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Climate Change Is Altering Animals' Colors

Lizards in France have grown lighter in color and so are many insects and birds across the globe. The effects of a changing climate are plainly visible throughout the animal kingdom

BY MARTA ZARASKA

Brown-lipped snail (Cepaea nemoralis). Blickwinkel/Alamy Stock Photo.

Climate Change

Zebras, a children's tale goes, became striped after "standing half in the shade and half out of it." While the author, Rudyard Kipling, wasn't a biologist, his story may hold some truth: research shows that when temperatures rise,

animals become lighter in color, resembling the sun-exposed parts of the storybook zebra. In the humid shadows, meanwhile, darker hues prevail.
As our planet warms up and rain patterns shift, the feathers and skin of many species are changing colors, often getting lighter. Snails in the Netherlands are going from brown to yellow. In a species of tropical bee in Costa Rica, the proportion of orange to blue individuals is increasing. Lizards in France are turning lighter, and so are many insects and birds across the globe. “Under global warming one would expect that the darker species, and darker individuals, might decline,” says Stefan Pinkert, an ecologist and evolutionary biologist at Yale University.

There are two main ways in which animal skin, fur and feathers are colored. Some of the hues we perceive are from the interaction of light with the microstructure of feathers or scales—think of a hummingbird that changes color depending on the angle at which you spot it. Others are caused by pigments, molecules that absorb light, such as carotenoids, which produce yellow, red and orange colors, and melanins, responsible for black, gray, brown and rustlike hues.

Melanins, the most common pigments in birds and mammals, may be affected by rising temperatures and changing rain patterns. “If you have more melanin in your skin or your fur or feathers, then it tends to absorb more heat,” says Matthew Shawkey, an evolutionary biologist at Ghent University in Belgium. This may be a disadvantage as the temperature soars, he says, because it can cause animals to overheat. On the flip side, if it rains more, pathogens tend to thrive. In such conditions, dark melanins can be protective because they “toughen up tissues,” Shawkey says.

A rule proposed by Charles Bogert, an American herpetologist, in a 1949 paper, predicts that hotter climates should have a higher presence of ectotherms, or so-called cold-blooded animals, that are lighter in color and therefore less likely to overheat. (These animals, such as reptiles and insects, can’t regulate their own body temperature, and they rely on external heat sources.)

In recent years, science has not only confirmed Bogert's rule but also extended it to endothermic, or warm-blooded, species. It's not just frogs, toads, snakes and midges that are lighter in warmer regions; birds get lighter as well. A 2024 analysis of more than 10,000 species of birds showed that in hot places, white and yellow feathers win over blue and black ones.

With global warming, some animal populations are becoming even lighter. Between 1967 and 2010, as temperatures in the Netherlands rose by 1.5 to two degrees Celsius, brown land snails gave way to yellow ones. Between 1990 and 2020 in the U.K., dragonflies and damselflies got progressively lighter, too—as Pinkert and his colleagues found in a 2023 paper. And if you've looked closely at some dragonflies, you may have noticed that they now have fewer dark ornaments on their wings.

In one recent study conducted in North America, male dragonflies from 10 different species had the smallest melanin-based color patches on their wings in the warmest years between 2005 and 2019. In this same time period, pretty spots also seemed to pale on Mediterranean Blue Tits—tiny birds with yellow chests and azure, hatlike markings on their head. Between 2015 and 2019, the blue head patches of tit populations around Montpellier, France, have gotten lighter by approximately 23 percent—a change related to the rise in local temperatures.

Experiments confirm the observational data: hot temperatures make animals turn lighter. In some cases, an individual may simply produce more or less pigment depending on temperature. Vivid dancer damselflies, for instance, can change their colors from dark to light and back to dark as mercury fluctuates throughout the day. Male chameleon grasshoppers go from black at 50 degrees Fahrenheit (10 degrees C) to turquoise at more than 77 degrees F (25 degrees C). "If you raise many different species of insects in cold temperatures, they develop darker, and if you raise them in warmer temperatures, they get lighter," says Kaspar Delhey, an evolutionary biologist at the Max Planck Institute for Biological Intelligence in Seewiesen, Germany.

Such effects are not limited to insects. Field experiments conducted in Spain showed that vultures that hatch in nests exposed to more sunlight have paler feathers than those that grow in more sheltered sites. It wasn't simply that the birds were sun-bleached—the melanin in their plumage wasn't degraded, as it would be if destroyed by sunshine. There was simply less of it to begin with.

Besides individual ability to adjust color based on temperature, animal populations living in warming regions may become lighter simply because paler animals move into new areas. There may be genetic changes at play, too, Pinkert says, but we still have "a critical knowledge gap" about how such evolution may be playing out.

