WHOSE EYES ARE THESE? Take a guess. Turn to the next page for more animal eyes to identify. Page 51 has the answers.

Wild Vision

Every creature's sight depends on light.

By MARY HOFF

Illustrations by TAINA LITWAK

High above a northern Minnesota lake an osprey soars, scanning the surface for the flash of a fish. In the water below, a minnow spies a snapping turtle just in time to dart out of reach. On shore a dragonfly snatches a mosquito from midair, while a goldfinch keeps an eye out for the bright feathers of a prospective mate.

What do these creatures have in common? They all rely on the sense of vision to thrive and stay alive.

How do they do it? Let's see!

JOSEPH KANE, DEMBINSKY PHOTO ASSOCIATES

What Is Vision?

Vision is the ability to use eyes to learn about the world. Along with the senses of hearing, touch, taste, and smell, vision helps living things find food and shelter, avoid being eaten, and reproduce.

Some creatures don't see anything at all. Without a sense of sight, they rely on other senses for survival. Some creatures can see light and dark shapes, but not color. Some see mainly movement. Some see better than we do. Some even see things we can't see!

Hawk or human, flatworm or fish, living things use chemicals called *pigments* to turn light into a message about their world. When pigments absorb energy from light, they send a message to the viewer: Light was here!

Identify these eyes. Answers on page 51.

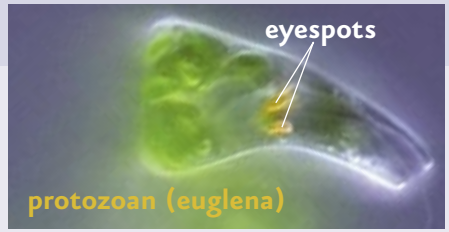
PHOTO CREDITS LISTED ON PAGE 51

Light Sensors

Some animals don't have eyes, but they can still sense light. One eyeless, light-sensing animal is a planarian, a small flatworm that lives in lakes and streams. A planarian has two light-sensing cups atop its head. It uses these cups to avoid light. If light hits the cups from one direction, the planarian moves in the other direction.

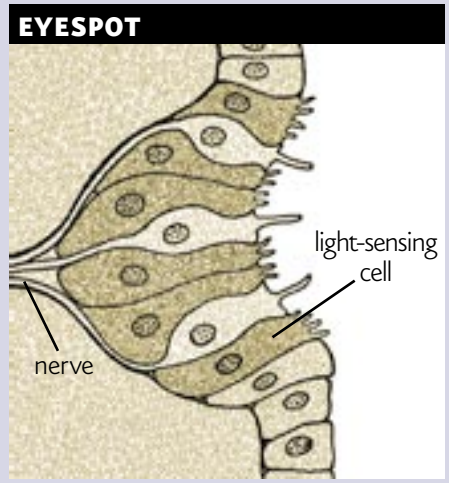
An earthworm has eyespots on its body. Like flatworm eye cups, these only sense light and dark.

BRUCE RUSSELL, BIOMEDIA ASSOCIATES

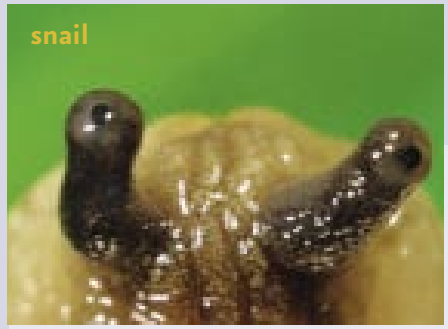


LIGHT-SENSING SPOTS Some protozoa—microscopic creatures that are neither animal nor plant—have eyespots that absorb light.

BRUCE RUSSELL, BIOMEDIA ASSOCIATES



DWIGHT KUHN, DEMBINSKY PHOTO ASSOCIATES



EYESTALKS A snail senses light with little pigment-holding holes at the tips of stalks that stick out from its head.

Arthropod Eyes

Insects, spiders, and crayfish relatives all belong to a group of organisms called *arthropods.* Arthropod eyes are very different from the eyes of humans and other animals with backbones.

Adult insects have up to five eyes. They come in two kinds, simple eyes and compound eyes. Many insects, including grasshoppers, butterflies, and some ants, have both simple and compound eyes.

These eyes have a clear surface called a *lens.* Light enters the eye through the lens. Lenses are light ushers. When you go to a show or a concert, an usher might tell you where to sit. A lens tells light where to go when it enters the eye. With its curved shape, a lens directs light to pigments that turn it into messages for the brain.

Simple eyes also have light-sensing cells. Light travels through the lens and hits the cells, which send a message—"I saw light!"—to the brain.

