

PIONEER EDITION

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NATIONAL GEOGRAPHIC *Explorer!*



Fooled You! ¹⁰

Eyes and Light ²

Seychelles Reef ¹⁸



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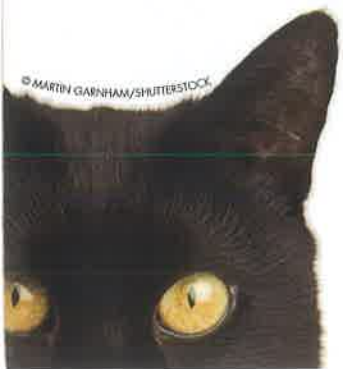
Reading Strategy: After you read each part of the story, stop and ask yourself: "What do you want to remember?"



ING O EYE

Using two or more eyes, people and animals turn light into sight.

BY LESLIE HALL



A falcon flies high above Earth. Suddenly, its sharp eyes spot a tasty mouse in the grass below. The bird dives down. Will it catch its dinner?

The mouse has sharp eyes, too. The eyes on both sides of its head can see almost everything around it. The mouse's eyes help it survive. Will it see the falcon and get away? One thing is for sure. Without eyes, neither animal has a good chance.

Animal eyes come in many shapes, sizes, colors, and numbers. Yet they all have the same job. They catch light. Then, with help from the brain, they turn light into sight. Human eyes work the same way. Look at this page. What you see is light bouncing off the page. The secret is in the rules of light.



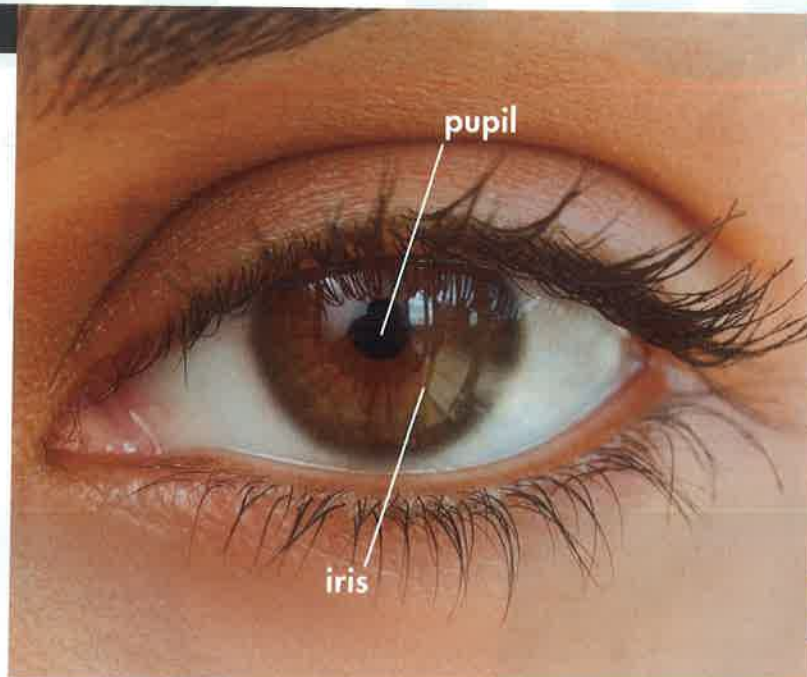
Light Rules

Light is a form of energy, like heat. It can come from the sun or a lamp. Light is the fastest known thing. It can race from the sun to Earth in about eight minutes! It doesn't always go so fast. Water or glass can slow it down.

As light travels, it follows rules. It can reflect, or bounce off things. Sometimes, it is absorbed, or soaked up by objects. It also can bend. These rules affect how and what we see.

EYES IN ACTION

From the outside in, eyes are built to turn light into sight. Take a closer look at the human eye. Which parts catch light? Which parts bend and focus light?





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Sharp Eyes. *This falcon can spot a rabbit from a mile away.*

Light! Eyes!