While Bogert's rule appears straightforward in regions that heat up yet remain dry, such as the Mediterranean, if rainfall increases alongside temperatures, species may turn dark instead of light. In 1833 Constantin Gloger, a German ornithologist, suggested that in humid places feathers are more likely to be black than white. One reason may be camouflage. In wet habitats, "there is more vegetation; the backgrounds are darker, and so a darker animal might be more camouflaged," Delhey says. Another explanation for Gloger's rule may be protection against pathogens, which often flourish in humid climates. A 2020 study of 16 bird species showed that feathers containing more melanin are better at resisting damage by nest bacteria. "The goal of this molecule is to protect the organism against various sources of stress. For instance, the feathers which are black are stronger," says Alexandre Roulin, an evolutionary biologist at the University of Lausanne in Switzerland, who was not involved with the study. Research suggests that melanin molecules may not only inhibit parasites but also reinforce cells, creating a barrier against pathogens.

When Delhey tested what happens when both temperatures and precipitation increase with climate change, he found that, at least in birds, "the effects of humidity are generally much, much stronger," he says. Delhey and his colleagues mapped the plumage colors of all species of passerine birds, of which there are more than 5,000, to climates in which they live. They found that the animals were lighter where warm and dry but darker where warm and

humid. Roulin and his colleagues found something similar in a 2024 study of thousands of museum specimens of barn owls collected across the globe between 1901 and 2018. The researchers showed that over time, plumage colors became lighter where the climate got warmer and drier but darker where both temperature and precipitation increased. “Where the climate change was stronger, the change in color was stronger,” Roulin says.

Yet changes in precipitation patterns caused by global warming are less straightforward than a future increase in temperatures. This is why, Delhey says, if he were to predict a general trend across animals, “based on the effects of temperature, they should get lighter.” Cold-blooded animals, such as insects, may also respond more strongly to heat rather than humidity, he says, yet research on this is still lacking.

Overall, shifts in animal coloration are expected to be subtle. “We are not going to see such a dramatic change that we’re not going to recognize species,” Delhey says. From a biological perspective, however, “that small difference may mean whether a species can survive,” he says. Meanwhile the animals that do adapt by changing their colors can serve as a visual reminder of humanity’s giant environmental footprint that has unsettled the entire planet. “You can track with your eyes what is the impact of climate change,” Roulin says.

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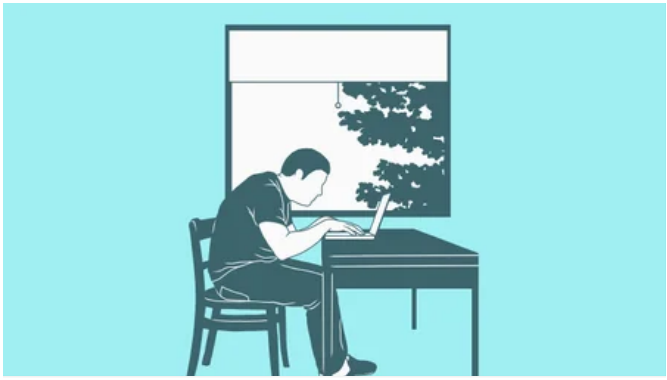

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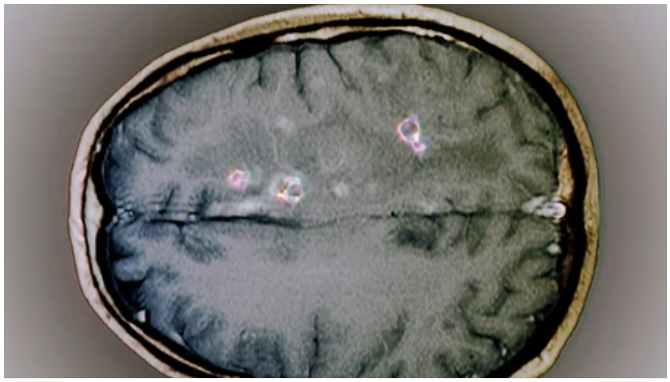

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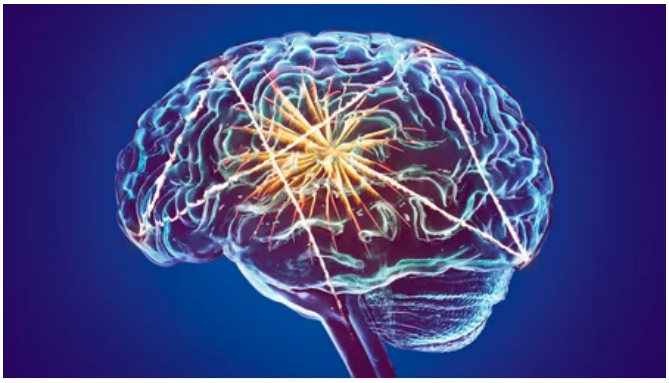

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