ANIMALS *speak* COLOR

A new exhibition reveals how they acquire the language and use it.

To delight and instruct, *The Language of Color* at the Harvard Museum of Natural History corrals a many-hued menagerie of birds, mammals, reptiles, fish, mollusks, and wonderfully iridescent beetles from the University's numerous collections of specimens, and adds a colony of live dart frogs in a miniature jungle. With text, videos, and engaging interactive computer displays, it offers revelations to humans not fluent in the language of color.

The poisonous dart frogs use conspicuous color to tell predators that they are not good to eat. Similarly, a venomous coral snake sports rings of bright color to advertise that it isn't to be messed with—by a bird considering it for lunch, for instance—while a milk snake, which isn't poisonous and could be taken quite safely, looks much like a coral snake and trades on the latter's reputation. Bauer fellow Marcus Kronforst studies a bad-tasting species of butterfly that is orange, black, and yellow, and other species of unsavory butterflies that mimic its color and pattern to form a uniformed corps of the unappetizing.

Colors can conceal as well as warn, as in, "You can't eat me because you can't see me—I'm a cuttlefish and can change my color to match my background in a millisecond." Or, conversely, "I'm so well camouflaged with stripes [or spots] that you can't see me creeping up...and *I'm* going to eat *you.*" Hopi Hoekstra, Loeb associate professor of the natural sciences, studies the genetic mechanisms at work in a species of mouse that adapts to its environment by being sand-colored if it lives at the beach and dark if it lives inland.

HM Visit harvardmag.com/extras to view a video of the exhibit.

Perhaps some of the richest language of color has to do with sex. Janis Sacco, director of exhibitions, offers such examples as a male bird of paradise from New Guinea that not only sports much bolder colors than any female of the species, but also a ludicrously long tail. "Pick me as a mate," he says, "because I have this splendid thing you females may select mates on the basis of, and I must be fit because I have managed to survive despite having to carry it around with me while wearing these obvious colors." One sex story fit for the tabloids concerns wrasses and parrotfish. In many species, the females in a group are much less

Tail of the panther chameleon, *Furcifer pardalis,* of Madagascar. The same species appears on the cover. Chameleons do not change color to match their backgrounds, but to communicate excitement, anger, fear, and other emotions.

Photograph by Paul Bratescu

colorful than the dominant male. If the male gets eaten, the dominant female changes her sex—and puts on those brilliant colors.

But note: an animal's color depends on how it appears to the intended observer, and animals don't necessarily see color as humans do. Apparatus at the exhibition allows visitors to experience color through others' eyes. A deer, for instance, cannot distinguish reds. A pair of parrots looking each other over may appear richly colored to us, but to the parrots, who see ultraviolet light, they are even better—intensely, bodaciously flamboyant—and must knock each other's socks off.

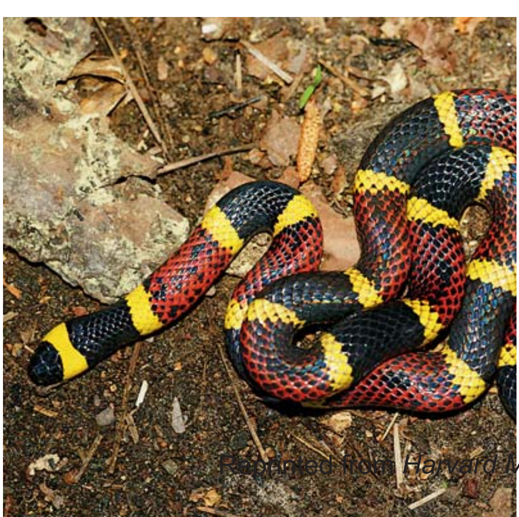
The *whys* of the language are various, and so are the *hows.* Many animals acquire the language of color through pigments that they themselves metabolize. Others take in pigments through what they eat and show the pigments through their skin, as in the case of the scarlet ibis, which eats crabs and shrimp that eat red algae. And some colors are produced not by pigments, but by microstructures in fur, feathers, or scales that reflect only certain wavelengths of light. If you're Kermit the Frog, you are green not because you have green pigment, but because you reflect blue light through yellow pigment. Visitors to the exhibition can examine, as if through an electron microscope, the inner parts of a tiny barb on the feather of a bluebird to see how this reflective trick is done. The white hairs of a polar bear or of an arctic fox's winter coat, on the other hand, are *clear*—they lack pigment to absorb wavelengths selectively, or structures to reflect certain wavelengths—so they reflect back the entire spectrum, making the animal look white to us.

