

Breakthrough of the Year

Well, here we are again: Breakthrough time. You might wonder what could possibly top last year's selection of the Mars exploration; indeed it's hard to forget that, since the rovers are still chugging along, having outlasted their 90-day warranties by more than a year! But the Breakthrough for 2005 should not disappoint: Evolution in Action.

Wait a minute, I hear you cry. Hasn't it been a trying year for evolution, considering the debates about teaching evolutionary theory in science classes in the United States and the headlines about Intelligent Design? On the contrary; in the research community, it's been a great year for understanding how evolution works, through both experiment and theory.* No single discovery makes the case by itself; after all, the challenge of understanding evolution makes multiple demands: How can we integrate genetics with patterns of inherited change? How do new species arise in nature? What can the new science of comparative genomics tell us about change over time? We have to put the pieces together, and it could not be a more important challenge: As the evolutionary geneticist Theodosius Dobzhansky once said, "Nothing in biology makes sense except in the light of evolution."

Our scientist/journalist teams have compiled a splendid case for this exploding science. One of my favorites is the European blackcap, a species of warbler that spends the winter in two separate places but then reunites to breed, with birds selecting mates from those who shared the same wintering ground. Assortative mating of this kind can produce a gradual differentiation of the two populations. Biologists have shown that new species can arise because of geographic barriers that separate subpopulations, but the divergent evolution shown in this case could result in new species arising within a single range.

A favorite, if unlikely, subject for evolutionary studies is the small fish called the stickleback. Repeatedly, sticklebacks have moved from the sea into fresh water. When that happens, the fish shed the rather heavy armor plates that protect them from marine predators, freeing themselves to enjoy *la dolce vita fresca*. New species have been generated in each invasion, always in the same way: by rapid evolutionary selection of the same rare and ancient gene.

The exciting thing about evolution is not that our understanding is perfect or complete but that it is the foundation stone for the rest of biology. As such, researchers are eager to explore issues that have been seen as problems. Genes that are now known to exert complex effects on body form at the macro level answer the commonly stated objection that complex structures could not have evolved from simpler precursors. And so it goes: Scientific challenges are raised, inviting answers.

Last year's crystal ball of things to watch for wasn't perfectly clear. For example, nothing seems to be working very well in the area of obesity drugs. And the haplotype map of the human genome isn't quite ready to provide us with well-hyped individual genetic barcodes that we can take into the doctor's office to predict our risk of developing complex diseases such as cancer, diabetes, and mental illness.

There were some hot runners-up this time around, as well. New insights about brain disorders came from studies showing that Tourette syndrome and dyslexia are associated with genes tied to normal neural development. It was also a year of triumph for robotic missions sent to probe the solar system: the Cassini-Huygens mission explored the saturnian system, including Titan; Voyager crossed the heliopause to reach the outer limit of the solar system; Deep Impact speared a comet; and Japan's Hayabusa visited a distant asteroid.

An especially significant runner-up was climate change. 650,000-year-old ice cores from Antarctica give a continuous record of correlations between atmospheric carbon dioxide and methane and the temperature changes imposed by glacial cycles. New information put to rest the idea, popular with those skeptical about global warming, that satellite measurements, in contrast to ground measurements, showed cooling. One by one, holes in the global warming case are being filled. Government actions should follow; of that, I'll say more in the first *Science* issue of the new year.

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*AAAS is collaborating with leading scientific organizations at the AAAS Annual Meeting (16 to 20 February 2006, St. Louis, MO) to give teachers a voice on the evolution issue and a way to tell the scientific community how best to support them.

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