

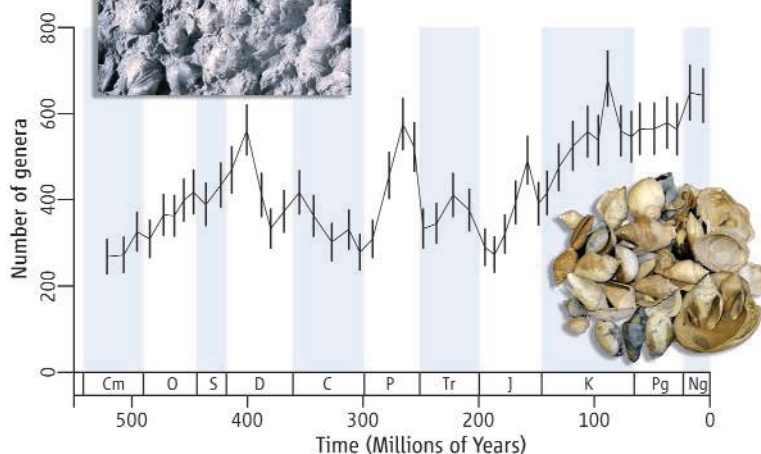
PALEONTOLOGY

Life's Innovations Let It Diversify, at Least Up to a Point

When paleontologists first seriously considered how life had evolved, the story looked simple: From a few basic types, organisms had diversified unhindered into myriad new forms over the past half-billion years. Then the bean counters got into the act. After correcting for sampling biases and other pitfalls in the fossil record, a group of quantitatively oriented paleontologists reported in 2001 that life at sea, at least, had followed a different course (*Science*, 25 May 2001, p. 1481). Although marine invertebrates had continued to innovate new ways of making a living, the scientists concluded, total diversity had hardly increased in 400 million years.

Now the number crunchers have rewritten the prehistory books again. On page 97, 35 of them—including authors of the original paper—present a new analysis of the Paleobiology Database, which records about 3.5 million specimens described in papers of the past century and more. They conclude that the diversity of marine inverte-

brates has indeed increased over time, although far less than some early analysts believed. Paleontologists not involved in the new study say they agree



Diversity constrained? The latest curve of marine diversity lacks a recent sharp rise, suggesting something reined in evolution. Alternatively, excluding young fossils found in loose sediment (near left) may have dampened the rise.

ica and Europe, neglecting fossils in remote lands. They collected more and smaller fossils from young, loose sediments than they did from older rock. And of course they were more likely to collect the fossils that tended to be preserved rather than the more vulnerable ones that fade away with time.

The Paleobiology Database—compiled under the supervision of John Alroy of the University of California, Santa Barbara (UCSB)—includes information needed to correct such biases in the record, information

with its general approach but doubt it will be the last word on the subject. “There’s a lot of improvement in methodology, and there’s a lot more data,” says David Jablonski of the University of Chicago in Illinois, who worked on the 2001 analysis but not the new one, “but there are still biases remaining in

Many studies have looked at how global warming may cause shifts in where plants grow, but very few have examined how specific traits, such as flowering time, are affected. The necessary long-term records rarely exist. But for 6 years, Thoreau tracked the life histories of more than 400 plant species in a 67-square-kilometer area. Another researcher covered the same ground at Walden Pond and its surrounds circa 1900. Then from 2004 to 2007, Boston University (BU) conservation biologist Richard Primack and his student Abraham Miller-Rushing regularly visited the area to make similar observations of about 350 species and to check how the abundances of these plants had changed through time.

Their data, published in February in *Ecology*, revealed that many flowers were blossoming a week earlier than in Thoreau’s time. They noted also that about half of the species studied had decreased in number, with 20% having disappeared entirely.

Working with his Harvard adviser Charles Davis, the BU group, and fellow Harvard graduate student Brad Ruhfel, Willis has put

EVOLUTION

Where Have All Thoreau’s Flowers Gone?

Early in May, the oaks, hickories, maples, and other trees, just putting out amidst the pine woods around the pond, imparted a brightness like sunshine to the landscape. ...

These words from *Walden* hint at the careful plant and animal records Henry David Thoreau kept during his stay at Walden Pond in Concord, Massachusetts, in the mid-1800s. By retracing this young naturalist’s footsteps, not once but twice in the past century, researchers have been able to chronicle the fate of hundreds of plant species as the New England climate has changed since Thoreau’s time. Using that data, Harvard University graduate student Charles Willis and colleagues have detected a disturbing pattern, one that he described last week in Minneapolis, Minnesota, at the



Flower man. Thoreau closely tracked Walden Pond plants

Evolution 2008 meeting.

By building a flora family tree that incorporates the “Thoreau” species and mapping onto the tree each plant’s response to the 2°C increase in the region’s average temperature since the famed author was at Walden Pond, the researchers have discovered that climate change has placed whole groups of plants at risk and that the more charismatic wildflowers that prompt conservation efforts, such as orchids, are among the most vulnerable.

The study is “an intriguing combination of historical data sets and modern molecular methods to address in a very novel way climate change effects,” says Carol Horvitz, a plant evolutionary ecologist at the University of Miami, Florida. “I think it’s brilliant.”

such as exactly where in the record and in what sort of rock each fossil was found. Alroy, lead author of both the 2001 study and the new paper, says both groups also applied statistical techniques as they “sampled” the database to ensure that their count resembled reality. Unfortunately, he says, the 2001 team made some assumptions about sampling that “turned out to be dramatically wrong” in ways that would have made an increase in diversity through time hard to find. The new analysis corrects those errors, he says. It’s also based on four times as much data spanning all of the past 500 million years.

