Mosquito genes explain response to climate change

by Jim Barlow

EUGENE, Ore. - University of Oregon researchers studying mosquitoes have produced the first chromosomal map that shows regions of chromosomes that activate â€“ and are apparently evolving â€“ in animals in response to climate change.

The map will allow researchers to narrow their focus to identify specific genes that control the seasonal development of animals. Such information will help predict which animals may survive in changing climates and identify which disease-carrying vectors may move northward, allowing for the production of appropriate vaccines, said William E. Bradshaw and Christina M. Holzapfel, researchers in the department of biology and members of the UO Center for Ecology and Evolutionary Biology.

"For the first time, we are moving down the track to identify genes that animals use to control their seasonal development," Bradshaw said. "Response to day length is often the primary cue that organisms use for going dormant, and although human beings are not as strongly seasonal as other animals, there are nonetheless seasonal components to our health and welfare just as there are in plants and animals."

The chromosomal map for the mosquito Wyeomyia smithii, which develop within the carnivorous leaves of pitcher plants, appears online ahead of publication in the May issue of the journal Genetics. The UO researchers identified regions on three chromosomes that respond to length of day, which scientists call photoperiodism. Two of the chromosomes also have overlapping gene expression that tells the species to go dormant, which they must do to survive.

"This chromosomal map is drawing a lot of interest in terms of understanding the genetic response of animals to rapid climate change and also to understanding the metabolic processes involved in disease intervention in humans and other complex organisms," Holzapfel said.

Bradshaw and Holzapfel first showed that the mosquito has changed genetically in response to recent, rapid climate change and now uses shorter, more southern day lengths to initiate dormancy in a landmark study that appeared in the Proceedings of the National Academy of Sciences (Dec. 4, 2001).

The new study â€“ funded by the National Science Foundation and National Institutes of Health â€“ doesn't tell exactly which genes drive the mosquito's response, "but it does tell us in what parts of the genome we must look to identify the mechanism of photoperiodism," Bradshaw said.

Collaborative studies already are underway to determine the same genes in stickleback fish at the UO and in fruit flies at the University of Pennsylvania.

"The response to climate warming in animal populations has penetrated to the level of the gene," Bradshaw said. "It affects development, reproduction and dormancy, and this response is occurring in diverse groups of animals from insects to birds and mammals."

The chromosomal map was created using mosquitoes that had developed in precisely controlled environmental rooms that allow the UO researchers to simulate climatic conditions occurring in nature anywhere in the world, from the tropics to the polar regions.

The newly created map contains 900 million DNA base pairs. There are three billion base pairs in humans. As various genome maps are being completed, scientists now face the task of determining how genes interact and how they produce specific phenotypes (observable traits), which include photoperiodic response and dormancy.

"Climate changes already are extending the growing seasons," Holzapfel said. "We know that portions of the country are becoming warmer and dryer than others. Plants and animals are not confronting this stress directly, but rather they are flowering, reproducing and going dormant at different times of the year than they used to. Many species will be unable to change quickly enough and will become extinct."

"Climate change will change the seasonal ecology of many animals," Bradshaw said. "Rather than having a bully coming to beat you up at recess everyday, you can take a body-building course and beat up the bully, or you simply can take recess at a different time. Many organisms are taking the latter course, using day length to guide them."

Co-authors of the study with Bradshaw and Holzapfel were former doctoral students Derrick Mathias, who currently is with the Kenya Medical Research Institute in Kisumu, Kenya, and Lucien Jacky, who now is at the University of California, Irvine.

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