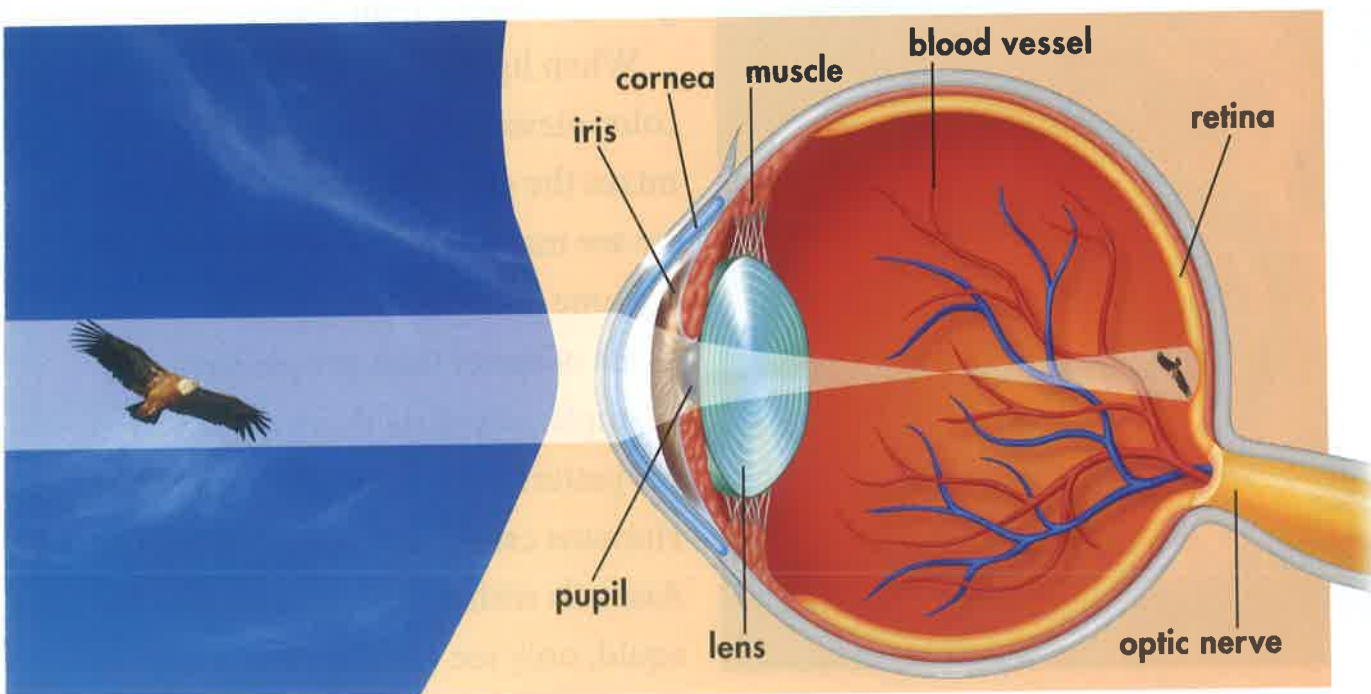
Right now, you are reading EXPLORER magazine. Light hits the page. Some of it bounces off the page, or reflects. Part of this light moves toward your face. Now, your eyes get to work.

First, light hits your cornea. That's the clear covering over your eye. The cornea bends the light. How does it do this? Light slows down as it goes through the cornea. That makes light bend, or slightly change its path.

And Action!

Next, light moves through your pupil. That's the dark center of your eye. Then, it passes through your lens. The lens bends the light, too. All this bending helps your eyes **focus**, or see a clear image.

The image shows up on your retina. It's like a movie screen at the back of your eye. There is one problem. The picture is upside down! Luckily, your brain flips it right-side up.



Night Sight

At night, your eyes need to work to catch more light. A muscle in the eye called the iris helps. It widens the pupil to let in more light. Parts in the retina, called rods, also help at night. Rods let eyes sense black, white, and gray. Each eye has 125 million rods!

Nocturnal animals have great night sight. Some have big eyes for the size of their heads. That helps them catch more light. Others, like cats, have an extra eye part. It's like a mirror. The eye catches light coming in and again when it bounces off the extra part. So a cat's eye is able to catch light twice!

Big Eyes. *This slender loris has extra big eyes to help it see in the dark.*



The Colors of Light

In low light, you see mostly gray. In bright light, you can see many colors. How? Light looks white. Yet it really is made up of many colors.

Look at the picture of the prism on page 7. It shows white light entering the clear glass. The glass bends and separates the colors of light. Now you can see a rainbow of colors!