The Language of Color teaches that colors and the percep-

Many nudibranchs, a type of mollusk, are toxic or bear spines. This species, *Chromodoris magnifica,* uses bright warning coloration—aposematic colors—to signal predators to stay away.

OPPOSITE: PHOTOGRAPH BY COLIN TEO. RIGHT: TONY RINALDO. BOTTOM LEFT: KORY ROBERTS. BOTTOM CENTER: ROGER T. HANLON. BOTTOM RIGHT: BRIAN GRATWICKE

Left: The male Lady Amherst pheasant, *Chrysolophus amherstiae,* with his magnificent (and cumbersome) tail, says "Look at me!" to prospective mates. Below, left: The nonvenomous milk snake at top, *Lampropeltis triangulum,* lives side by side with the poisonous and brightly colored Texas coral snake at bottom, *Micrurus tener*, and takes on similar colors to fool predators into avoiding it, too—a trick called Batesian mimicry. In habitats where coral snakes are absent, such as New England, the milk snake's colors are more subdued. Below, center: In the blink of an eye, as a video shows, the giant Australian cuttlefish, *Sepia apama,* can change color to blend with its background. Below, right: The exhibition features a display of live frogs that, in the wild, have in their skins bitter, alkaloid toxins (derived from what they eat) strong enough to sicken or kill animals much larger than themselves. Their bold colors trumpet a warning. The dyeing poison frog, *Dendrobates tinctorius,* a blue morph of a species native to Suriname, appears at top, and at bottom, the phantasmal dart-poison frog, *Epipedobates tricolor,* from Ecuador.



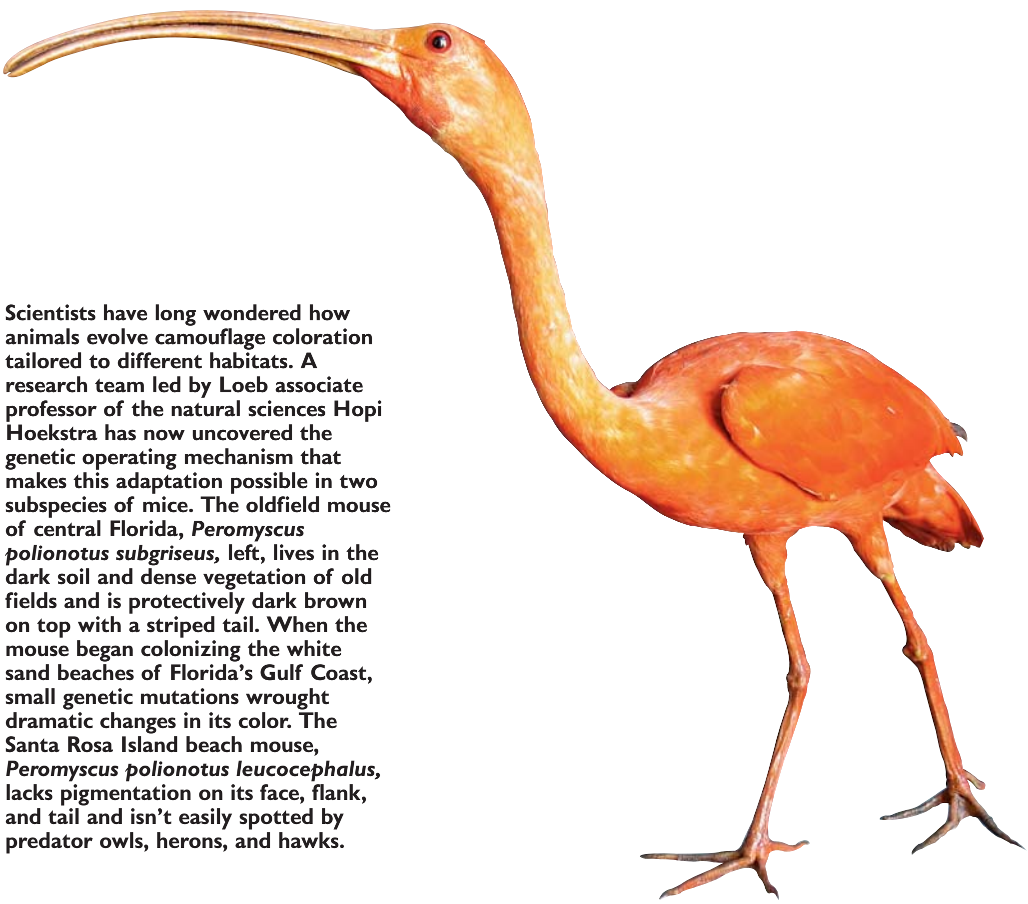
tion of them co-evolve. "Evolution R Us," says museum executive director Elisabeth Werby, who conceived the exhibition, "and color is a great way to get people excited about evolution, not as some dusty old theory that began and ended with Darwin, but as something which continues to inform all biology. Evolution is responsible for the amazing diversity and variety of nature showcased here. Evolution allows us to ask and answer the questions that researchers at Harvard are asking, such as, 'Why does the zebra have stripes?' Instead of reverting to the *Just So Stories*, we can use evolutionary theory to start to answer these questions." ~CHRISTOPHER REED

