In a warmer world, bugs may be big beneficiaries

by Scott_LaFee

And the houses shall be full of swarms of insects, and also on the ground on which they stand.

- Exodus 8:21

GLOBAL SWARMING - Global warming may mean more bugs around. CNS Photo Illustration by Jacie Landeros/Bigstock Photo. Climate change is not the wrath of God, but one possible consequence of rising global temperatures may be almost Biblical in nature: a population explosion of bugs.

The world's shifting weather patterns are already having an effect, say scientists. Warmer weather is driving many insect species northward and to higher elevations, creating novel situations like the emergence of insect-borne tropical diseases in Canada.

But some researchers suggest changes even more fundamental may be occurring. Hotter days and longer warm seasons in more places mean warm-weather insects have more time and more space to feed, develop and reproduce. It has been estimated that an increase of less than 4 degrees Fahrenheit can add one to five more life cycles per season for some insects.

"Most species of insect are warm-adapted," said Raymond Huey, a professor of biology at the University of Washington. "Warm-adapted insects generally have higher maximum rates of reproduction. If there's (evolutionary) selection from climate warming for species that do well at higher temperatures, it follows that you're going to see an increase in maximum rates of reproduction."

In other words, warm-weather bugs would produce even more warm-weather bugs.

The situation is not that simple, of course, as Huey would be the first to admit. The dynamics and consequences of global warming are far from fully understood. Entomologists continue to debate fundamental aspects of insect biology. And change invariably produces both winners and losers, even among insects.

But if you're a bug that favors higher temperatures, climate change is likely something you can warm to.

A CRISIS WITH LEGS

Insects (and other arthropods) are masters of diversity and reproduction. They are found on every continent, in every habitat, on the planet. There are midges (gnats) in Antarctica; beetles above the Himalayan timberline; marine spiders that skate upon the open ocean.

Termite queens can produce 6,000 to 7,000 eggs a day, sometimes at the rate of one egg every two seconds. The ova of some parasitic wasp species divide multiple times, with one egg generating as many as 2,500 new wasps.

A 1952 study estimated that a single pair of houseflies could produce 191 quintillion descendants between April and August if all of the progeny lived and reproduced normally. Another study projected that a single female aphid could, in theory, produce 1,560,000,000,000,000,000,000,000 aphids in one summer.

In a survey of a single square mile of Pennsylvanian oak forest litter and soil, researchers found an estimated 294 million mites, 119 million springtails and 11 million insects and other arthropods. A Louisiana entomologist calculated that a cubic mile of bayou air, starting 50 feet above the ground, contains an average of 25 million bugs.

As much as one-third of the Earth's terrestrial biomass - the total weight of all living organisms on land - consists of ants and termites.

So clearly, bugs abound. (Species estimates range from 5 million to 50 million.) What researchers are now noting - and documenting - is a distinct shifting in that abundance and diversity due to climate change.

Generally speaking, this isn't surprising. Fossil evidence indicates insects (along with plants and other forms of life) have regularly altered their geographical ranges in response to shifting climates.

"Numerous studies in Europe have mapped the distribution of beetles over time," said Huey. "What happens is that their wing covers, which are hard, get preserved in gravel pits - so well preserved, in fact, that you can detect color patterns and distinct species. Scientists have been able to show that during interglacial periods (warmer periods between ice ages), beetles moved very far north."

Similar phenomena are being seen today. In Great Britain, for example, researchers recently uncovered established colonies of the green shield bug, an agricultural pest indigenous to the Mediterranean, Middle East, Africa, Australia and North America.

The bug is not a complete stranger to Great Britain. It's an occasional hitchhiker in imported vegetables. But scientists had presumed England's cold winters prevented the species from making a permanent home.

No more. British meteorologists say the average temperature in central England has increased almost 2 degrees in recent decades, from 48.92 to 50.72 Fahrenheit. That's enough of an increase, it appears, for the green shield bug to now call Great Britain home.

"I'm always reluctant to invoke global warming, but it's the only explanation," Max Barclay, curator of beetles at London's Natural History Museum, told the BBC.

In the western United States, David Porinchu, an assistant professor of geography at Ohio State University, has discovered that species of warmer-water midges have usurped cooler-water species in recent decades.

"High-latitude regions may be like canaries in a coal mine," Porinchu said. "The areas I studied are remote lakes in mountainous areas. They aren't heavily impacted by any obvious human activities. You'd think they would be pretty buffered from change, but that appears not to be the case."

The issue becomes particularly worrisome when you consider the results of a study conducted by Huey and colleagues at the University of Washington.

Insects and other ectotherms (coldblooded animals) are subject to what scientists dub "the tyranny of thermodynamics" - the fact that temperature is arguably the single most critical factor of life. Cold is a fundamental constraint. Insects adapted to living in cold weather are invariably less mobile than their warm-weather counterparts. They have slower metabolisms. They develop, grow and reproduce at lesser rates.

Example: Arctic spiders (there are 70 species in Greenland alone) take up to seven years to mature, due to chill temperatures and scarcity of food. That compares with just one or two years for related species farther south.

If you're a bug, warmer is better, writes Melanie Frazier, a doctoral student and co-author of the study.

Frazier, Huey and David Berrigan, an environmental scientist with the National Cancer Institute, examined the maximum potential reproductive rates of 65 insect species.

"The question was, how well do insects adapt to shifting temperatures?" said Huey.

All insects have an optimum temperature range in which they live and reproduce best. Some scientists have argued that highly adaptive insects simply adjust their optimum range to meet long-term changes in temperature. But Huey and colleagues concluded that this ability is not equal among bugs.

"Typically, as temperatures increase, rates of reproduction increase - up to a maximum," he said. "After that, if temperatures are too high, reproduction rates drop dramatically because the insects are heat-stressed."

Warm-adapted insects, he said, begin with higher maximum rates. They can continue to reproduce at greater efficiencies at greater temperatures. "If climate warming persists," said Huey, "that likely selects for insects able to do better at warmer temperatures."

Warmer temperatures may also mean hungrier insects.

A study by scientists at the Smithsonian Institution and the University of Utah examined fossil leaf records in Wyoming from two periods: the Paleocene (56 million years ago) and the Eocene (53 million years ago). In those 3 million years, Wyoming's temperature rose 13 degrees Fahrenheit, transforming a temperate region of maples and other deciduous trees to a swampland dominated by evergreens.

The evidence suggests that in the warmer period, insects were more numerous and diverse. Fossil leaves showed many more bites from more types of insects.

SPREADING DISEASE

The big concern, of course, is what these findings portend. Which insects are most likely to benefit most from global warming?

Many of the most notorious vectors of disease are warm-weather-loving insects, such as mosquitoes and ticks. "And crop pests tend to be warm-weather species because their crop targets grow in warm weather," said John Trumble, a University of California Riverside entomologist.

The World Health Organization and others have already noted troubling trends: Malaria is being reported increasingly at higher elevations in Africa and Latin America. Britain's health minister recently warned that the disease might soon reach that country.

Asian tiger mosquitoes, which carry dengue fever, have been reported as far north as the Netherlands. Sweden's warmer winters have produced a related rise in cases of tick-borne encephalitis.

For more than a decade, scientists have been predicting climate change could spread and exacerbate certain diseases in the world. These warnings, however, were usually accompanied by qualifications about the need for more data and the persistent uncertainties about variables like population demographics, medical technologies and normal, short-term weather fluctuations.

Now, says Dr. Paul Epstein, associate director of Harvard University's Center for Health and the Global Environment, it appears researchers underestimated the link between climate change and disease.

"Things we projected to occur in 2080 are happening in 2006," Epstein told The Washington Post. "What we didn't get is how fast and how big it is, and the degree to which the biological systems would respond."

To be sure, there remains broad, vigorous debate among scientists about exactly how climate change will affect insects and their place on the planet.

English zoologists David Rogers and Sarah Randolph have argued that malaria will probably not become a larger health threat because the disease's carriers - mosquitoes - are controlled by more factors than just warm weather. These factors include rainfall, humidity and the abundance of suitable hosts and predators.

And Camille Parmesan, a University of Texas zoologist, notes that insects are also victims of climate change. Many butterfly species, for example, are relative homebodies, evolving specific adaptations to specific localized habitats. They're pretty much stuck where they are, and a shift in vegetation patterns caused by climate change can spell disaster.

Edith's Checkerspot butterfly is an example, Parmesan said. At the southern end of its range in Mexico, the species appears to be going extinct at a rate four times higher than at the northern end in Canada. The extinction rate is also 2.5 times greater at lower elevations than above 8,000 feet.

"The Quino Checkerspot butterfly - your locally endangered species - is being severely impacted by climate change as well as by urbanization," Parmesan added. "The combination of the two leaves me in doubt as to whether it will be here in another 30 years."

Parmesan notes that some insects are undoubtedly adapting well to warming temperatures, but she questions whether any can evolve quickly enough to take full advantage of the situation.

"To really come up with something new that's going to allow a species to live in a completely new environment takes a million years," Parmesan wrote in a 2006 paper that reviewed 800 studies of human-induced climate change on thousands of species. "It's not going to happen in a hundred years or even a few hundred years. By then, we might not even think of it as the same species."

Trumble, the UC Riverside entomologist, agrees climate change will hurt some bugs. "We're going to have droughts in the future of unprecedented size in places where they've never been before, like the Amazon," he said. "If climate change means that this occurs more and more frequently, it will have a huge impact on insect diversity."

But many of the most troublesome insects are also among the most adaptable, he added. The common house mosquito, for example, does quite well in drought-stricken areas, thriving in drainpipes and sewer puddles. Crop pests, too, tend to be generalists. These insects learn to cope.

The climatic question may be how humans will cope with them - maybe a lot of them.

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