When light hits an object, the object soaks in some of the colors. It reflects others. A leaf looks green because it reflects mostly green.

Color Vision

It takes more than light to see color. It takes cones. Cones are special parts in the retina. A person's eye has seven million cones! Cones sense red, green, and blue light the best.

When light hits the cones, it sends color messages to the brain. The brain mixes the colors together. That's how we see many more than three colors.

Some animals have different kinds of cones than people have. For example, scientists think a bee can see patterns made by ultraviolet light. Humans cannot see ultraviolet light. Animals with no cones at all, like the squid, only see black, white, and gray.



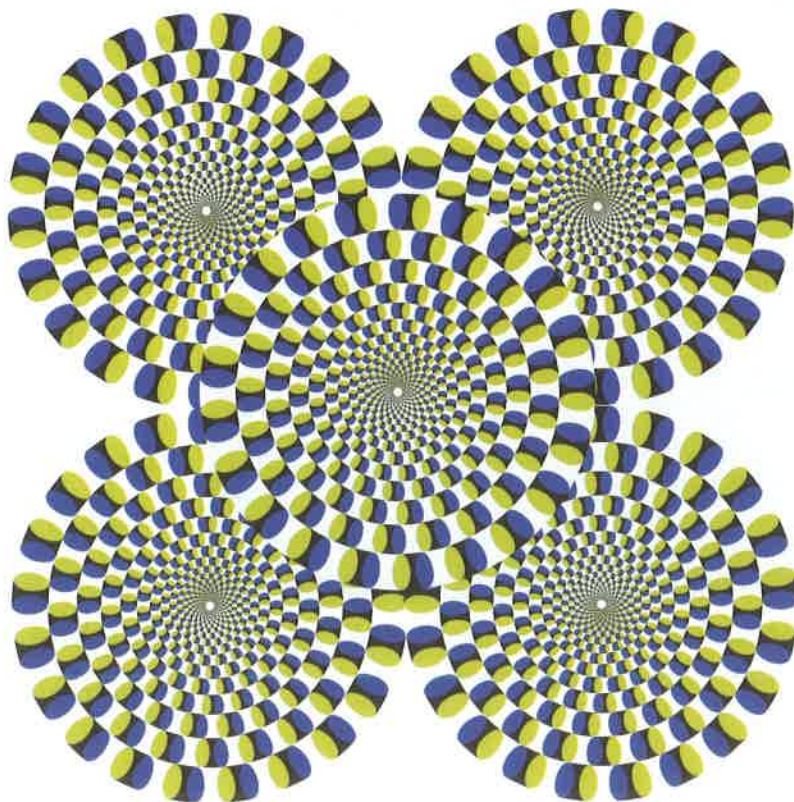
Rainbow Maker. *When light goes through a glass prism, you can see a rainbow of colors.*

© IVANAGOTTI/SHUTTERSTOCK

IS SEEING BELIEVING?

Don't believe everything your eyes tell you. Optical illusions are pictures that trick the brain. Some illusions make you see something different each time you look at the same picture.

Others make you think a picture is moving. Are these circles spinning? Or are your eyes and brain tricking you?



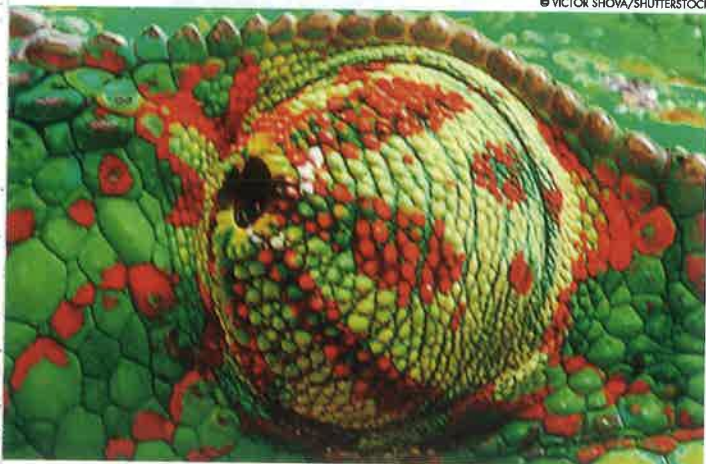
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Eye See You. When a red-eyed tree frog sleeps, it sees through a special eyelid.



Perfect Pupils. A cuttlefish's pupil is shaped like the letter W.



Sneak Peek. Just the pupil peeks out of a hole in a chameleon's eyelid.

Wild Eyes

Animal eyes can be wildly different. Some have oddly shaped pupils. Some move in different ways. Many animals have two eyes. Others have dozens.


Why are they so different? Each animal catches the light it needs to survive. For example, a falcon's eyes are big for the size of its head. So are its retinas. That means its eyes can sense more light.

Also, the falcon's eyes are on the front of its head. They face forward. The falcon sees the same image twice, once through each eye. This type of **vision** helps the falcon know how far away the little mouse is.

Seeing Danger

Other animals, like the mouse, have eyes on the sides of their head. They can see in front, above, below, beside, and even behind their bodies. That may help them escape predators.

A clever chameleon can turn one of its eyes to look backward while the other eye looks forward. Just try sneaking up on a chameleon! Then there is the box jellyfish. It has 24 eyes dangling from its body! This may help it avoid hitting rocks as it swims.



Bug Eyes. Each damselfly eye has thousands of lenses.

© HUB THEUNISSEN/SHUTTERSTOCK

A Bug's Eye View

Insects may have the wildest eyes of all. Look at the damselfly in the picture above. Each of its eyes has many tiny lenses. These eyes are called compound eyes. Each lens catches light and makes an image. The bug's brain puts all the images together into one picture.

A fly's eye has 3,000 lenses. A bee's eye has more than 5,000. The dragonfly has 30,000! All these lenses help an insect see even the tiniest motion around it. That's one reason why some insects are hard to catch!

A Bright Future

Today, scientists study all kinds of eyes. This gives them ideas for new inventions. Imagine an artificial eye that works just like the real thing! Eyes just might help us see a better, brighter future.

WORDWISE

focus: to make a clear image in the eye

nocturnal: active at night

vision: sense of sight, or seeing



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Foiled

A stem that slithers? A flower that flies?
Things in nature aren't always as they seem.



Reading Strategy: As you read this story, use the writer's words to picture how the animals and plants look and act.



FRANCESCO TOMASHELLI/PHOTO RESEARCHERS, INC.

You!

By Susan Blackaby



© TRANSLAMINO/CORBIS

The jungle in Panama is full of strange sights. A twig flies by. A shiny stone hops along. Small white flowers creep forward. But look closer—these are just copy cats. The twig is an insect. The stone is really a frog. And the flowers are mantids. In nature, things are not always what they seem to be.

Nature's Copy Cats

Like the insect and the frog, many animals **mimic**, or copy, other things. This can make the copy cat hard to see. It can confuse a hungry predator. If the copy cat needs it, mimicry can also catch the eye of a passerby. That may help the mimic survive.

A leaf-litter toad is a great copy cat. The veins down its back make it look just like a leaf. The toad's brown colors blend in with dried leaves on the forest floor.

Thorn bugs are good copy cats, too. Each bug looks like a thorn. A lot of thorn bugs together look like a prickly branch. Birds back off!

A Mouthful of Thorns. A thorn bug isn't very safe by itself. Yet when many gather on a branch, their bodies look like thorns.

Disguised as Dangerous

Some mimics copy animals that are **toxic**. For example, coral snakes and milk snakes both have red, yellow, and black stripes. But coral snakes are deadly. Milk snakes aren't. Predators can't tell them apart. So they stay away from both!

A mimic octopus can copy many toxic creatures. Say some damselfish are looking for an octopus meal. In a flash, the octopus makes itself look like a sea snake. It buries all but two of its arms. It waves those two arms like a snake. Sea snakes eat damselfish! So the fish leave the octopus alone.





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Plant Pretender. This flower mantid looks so much like a flower that it can surprise its prey.



Dangerous Duos

Some deadly animals mimic each other for extra protection. Take mantella frogs. There are many species, but two look alike. Both are toxic. Why do they mimic each other?

Mimicry can protect the frogs from shared enemies. If a predator learns the frog is toxic, it will stay away from all look-alikes. This gives each frog a better chance to survive.

These frogs aren't the only dangerous pair. Bees and wasps look alike. Both have stingers to attack enemies. Postman and red postman butterflies look alike, too. And they both taste terrible to birds!

Ant Antics

Ants bite, sting, and fight their attackers. They don't make great meals. So there are a lot of ant wannabes crawling around!

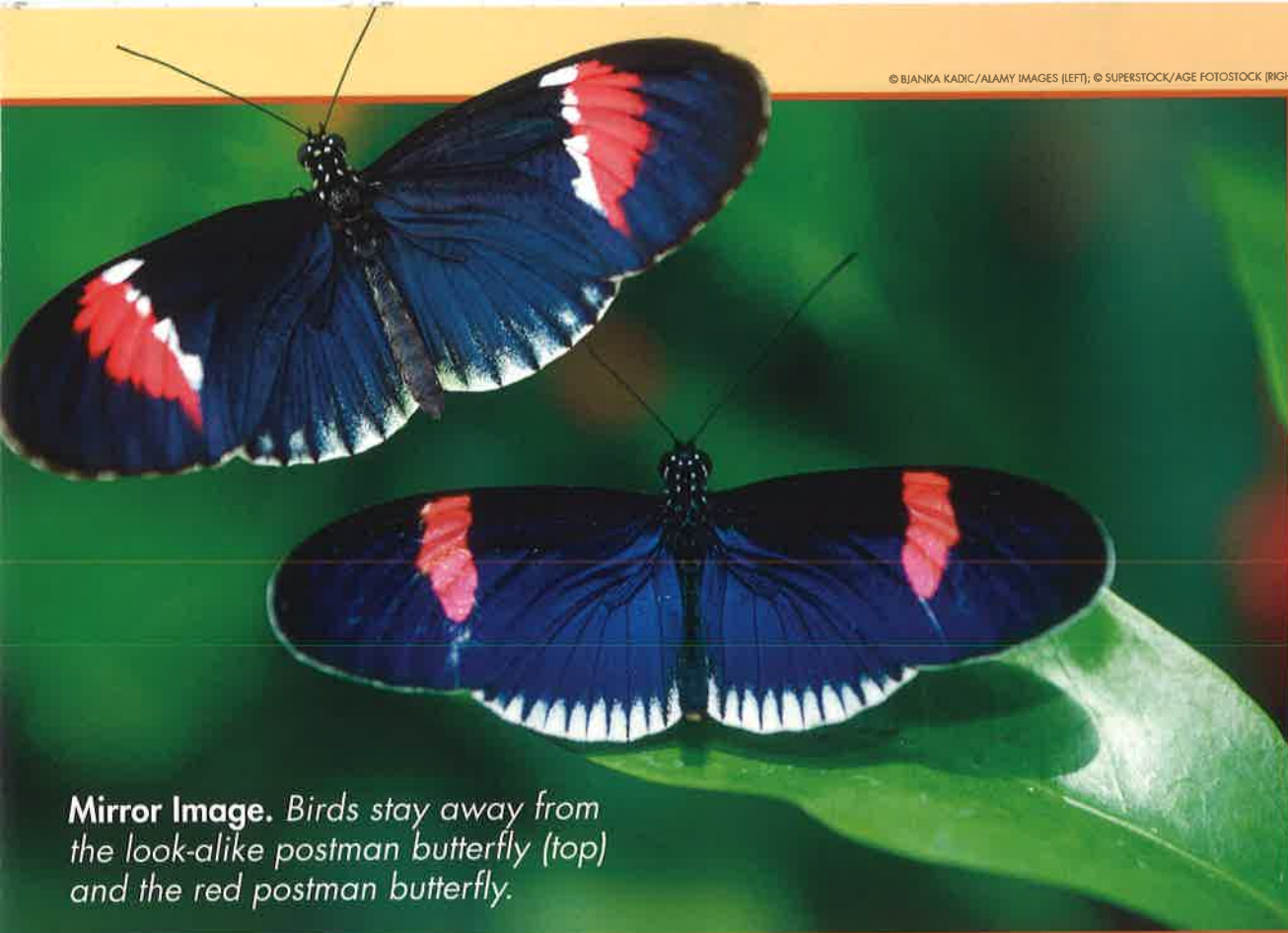
Plant bug nymphs look and act like a poisonous type of ant. But watch out! The real ants may discover the plant bugs' trick. If that happens, the ants will attack them.