The Language of Color *runs through September 6, 2009. For information about the museum and exhibition hours, visit www.hmnh.harvard.edu.*




What humans see of the world is not all there is to see. An interactive computer display allows us to see how a deer, a whale, a bee, a fish, and a bird might perceive the world. Although we cannot visualize all that a parrot sees, for example, we can note how ultraviolet light, which it does detect, changes the emphasis of plumage on these two white-bellied caiques, *Pionites leucogaster,* perhaps evaluating each other as potential mates. A blossom of *Rudbeckia hirta,* a black-eyed Susan, under normal light looks simply yellow to us. The black-and-white image shows the same flower under UV light and reveals patterns that have probably evolved to attract pollinator bees and butterflies that can see the UV part of the spectrum. Bottom: A group of mares of *Equus burchellii,* the Burchell's zebra of the African plains. The exhibition explores research into how the zebra gets its stripes. What are the stripes good for? One theory is that when animals are in groups, the stripes make it more difficult for a predator to distinguish the outline of a single individual.

Nearly all the blues we see in the animal world, including the colors of the bluet damselfly above (of the genus *Enallagma*), are produced not by blue pigment but by blue light reflected by tiny tissue structures that scatter light and often enhance it. The scarlet ibis (below), *Eudocimus ruber,* gets its color from carotenoid pigments in the food it eats.



Scientists have long wondered how animals evolve camouflage coloration tailored to different habitats. A research team led by Loeb associate professor of the natural sciences Hopi Hoekstra has now uncovered the genetic operating mechanism that makes this adaptation possible in two subspecies of mice. The oldfield mouse of central Florida, *Peromyscus polionotus subgriseus,* left, lives in the dark soil and dense vegetation of old fields and is protectively dark brown on top with a striped tail. When the mouse began colonizing the white sand beaches of Florida's Gulf Coast, small genetic mutations wrought dramatic changes in its color. The Santa Rosa Island beach mouse, *Peromyscus polionotus leucocephalus,* lacks pigmentation on its face, flank, and tail and isn't easily spotted by predator owls, herons, and hawks.

TOP: DAVID CAPPAERT, MICHIGAN STATE UNIVERSITY/BUGWOOD.ORG. LEFT, TOP: ALABAMA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT/AUBURN UNIVERSITY. LEFT, BOTTOM: SHAWN CAREY. RIGHT: ANDREW SCHAPER. OPPOSITE, TOP: PHOTOGRAPHS BY ANDREW DAVIDHAZY/ROCHESTER INSTITUTE OF TECHNOLOGY. OPPOSITE, BELOW: PARISH JENKINS, MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY