nosed mole's nervous system. The eleventh pair of rays has a higher concentration of nerve endings than the other rays. The nerve fibers lead to the sensory field of the cerebral cortex. Brain studies on other animals and the human being have shown that more sensitive organs or tissues are connected with larger areas of the neural sensory field. “Brain space” is not a function of the size of the organ, but of its sensitivity. The fovea of the retina has more brain space than the rest of the retina, just as the sensory field for the human tongue is much larger that that of the trunk of the body, excluding the limbs.

Catania and his colleague, Jon Kaas, confirmed this correlation in the star-nosed mole: By far, the largest part of the sensory field is represented by the star. The next largest area is for the paws, followed by the area connected to whiskers behind the star on the snout. What surprised them was that the brain field for the star was actually divided into ray-like projections — a star within the brain! The brain ray for the small eleventh ray was much larger than each of the others, indicating how the animal focuses its sensitivity through this part of the star organ. So even into the fine structure of the brain we find that the poles of focus and background in sensory activity are represented.

Although there is no comparable human organ, we can gain an idea of the star as a sensory organ since we are also sensory beings. In sense activity, we have the interweaving of open exploration and centered focusing. With sight, we know this interplay well. Sight is our primary sense through which we focus our attention on the world, but without the background, without the general sensory openness that allows us to take in a whole picture, we wouldn't see anything. This mutual relation between focus and background metamorphoses in each particular sense and in each animal with its specific configuration of organs and senses.

For example, the sense of smell is usually not a focal sense in human beings. But it is for a fox. Once I was following the tracks of a red fox in the snow and came upon a slightly raised spot with some twigs of a bush sticking through the snow upon which it had urinated. This is a fox's scent marking. It smelled musty and like a mild form of skunk scent. I realized how often I had smelled this scent on walks, but never put it into any context. I found a few more scent markings and had a flash of what it must be to be a fox, nose low to the ground, wandering through a world of scents and at the same time putting scents out into the world.

A Mole's Eye View

To enter into the world of the star-nosed mole we must leave behind so much that is familiar to us. It's a dark world of continual contact with the cool moist earth, the mole digging through that earth with large, powerful paws, and an organ out front, in continual movement, probing and discriminating. A "mole's eye view" of the world is a view through touch.

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