Some creatures just act like ants. Some spiders wave their front legs to look like an ant's antennae. They also walk in a zigzag pattern as ants walk. Other bugs move in groups, as many ants do. This keeps them safe since many attackers avoid groups of ants.



JAMES CARMICHAEL JR./NHFA/PHOTOSHOT (LEFT); © MIGUEL VENECES AND FRANK GLAW (RIGHT)

Double Trouble. These mantella frogs are different species. Predators stay away from both of these toxic frogs.



Mirror Image. Birds stay away from the look-alike postman butterfly (top) and the red postman butterfly.

Ant Pretender. Attackers can't tell which is the toxic ant (right) and which is the harmless plant bug nymph (left).



Strange Sightings

Some copy cats try to shock attackers with fake eyes or fake heads. This is what a dead-leaf caterpillar does.

The caterpillar has large spots that look like extra eyes. Also, the fake eyes are on a big, snake-like head! Hopefully, these things will surprise attacking birds. That may give the little caterpillar extra time to escape.

The rubber boa seems to have a head at both ends of its body. It uses the extra head to stay safe. This is handy! Confused predators bite its tail. The snake has a better chance of surviving that. Meanwhile, the snake can fight back with its real head.

Surprise Me. *This caterpillar's fake eyes and large head may surprise attackers.*



Flower Power

Animals aren't the only mimics. Plants can be copy cats, too! Some do it to attract insects. The bee orchid looks and smells like a female bee.

A male bee lands on the flower. It thinks it has found a mate. The flower's **pollen** sticks to its legs. Pollen is what plants need to make new seeds. The bee helps out by taking the pollen to the next flower.

Carrion flowers may be beautiful. But they smell like dead animals! Flies love the smell. They drop in for a sniff. Pollen sticks to their legs. When they fly off, they carry the pollen.

Safe and Sound

Now you know, you can't always believe your eyes, nose—or ears! For example, a tiger moth makes sounds like a toxic moth. This scares away bats. A drongo bird has a call that sounds like a whole flock. Can you spot copy cats? Don't let nature fool you!

Wordwise

mimic: to copy something

pollen: yellow powder plants need to make new seeds

species: type of plant or animal

toxic: poisonous

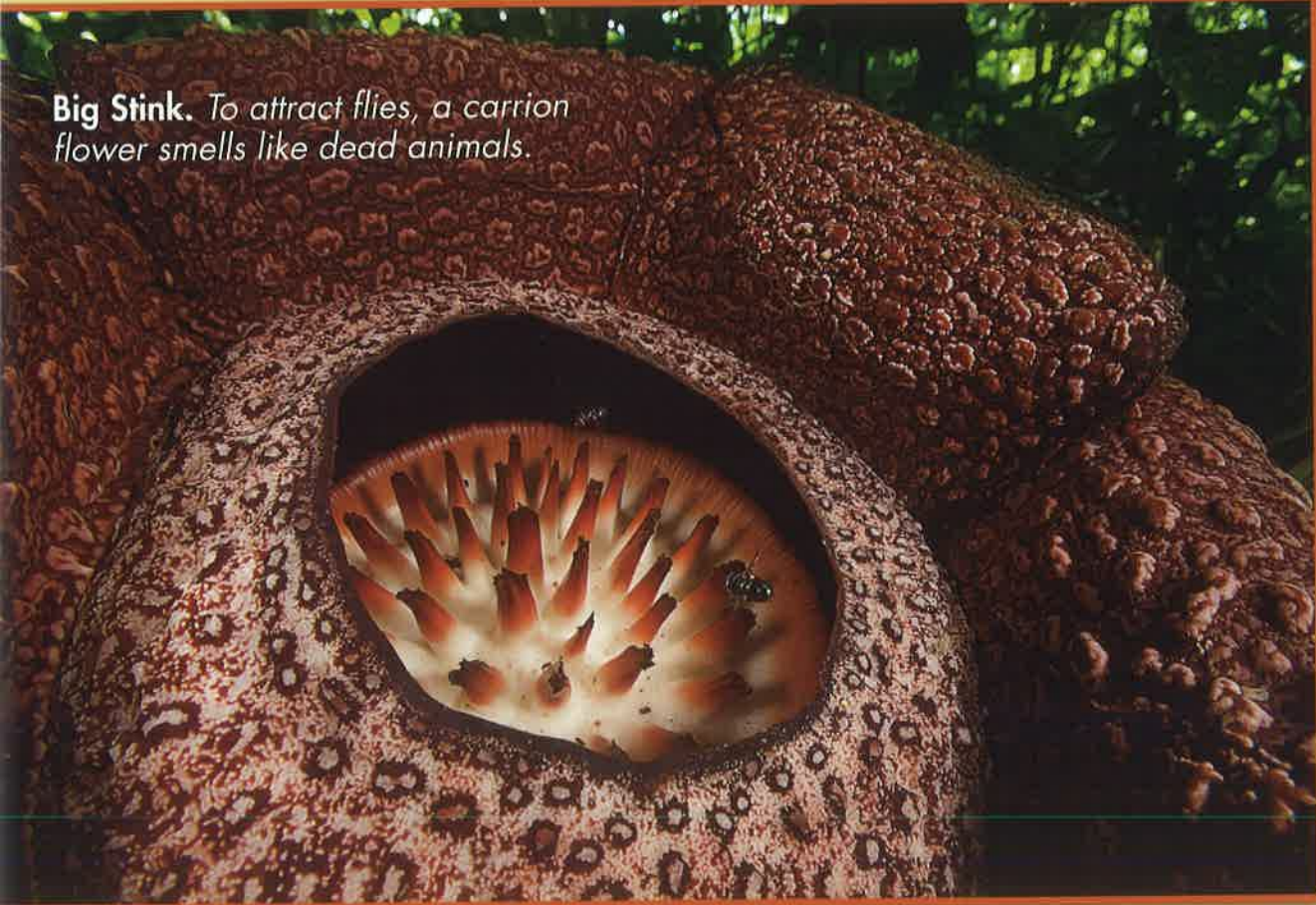
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Bee Blossom. *Male bees think this flower is a female bee.*