Compound eyes are made up of tiny pencil-shaped tubes called *ommatidia.* At the top of each ommatidium—where the eraser would be on a pencil—is a lens.

Around the sides—where the wood of a pencil is—are cells that sense light.

At the bottom—the writing part of the pencil—are nerve cell extensions that carry messages about light to the brain. Each ommatidium sees, in a fuzzy way, a little piece of the world.

Compound eyes don't provide clear images of the world around them. But they are very good at detecting motion. That's why it's so hard to catch a fly!

Mary Hoff *is a freelance science writer from Stillwater.*

SPIDER EYES

You probably know that spiders have eight legs. But did you know that most spiders also have eight eyes? All spider eyes are simple eyes.

Jumping spiders have especially good eyesight. How does that help them survive? Hint: Their name comes from how they capture their prey.

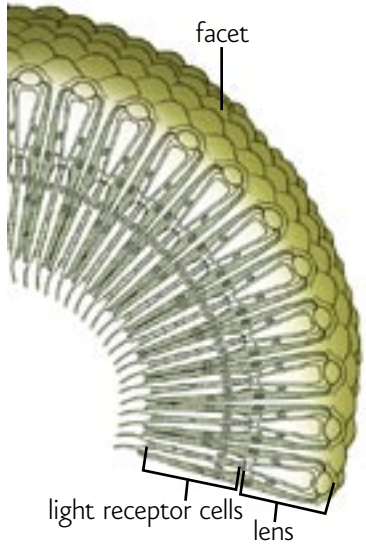
JOHN MIELCAREK, DEMBINSKY PHOTO ASSOCIATES

HOW MANY?

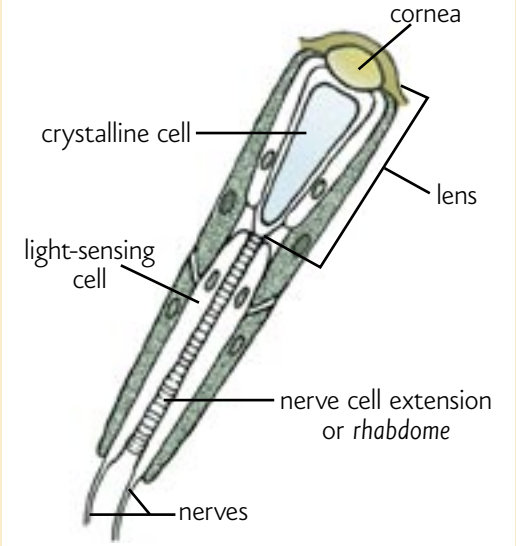
Dragonflies have compound eyes. They have extra good vision because they have thousands of tiny tubes called *ommatidia*. While ants have only a few ommatidia, dragonflies may have as many as 25,000.

SKIP MOODY, DEMBINSKY PHOTO ASSOCIATES

COMPOUND EYE



OMMATIDIUM



Vertebrate Eyes

Deer, ducks, frogs, fish, porcupines, people, and other *vertebrates*—animals with backbones—have two eyes.

Animals with two eyes see a slightly different view with each eye. Where the two views overlap, the brain can combine the signals to get information on the relative distance of objects. This is called *stereoscopic vision.*

Animals in which the views of the two eyes overlap a lot—such as people and owls—have good stereoscopic vision. Animals whose vision overlaps less—such as deer and rabbits—have less stereoscopic vision, but they can see more around them.

SKIP MOODY, DEMBINSKY PHOTO ASSOCIATES

GARY MESZAROS, DEMBINSKY PHOTO ASSOCIATES

FIELD OF VISION

Predators such as wolves and pine martens tend to have eyes pointing forward, giving them a narrow field of vision but good stereoscopic vision.