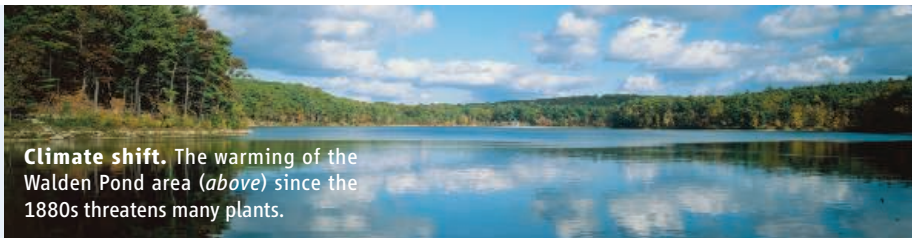
The resulting graph of changing diversity over time resembles the pre-2001 curve in showing a steep rise in diversity in the first 100 million years. The curves differ most sharply in the past 65 million years, when diversity soars dramatically on the pre-2001 curve but hardly rises on the new one. As a result, the number of genera in geologically recent times appears to have increased only about 30% over life’s early peak, not three- to fourfold as the old curve showed. Something has been constraining evolution and diversity for hundreds of millions of years, the group concludes—perhaps some bottleneck in the way energy moves up through the food chain in the global ecosystem.

Although the latest diversity curve marks a big improvement over the 2001 effort, it

may go too far, says paleontologist Richard Bambach of the Smithsonian National Museum of Natural History in Washington, D.C., another co-author of the earlier paper but not of the current one. “We’re getting into the ballpark, [but] they’re taking the most conservative approach,” he says. The newly estimated diversity of the past 10 million years in particular may be “excessively conservative,” he says.

For one thing, Bambach says, the group excludes all fossils recovered from sediments that have not yet turned to stone. That makes sense in principle, he explains. Because sieving loose sediments for fossils is so much easier than breaking rocks, including fossils from silt and mud could inflate the apparent diversity of more recent times, when most such “unlithified” sediments are found. On the other hand, if diversity really has increased recently, ignoring younger samples could seriously undercount it, Bambach says. Jablonski also suspects that younger diversity is being missed in the western tropical Pacific Ocean. Today, shellfish are wildly diverse there, he notes, but in the database they appear to be relatively impoverished only a few million years ago. More likely, he says, the database has yet to include the older literature from that region. Thus, some observers are looking for a third iteration of life’s changing diversity.

—RICHARD A. KERR



Climate shift. The warming of the Walden Pond area (above) since the 1880s threatens many plants.

these data into an evolutionary context by looking at how closely related the affected species were. They pieced together a family tree of more than 500 species and noted changes in their range, abundance, and other traits—such as which had flowering times that were tied to spring temperatures and which did not. In this way, they could check to see if there was a correlation between flowering time and how well a species fared over 1.5 centuries.

“Certain [groups] were very sensitive,” Willis reported at the meeting. A plant’s ability to change its flowering time depending on the spring weather in a given year proved a key predictor of its current health. “Species that had not shifted [flowering times] are declining in abundance.”

Wildflowers with more northern ranges proved the least flexible. Thus irises, orchids, lilies, and bladderworts were among the plants that had declined the most—they tended to flower the same time of year, regardless of the weather. “That climate change is affecting whole sets of species differently is intrinsically interesting,” says Horvitz.

Rare as they may be, these sorts of analyses can help researchers predict which species are threatened most by global warming and which are likely to adapt, says George Weiblen, an evolutionary biologist at the University of Minnesota, Minneapolis. “Finally, evolutionary biologists are chiming in on the effects of climate change.”

—ELIZABETH PENNISI

Peruse These Ties

Congressional appropriators want to give the U.S. National Institutes of Health (NIH) a billion-dollar budget increase next year. But senators also want NIH Director Elias Zerhouni to stiffen his agency’s oversight of the financial ties between academic scientists and pharmaceutical companies.

Last week, the Senate spending panel ordered NIH’s parent body, the Department of Health and Human Services, to begin the process of rewriting regulations meant to avoid financial conflicts of interest among nonfederal scientists. Grantees now must report to their institutions relevant income from any company exceeding \$10,000 annually. (NIH intramural scientists are banned from receiving all such income.) A House spending subcommittee has asked NIH directly to improve its conflicts policy. NIH is already planning to seek comments on revising the regulations, Zerhouni said in a 20 June letter to Senator Charles Grassley (R-IA), who is investigating several cases in which academic researchers may have failed to report income from drug companies (*Science*, 27 June, p. 1708).

The Senate language is part of a 2009 spending bill that is unlikely to be approved until after the November elections. But agencies ignore such congressional requests at their peril. The bill itself would provide NIH with a \$1.025 billion hike, to \$30.2 billion, the agency’s largest increase in 6 years. A parallel House bill would give NIH a \$1.15 billion increase.

—JOCELYN KAISER

Austrian Astronomers Score

VIENNA—Last week, the Austrian government joined the European Southern Observatory (ESO), Europe’s premier telescope facilities, based in Chile’s Atacama Desert. “At meetings, everyone always assumed we were members,” says Josef Hron, an astrophysicist at the University of Vienna. Cash-strapped Austria has declined membership since ESO was established in 1962, he says, but the economy and astronomy have flourished in the country over the past decade. Considering the \$3.6-million-per-year cost of membership—plus a \$36 million entrance fee to be paid over 15 years—Austrian astronomers have just seen their budget doubled. Not only will they have far easier access to ESO’s Very Large Telescope—currently the largest of its kind—but they plan to take an active role in future ESO projects, such as ALMA and the Extremely Large Telescope.

—JOHN BOHANNON