© CHRISTIAN ZIEGLER

Big Stink. *To attract flies, a carrion flower smells like dead animals.*




Reading Strategy: To make sure you understand the information, ask questions as you read this story. Then look for the answers.



Search for Survivors

The Seychelles are beautiful islands to the east of Africa. But marine biologist David Smith wasn't there to sightsee. He was there to search for coral reefs...dead or alive.

by Beth Geiger



David Smith and seven other divers have come to Curieuse Island to explore a reef. Splash! They dive into the ocean.

They find broken corals on the ocean floor. The reef seems dead. But wait! Smith thinks he sees a glowing rock. It is a living **colony**, or group, of small animals called coral polyps.

Construction Zone

Coral polyps are builders. They make **coral reefs** by building skeletons around themselves. When the polyps die, young polyps build on the old skeletons. That's how a reef grows.

Coral reefs grow to many sizes. Some are small. Others are as large as cities. The Great Barrier Reef in Australia is the biggest reef.

Coral reefs grow in many shapes, too. Some look like trees. Others look like deer antlers. Still others look like eggs or human brains!

The coral polyps eat small plants called algae. But the algae do not die. They stay in the polyps' tentacles. There, they make food that the polyps share. Their colors shine through a polyp's clear body. The algae help to make the reef as bright as a rainbow.



Variety Show

Smith and the other divers have come hoping to find a healthy reef. He says there is much to see. Damselfish graze on algae. Narrow filefish slip by corals. Sea slugs slime the ocean floor. Moray eels hide in cracks.

Fish called sweetlips hold their mouths open. Cleaner fish duck in to clean. Other fish wait their turn.

