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| **Mosquito Adapting to Global Warming, Study Finds** |
| **Bijal P. TrivediNational Geographic Today** |

Scientists have found a mosquito that appears to have evolved and adapted to climatic changes induced by global warming— the first documented case of a genetic change in response to the apparent heating up of the planet.

Even more surprising, said evolutionary biologist William Bradshaw, of the University of Oregon, in Eugene, who led the study, is that this evolutionary change can occur in as little as five years.

Mosquitoes use the length of day to anticipate the oncoming winter and to plan hibernation. But with the onset of warmer winters mosquitoes are reproducing later in the year and postponing dormancy; instead of beginning hibernation in late summer when the days are still long, these mosquitoes are using fewer hours of daylight later in the year as their cue to go to sleep.

Bradshaw and colleague Christina Holzapfel found that compared with 30 years ago northern populations of the mosquito *Wyeomyia smithii* have adapted to milder winters and become dormant later in the annual cycle.

The mosquito, which lives at the base of the carnivorous pitcher plant, is found in North America. It is not a mosquito that sucks the blood of mammals but rather one that lives off its host plant.

In 1972 *W. smithii* mosquitoes from locations 50 degrees north (close to Sioux in western Ontario) began hibernation when the length of daylight was 15.79 hours. In 1996 *W. smithii* would have entered dormancy when the day length was 15.19 hours—this corresponds to about nine days later in the fall.

These results are published in the November 6 issue of the *Proceedings of the National Academy of Sciences.*

"This is not the type of experiment you can plan for," explained Bradshaw.

Bradshaw and Holzapfel have been collecting mosquitoes from 31 locations in North America for about 30 years.

Their original intention was to understand how the hours of daylight affect the length of the mosquitoes breeding season.

In Manitoba, Canada, for example, cool weather arrives early in August and mosquitoes begin hibernating in July when the days are still long. By contrast, mosquitoes in Florida don't begin hibernation until November when the days are short, as cooler weather does not strike till December.

The two populations of mosquitoes are genetically distinct; Manitoba mosquitoes, if brought to Florida, will not become dormant later in response to the warmer weather.

Response to day-length, or photoperiod, is a gene-based trait that affects the mosquitoes seasonal life cycle. Bradshaw and Holzapfel find that these northern mosquitoes are becoming more like their southern cousins suggesting that a genetic change has occurred.

Other populations also seem to be adapting to the longer growing season brought on by global warming. British birds began egg laying nearly nine days earlier in 1995 than in 1971. British frogs began spawning almost ten days earlier in 1994 than 1978.

The greatest consequence of altering the breeding seasons of insects such as *W. smithii* is a "discordance between predator and prey" says Bradshaw. Altering the breeding season affects all the creatures that rely on *W. smithii* as a source of food.

Many species of birds, for example, feed on the mosquito larvae. However, if the mosquitoes have already hatched the chicks will go hungry.

Bradshaw anticipates that other species are also evolving and adapting to the extended growing season. Bradshaw and Holzapfel hope to identify the gene associated with response to daylight and the genetic changes responsible for delaying dormancy.

If there is some good news, it is that *W. smithii* doesn't bite.

# Effects of Global Warming

## Signs Are Everywhere

The planet is warming, from North Pole to South Pole, and everywhere in between. Globally, the mercury is already up more than 1 degree Fahrenheit (0.8 degree Celsius), and even more in sensitive polar regions. And the effects of rising temperatures aren’t waiting for some far-flung future. They’re happening right now. Signs are appearing all over, and some of them are surprising. The heat is not only melting glaciers and sea ice, it’s also shifting precipitation patterns and setting animals on the move.

Some impacts from increasing temperatures are already happening.

* Researcher Bill Fraser has tracked the decline of the Adélie penguins on Antarctica, where their numbers have fallen from 32,000 breeding pairs to 11,000 in 30 years.
* Some butterflies, foxes, and alpine plants have moved farther north or to higher, cooler areas.
* Spruce bark beetles have boomed in Alaska thanks to 20 years of warm summers. The insects have chewed up 4 million acres of spruce trees.

Other effects could happen later this century, if warming continues.

* Species that depend on one another may become out of sync. For example, plants could bloom earlier than their pollinating insects become active.
* Some diseases will spread, such as malaria carried by mosquitoes.
* Ecosystems will change—some species will move farther north or become more successful; others won’t be able to move and could become extinct. Wildlife research scientist Martyn Obbard has found that since the mid-1980s, with less ice on which to live and fish for food, polar bears have gotten considerably skinnier.  Polar bear biologist Ian Stirling has found a similar pattern in Hudson Bay.  He fears that if sea ice disappears, the polar bears will as well.

**Questions to Answer**: SEPARATE SHEET OF PAPER (no separate sheet? No credit for you)

1. According to the first article, why is the mosquito a noteworthy example of global warming effects?
2. How have mosquito reproductive patterns changed over the years? Why is this significant?
3. How do breeding patterns of mosquitoes compare in hot and cold regions of the world?
4. How has global warming affected this predator/prey relationship? Use the examples the article has provided.
5. In the article it discusses certain species moving farther north to survive. What will eventually happen to these species if global temperatures continue to climb? Why will this happen?
6. How can invasive species be created due to global temperatures rising? Use an example provided in the articles.
7. Explain, using two reasons, why mosquitoes can negatively alter ecosystems as a result of global temperature increases.
8. Why, given your knowledge of global warming, will the polar regions be more adversely affected by climate change than other parts of the world?
9. The second article discusses effects of global warming later this century. Even if we did everything in our power to stop global warming now, why would we still see effects in the future (possibly for the next hundred years!)?