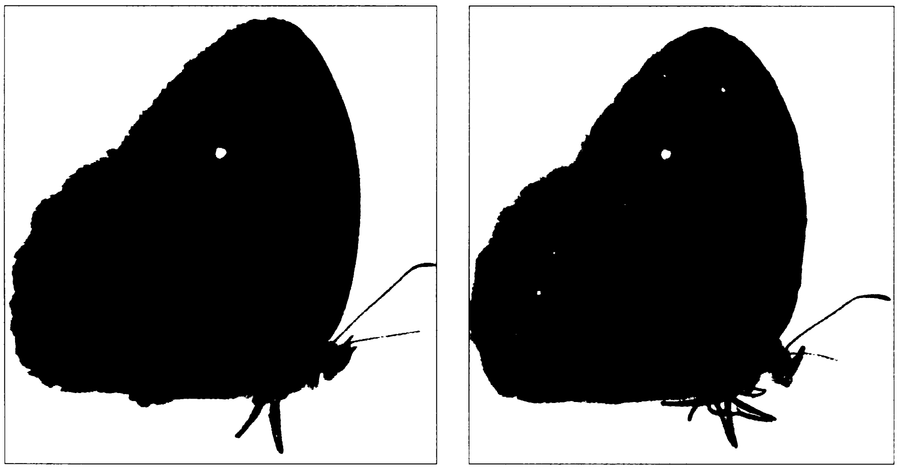
Butterfly Wings It with a Few Genes

While folklore claims that leopards can't change their spots, butterflies can shed theirs with surprising ease. An international team of biologists has found that butterflies can alter their wing patterns in just a few generations using existing genes that served another purpose earlier in embryonic development.

Evolutionary biologists have tracked butterfly markings and coloration for decades because of the insect's ability to adjust to predators and environmental stress. "Butterflies are an obvious choice [to study]—they're visually dramatic creatures," says Sean Carroll of the University of Wisconsin-Madison, a coauthor of the new report in the Nov. 21 NATURE.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Of two new butterfly species, the plain one (left) differs from its more vivid relative (right) by only a few genes.

The researchers focused on the East African butterfly *Bicyclus anynana.* This extraordinary insect is born looking so dramatically different from wet to dry season that entomologists had long considered it two distinct species.

In the wet season, when temperatures are higher and food is plentiful, *B. anynana* sports distinctive bull's-eyes, or eyespots, on its wings. Enticed by this ornamentation, predators attack the wings of the insect instead of its body. As the dry season dawns, the wings lose their eyespots, and the insects soon resemble the brown leaves littering the forest floor. *B. anynana* breeds year-round, producing either spotted or plain offspring according to the season.

"The fundamental question is, What generates patterning?" says Carroll.

The team from Wisconsin, the University of Leiden in the Netherlands, and the University of Edinburgh in Scotland first tracked *Distal-less,* a gene that regulates development in the arthropod embryo, to determine when patterns begin to form in the butterfly's wings. From earlier work, they knew that the gene turns on at the sites of future wing markings (SN: 7/9/94, p. 23). Only one cell thick, the wing acquires its color and markings in response to simple chemical messages sent from cell to cell.

By tracking the activity of *Distal-less*, the team learned that eyespots bloom late in the final stages of growth, just before butterflies emerge from their cocoons. "Which is what you expect, since the butterflies are getting ready for whatever season they'll emerge into," says Carroll.

Next, the researchers mimicked permanent wet and dry seasons in the lab, breeding groups of butterflies at constant high or low temperatures. Within 20 generations, two distinct new species had evolved. The warm weather line developed eyespots regardless of the temperature it emerged into, while the cold weather variety never developed eyespots.

Carroll notes that only five or six genes changed between the two species. In evolution's fierce contest between camouflaged butterflies and sharp-eyed predators, species that adapt quickly and efficiently, like *B. anynana*, have an advantage. "This butterfly evolves rapidly through small genetic changes," Carroll says.

"This paper is one of the very few really tight collaborations between good people in molecular genetics, developmental biology, and evolutionary biology," notes H. Frederik Nijhout of Duke University in Durham, N.C. In his view, the study gives the emerging field of developmental evolution its first set of genetic tools for understanding the evolution of butterfly color patterns.

"Ultimately, the more interesting story may be *Distal-less*," says Nijhout. In arthropod embryos, the gene controls where appendages grow. By demonstrating that the same gene orchestrates where eyespots appear in butterfly wings, the researchers have shown that what a gene does depends on the animal's stage of development, he says.

"It means you can manage development with far fewer genes than you might have thought," he says. —*D. Vergano*

Probe makes unintended splash

A Russian probe bound for Mars and carrying 200 grams of plutonium crashed into the South Pacific minutes after its launch on Nov. 16. Although the submerged plutonium does not appear to pose a threat, some worry that the cash-strapped, understaffed Russian space program may have hit bottom.

The Russian space agency reported that the fourth-stage booster engine of the probe, Mars '96, misfired. Space policy analyst Marcia S. Smith of the Congressional Research Service in Washington, D.C., says it's unclear whether the crash stemmed from a rocket malfunction or a failure of the craft to command the fourth-stage engine to fire.

U.S. officials who thought they were tracking the plutonium-bearing probe issued a warning on Nov. 17 that Mars '96 might hit Australia. In fact, the probe had already gone to its watery grave a day earlier, and the U.S. team was monitoring remnants of the detached rocket engine, Russian scientists said.

Mars '96 featured four landers, including two designed to penetrate the Martian surface. Landers won't fly again until 2001, when NASA's Mars Surveyor 2 is slated for launch. Russian participation in that flight is now less certain. If the Russians don't fly a follow-up probe scheduled for 1998, it might be difficult for them to retain scientists and engineers until 2001, Smith says.

Russian scientists have conceded that time and money constraints prevented them from fully testing the 22 scientific instruments on Mars '96. Whether that extended to an incomplete evaluation of the craft and its rocket remains to be seen, says Louis D. Friedman of the Planetary Society in Pasadena, Calif. —*R. Cowen*