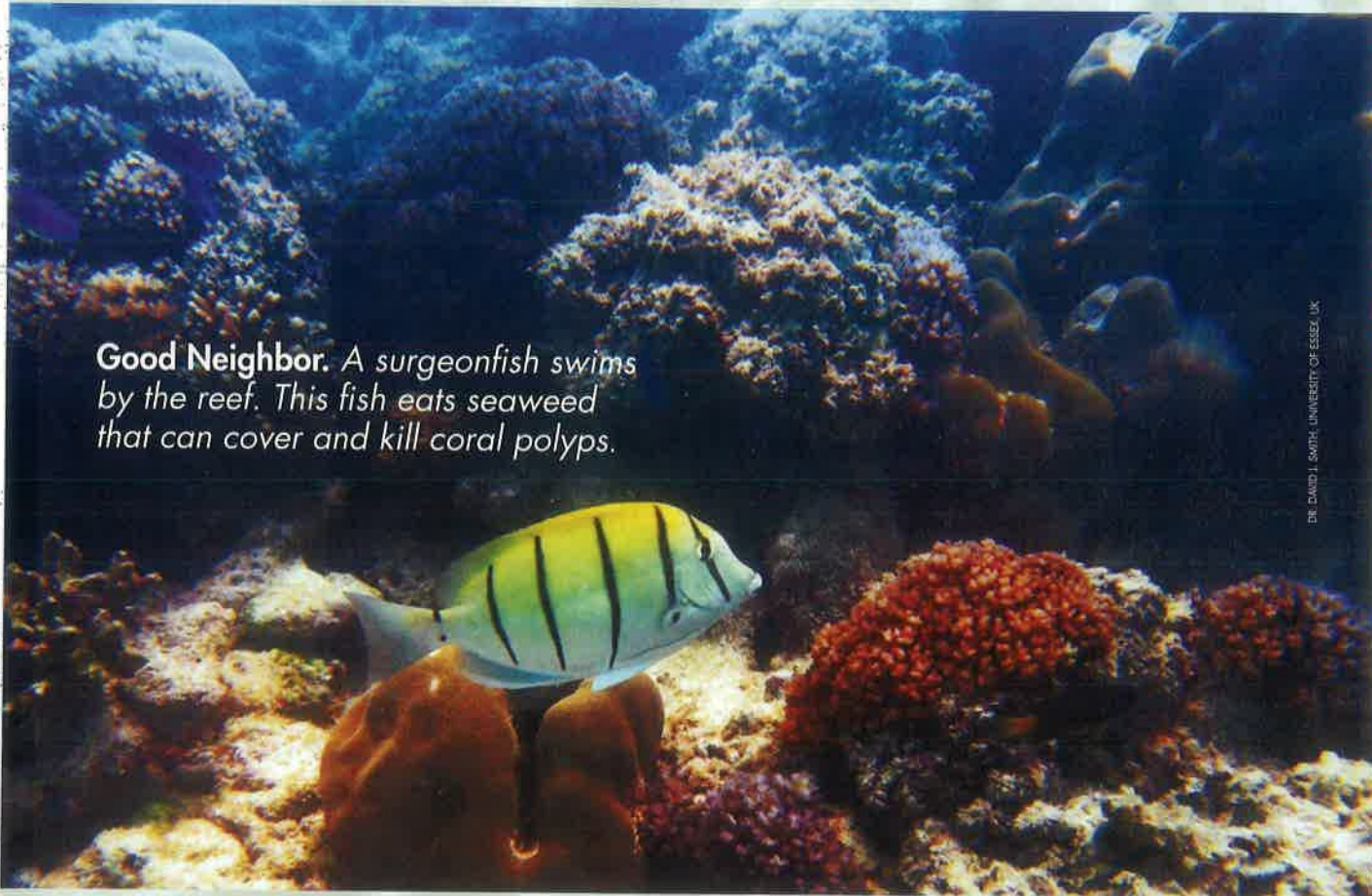
Each of these reef creatures has **adaptations** for staying alive. Those are behaviors or body parts that help an animal survive. For clownfish, survival isn't a thing to joke about.

Sights and Sounds

The clownfish hides in the stinging tentacles of an anemone. The fish is coated in slime. This slime keeps the clownfish safe from the stinging tentacles. It does not get zapped.

Smith says a blue surgeonfish looks gentle. But watch out. It can slice into flesh with its sharp spines. Ouch! It is best to watch this dangerous fish from a distance.

There also is a lot to hear in the reef. Fish and shrimps beep and chirp. Crunch! A parrotfish grinds a piece of coral with its strong teeth.

A photograph of a surgeonfish with a yellow body and black vertical stripes swimming over a diverse coral reef. The reef is covered in various types of coral, including branching and brain corals, in shades of blue, purple, and red. The water is clear and blue.

Good Neighbor. A surgeonfish swims by the reef. This fish eats seaweed that can cover and kill coral polyps.

DE DAVID J. SMITH, UNIVERSITY OF ESSEX, UK