Prenatal Competition

ABOUT 150 YEARS AGO Darwin proposed that the different developing body parts of an organism might compete with each other for resources as they grow within an egg or a womb. That competition, Darwin believed, would determine the final size of the body parts. More recently biologists have favored the idea that genetic constraints, not competition, determine the size of developing organs. But now it seems that Darwin may have been right after all.

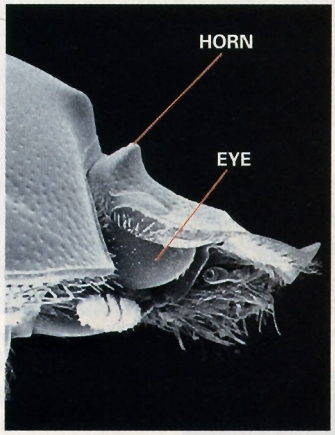
Biologists Fred Nijhout of Duke University and Douglas Emlen of the University of Montana had been studying metamorphosis in insects. A caterpillar, for instance, has small clusters of cells destined to become the wings, legs, and mouthparts of a butterfly. The cells don't grow much as the caterpillar eats leaf after leaf. But when the caterpillar stops feeding, just before metamorphosis, the cells "suddenly grow like gangbusters," says Nijhout. This peculiarity, he realized, gave him the perfect opportunity to

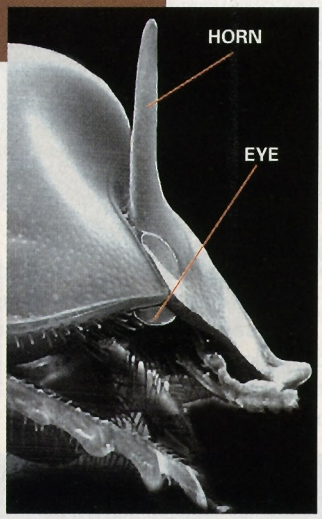
TOP: Dana Berry; BOTTOM: courtesy Bill Styer/Acarology Lab, Ohio State University

test Darwin's theory. Since the caterpillar wasn't eating, Nijhout could observe the development of body parts when a limited supply of nutrients was available for growth—the perfect condition for competition.

The researchers first anesthetized caterpillars and removed the cells that would ordinarily become hind wings. When the butterflies emerged from their cocoons two weeks later, their front wings were larger than those of normal butterflies. The mass of the front wings had increased by the same amount that would have been in the missing wings. Next Nijhout and Emlen looked at horned beetles. When they treated beetle larvae with a hormone that curbs horn growth, the beetles grew bigger eyes. They also noticed that beetles bred to grow big horns invariably had smaller eyes than beetles bred to have small horns (compare photos).

THE DEVELOPING BODY PARTS OF INSECTS COMPETE WITH EACH OTHER FOR RESOURCES AS THEY GROW.





Was Darwin right after all? "The simple explanation would be that these things are truly competing for nutrients," Nijhout says. But it's also possible, he adds, that each part interferes with the others' growth, producing substances that stunt other tissues. "We know very little about these higher-level physiological controls."

GEOLOGY

A Billion Years of Stability

IN THE EVOLUTION OF LIFE, cooperation among organisms is probably at least as important as competition. The first complex single-celled creatures—eukaryotes—probably appeared when a host bacterium engulfed a smaller bacterium, perhaps one that could use photosynthesis to turn sunlight into energy. But to make such a symbiotic relationship permanent—to make one new organism out of two—is no easy task. "If you get more nutrients into the environment, from upwelling or pollution, the little photosymbiotic plants living in the host will swim away," says geologist Martin Brasier of Oxford. When nutrients aren't scare, there is no reason for them to maintain the symbiosis.

Even 10 million years probably isn't long enough to cement the relationship, says Brasier. The organisms must be subjected to hundreds of millions of years or more of unvarying conditions. Was there ever such a time on Earth? Brasier and his colleague John Lindsay of the Australian Geological Survey Organization say there was—a billion-year period in the Precambrian. Not coincidentally, say the researchers, the first eukaryotes appeared near the end of that billion years.

Brasier and Lindsay studied cores drilled from ancient ocean sediments in north central Australia. They looked specifically at the ratios of two carbon isotopes, carbon 13 and carbon 12. Oceanic plants tend to absorb more carbon 12 than 13, leaving more of the heavier isotope behind in seawater, which eventually becomes incorporated into rocks. So the amount of carbon 13 in the ocean core samples indicates how much plant life was once present. Geologists expect to see big fluctuations in the carbon-isotope record, especially over a billion-year period, because plant populations would be expected to rise and fall in response to events like mountain building. When mountains rise, erosion accelerates,

TOP (2): Fred Nijhout/Duke University; BOTTOM (2): Douglas Emlen