Light may aid birds' magnetic orientation

As recently as five years ago, scientists still argued about whether animals could really navigate using Earth's magnetic pull (SN: 7/23/88, p.55). Researchers now know that birds, fish, insects, even bacteria can sense magnetic fields, but in most cases how animals do this remains a mystery.

Two reports in the Aug. 5 NATURE shed light, literally, on this mystery. Exposure to the sky's polarized light helps the Savannah sparrow calibrate its magnetic compass, say Kenneth P. Able and Mary A. Able, biologists at the State University of New York at Albany. Another bird uses light to activate magnetic sensors, says Wolfgang Wiltschko of the University of Frankfurt in Germany.

Because the magnetic poles do not coincide with Earth's axis, animals would go off course if they switched to magnetic guidance without first adjusting their internal compasses to match other orientation cues, says James L. Gould of Princeton University. Some birds depend on star patterns for this calibration.

To determine other cues used, the Able duo raised 63 young sparrows for two months, never allowing them to see the outdoors. They then divided the birds into two groups, keeping one group in magnetic fields shifted by 90°. Calibration in that shifted field would make them fly the wrong way, Kenneth Able notes.

Half of each group then viewed the normal sky, and half saw the sky through a depolarizing filter. When the birds later tried to use their magnetic compasses, those kept in shifted magnetic fields and allowed to see the normal sky headed 90° off north-south, he says. But those in the shifted field and exposed to depolarized light still flew north-south, indicating that the sparrows use polarized light patterns, not the sun's position, for calibration.

"My intuition is that this will turn out to be the major mechanism for diurnal calibration," Gould predicts.

Gould and others are less certain about the universality of the second report. In that study, Wiltschko and his colleagues tested 22 silvereyes (*Zosterops l. lateralis*), a common bird that migrates between Tasmania and mainland Australia. They placed each bird in a large, covered funnel cage. When subjected to white, blue, or green light, the birds tended to head off in a north-northeast direction. But in red light, the birds became disoriented, the researchers report.

Typically, light excites electrons in eye pigment molecules such as rhodopsin. This sets off a series of energy transfers from one molecule to another until the energy dissipates and a nerve cell fires off a signal to the brain. As the theory goes, this cascade in animals with a magnetic sense contains a molecule whose ability to transfer energy will change depending on its position relative to Earth's magnetic field, explains John B. Phillips, a biologist at Indiana University in Bloomington. Thus, as the animal scans the horizon, it will detect a bright or dark spot in a seemingly uniformly lit sky when its eyes align with Earth's magnetic field.

"The [silvereyes] do exactly what the theory predicts," Gould comments. Because rhodopsin does not respond to red light, that wavelength fails to activate the magnetic sensor and thus fails to provide direction to the birds.

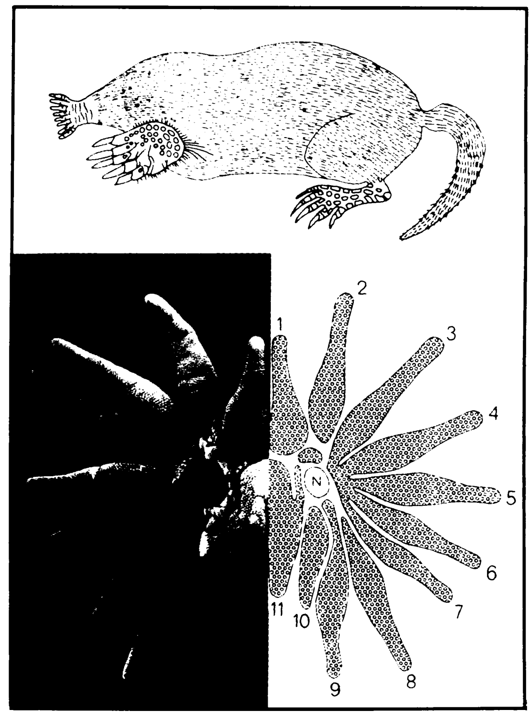
However, Phillips and geobiologist Joseph L. Kirschvink of the California Institute of Technology in Pasadena are not sure about this interpretation. They point out that red light may influence the silvereyes' behavior independent of any direct connection to magnetoreception.

Also, Phillips demonstrated last year that some colors of light cause red-spotted newts to shift their orientation 90°. New data indicate that fruit flies use a similar sensor, says Phillips. But light seemed to exert an "all-or-none" effect on the silvereyes' sensor. Because vertebrates share common mechanisms for the other senses, "I'm really surprised that a different mechanism is popping up," Kirschvink comments. *– E. Pennisi*

Stars and stripes from mole's nose to brain

A star-nosed mole, digging tunnels in the dark, uses 22 fleshy rays that radiate from its nose to feel for edible morsels in the soil. These rays, dense with tactile receptors, enable moles to do "things with that nose that we can't do, that we don't even know," says Jon H. Kaas, a neuroscientist at Vanderbilt University in Nashville. Kaas wondered how such a complex sensory organ would be represented by the arrangement of nerves in the mole's brain.

He and Kenneth C. Catania, a neuroscience graduate student at the University of California, San Diego, examined 15 moles' brains and found that each ray corresponds to a distinct stripe of high neural activity in the cortex. Furthermore, the stripes form the same star pattern as the rays themselves. The investigators reasoned that because each nose ray moves independently, it activates a distinct group of clustered neurons in the cortex.



An alert star-nosed mole (above). Face-on photo shows right side of the nose; drawing of the left side shows circles that map tactile-receptor complexes.

The finding helps explain principles of brain organization, the scientists report in the Aug. 5 NATURE. It supports the theory that "neurons that fire together stay together, and those that don't fire together separate from each other during development," Kaas says. Thus, neural activity patterns generated by distinct sensory surfaces, such as each nose ray, create a corresponding brain map of neurons. What's more, the mapping process begins *in utero*, stimulated by the physical activity of the developing fetus.

Scientists have found similar correlations between sensory organs and brain neurons in other species, Kaas says. Each individual whisker of a rat or mouse is represented by a barrel-shaped cluster of neurons in the cortex. Nerve clusters in the brains of monkeys and raccoons mirror their fingers. In each, the sensory organ is exquisitely sensitive and critical to survival. Small-eyed raccoons, for example, can barely see; instead, they feel vibrations generated by prey in water.

Such correlations are clearest in the compact brains of small animals, Kaas says. Neurons are distributed more broadly in large mammals, making the nerves' spatial patterns less obvious. However, "we think these brains are constructed the same way," Kaas adds. In humans, the most active sensory organ is the skin of the fingers, lips, and tongue. Thus, says Kaas, a human fetus sucking its thumb may stimulate neural activity that in turn shapes the arrangement of nerves in its developing brain.

– B. Wuethrich