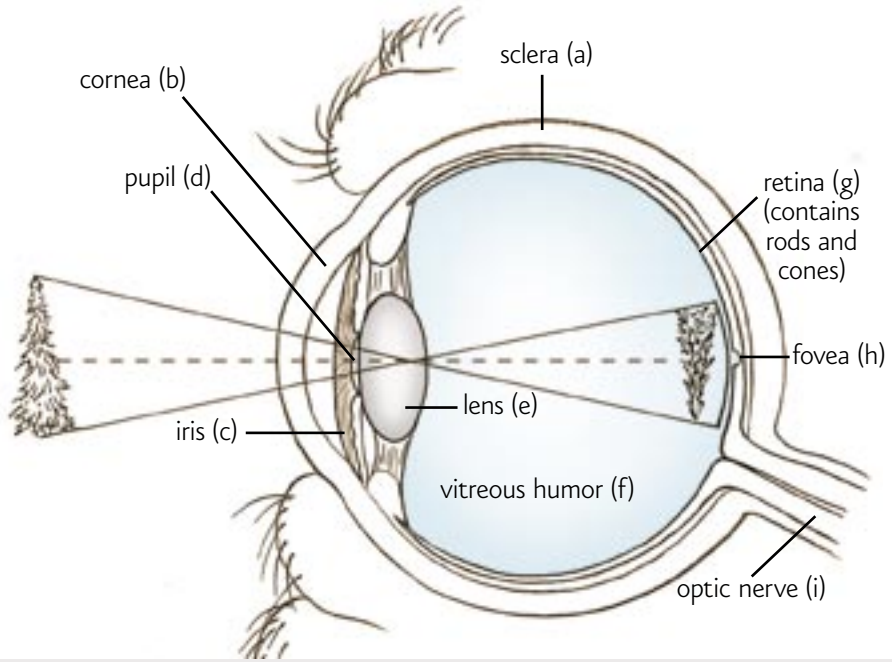
Prey animals such as mice tend to have eyes pointing toward the side, giving them little stereoscopic vision but a wide field of vision. How does this help each survive?

BILL MARCHEL

GROUND VIEW

A woodcock spends a lot of time with its head down and its beak in the mud, digging for food. Its eyes are set so far back on its head that it can see behind as well as in front of itself.

MAMMALIAN EYE



SCLERA (a): tough outer covering of eyeball.

CORNEA (b): clear part of outer covering over iris and pupil. Light enters through it.

IRIS (c): circular, colored part of eye. It expands and contracts to let in more or less light.

PUPIL (d): opening in middle of iris.

LENS (e): clear ball behind iris. It directs light to light-sensing cells.

VITREOUS HUMOR (f): clear, jellylike substance that fills much of eyeball behind lens.

RETINA (g): inner coating at back of eyeball. It contains *rods* and *cones*.

RODS: light-sensing cells that are very sensitive to light but don't provide any information about color.

CONES: light-sensing cells that are less sensitive than rods, but produce a sharper image and contain pigments that enable the eye to see color.

FOVEA (h): part of retina with lots of light-sensing cells.

OPTIC NERVE (i): sensory fibers that send messages from retina to brain.

More Vertebrate Eyes

AMPHIBIAN EYES

Most amphibians (frogs, toads, and salamanders) use vision to find and catch their prey. Most have four kinds of light-sensing cells: two kinds of rods and two kinds of cones. Frogs are good at judging distances and really good at seeing movement, even if it's far away.

A.B. SHELDON

bullfrog

NIGHT VISION

Many animals that are active at night have a reflecting layer behind the retina. This layer is called a *tapetum* (tapeta when you mean more than one). The tapeta help animals see better in the dark by giving the little light that enters the eyes a second chance to stimulate light-sensing cells.

Animals with tapeta include skunks, deer, frogs, and cats. The tapeta also help us see them in the dark! If you shine a light at a cat or dog, for example, the light bounces off its tapeta and back to you, making it look like its eyes are shining. The tapeta are also responsible for the glowing eyes you see in a flash photo of a dog.

BILL MARCHEL

white-tailed deer fawn, *tapeta* glowing

Color Code

Just as music spans a range from low notes to high notes, light spans a spectrum from low energy to high energy. Animals that see color have several kinds of light-sensing cells in their eyes. Each is most sensitive to light with a different amount of energy. The animal's brain combines messages from different kinds of cells to create the rainbow of colors it sees.

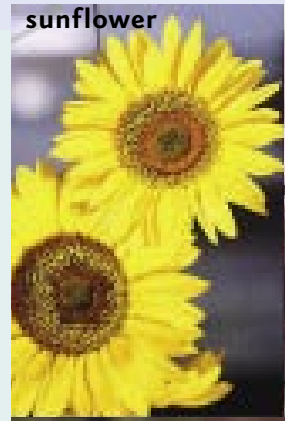
Some animals have no color-sensing cells in their eyes. They see only black, white, and shades of gray. Squirrels and white-tailed deer have two kinds of color-sensing cells. Human eyes have three. Some birds have four or five.

The rainbow of color humans can see stretches from red to orange to yellow to green to blue to violet. The color-sensing cells in our eyes are most sensitive to red (low energy), green (medium energy), and blue (high energy) light.

Some insects lack cells that sense red but have cells that can sense beyond violet in the light spectrum. This ultraviolet light has more energy than violet. Some birds see ultraviolet too.

ULTRA SECRET MESSAGE

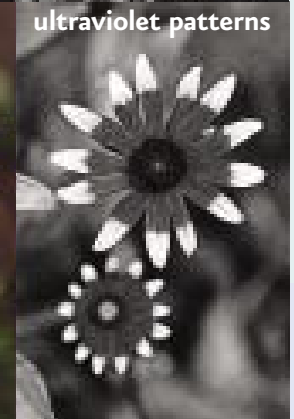
Look at the flowers on the left. That's the way we humans see them. Now look at the same flowers on the right. That's how they may appear to animals that can see ultraviolet. Many flowers have patterns only visible to animals that can see ultraviolet. An ultraviolet pattern is like a secret message that attracts insects that can pollinate the flower. Many plants need pollinators to reproduce.



sunflower

ultraviolet patterns

black-eyed Susan



ultraviolet patterns

ANDREW DAVIDHAZY, ROCHESTER INSTITUTE OF TECHNOLOGY

Get a Good Look

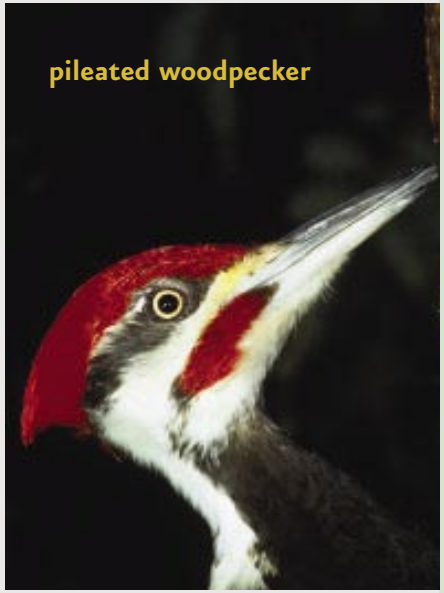
Anyone who wants to find creatures outdoors can take some hints from what scientists have learned about animal vision.

TIPS FOR SPOTTING BIRDS

Birdwatchers and hunters are likely to get closer to a bird when it cannot see them. What can you do to reduce your visibility?

- Wear drab colors and avoid bright colors, especially red, because birds see color well.
- Avoid white clothing.
- Stay as still as you can. If you must move, do so slowly and quietly because birds notice movement.

JOHN D. LUTZ, DEMBINSKY PHOTO ASSOCIATES



BILL MARCHEL

TIPS FOR SEEING DEER

Experienced hunters know that almost as important as spotting a deer is having the deer *not* spot you.

- Avoid wearing blue or purple because deer probably see color, especially in the blue and violet range.
- Assume that when you see a deer, it sees you. A deer can see for a long distance and almost all the way around itself because its eyes are on the sides of its head.
- Stay still because deer detect motion.

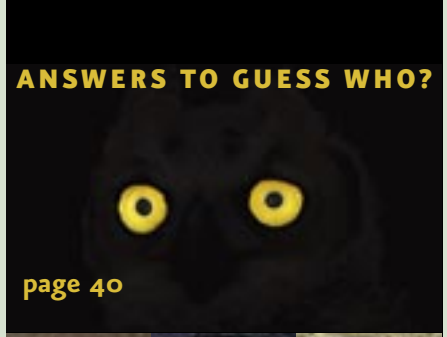
TIPS FOR LURING FISH

Green lure or yellow one? Shiny or dull? Fish have good color vision—but they don't really seem to prefer one color of bait over another. What will catch a fish's attention?

- Choose a lure that stands out against the background of water and vegetation because fish notice contrast.
- Try a lure that reflects light because fish notice flash. For example, a flashy lure mimics the flash of scales on a minnow.
- Move your lure because movement can help a fish decide to strike too. Sometimes fish respond to fast movement, as though the lure were a prey fish swimming through the water. Uneven speed may mimic the movement of a frog or insect.

ERIC ENGBRETSON

ANSWERS TO GUESS WHO?



Answers: Top, page 40: great horned owl. Page 42: A, loon; B, walleye; C, timber rattlesnake; D, timber wolf; E, deerfly; F, raccoon; G, Cope's gray treefrog; H, polyphemus moth (false eyespot on wing); I, goshawk.

EYE PHOTOGRAPHS BY BILL MARCHEL: LOON, WALLEYE, RACCOON, AND HAWK. BY A.B. SHELDON: TIMBER RATTLESNAKE, COPE'S GRAY TREEFROG. BY DEMBINSKY PHOTO ASSOCIATES: DEERFLY BY ROD PLANCK; GRAY WOLF BY SKIP MOODY; POLYPHEMUS MOTH BY SHARON CUMMINGS.

ATTENTION TEACHERS!

To find an online teachers guide for this article, visit www.dnr.state.mn.us/young_naturalists/vision. To learn more about using *Minnesota Conservation Volunteer* as a teaching tool, contact Meredith McNab, meredith.mcnab@dnr.state.mn.us or 651-215-0615.