Study shows spiders, not birds, may drive evolution of some butterflies

March 12 2013, by Danielle Torrent

(Phys.org) —Butterflies are among the most vibrant insects, with colorations sometimes designed to deflect predators. New University of Florida research shows some of these defenses may be driven by enemies one-tenth their size.

Since the time of Darwin 150 years ago, researchers have believed large predators like birds mainly influenced the evolution of coloration in butterflies. In the first behavioral study to directly test the defense mechanism of hairstreak butterflies, UF lepidopterist Andrei Sourakov found that the appearance of a false head – a wing pattern found on hundreds of hairstreak butterflies worldwide – was 100 percent effective against attacks from a jumping spider. The research published online March 8 in the *Journal of Natural History* shows small arthropods, rather than large vertebrate predators, may influence butterfly evolution.

"Everything we observe out there has been blamed on birds: aposematic coloration, mimicry and various defensive patterns like eyespots," said study author Andrei Sourakov, a collection coordinator at the Florida Museum of Natural History's McGuire Center for Lepidoptera and Biodiversity on the UF campus. "It's a big step in general and a big leap of faith to realize that a creature as tiny as a jumping spider, whose brain and life span are really small compared to birds, can actually be partially responsible for the great diversity of patterns that evolved out there among Lepidoptera and other insects."

Sourakov's behavioral experiments at the McGuire Center showed the

Red-banded Hairstreak butterfly, *Calycopis cecrops*, whose spots and tail imitate a false head, successfully escaped all 16 attacks from the jumping spider, *Phidippus pulcherrimus*. When 11 other butterfly and moth species from seven different families were exposed to the jumping spider, they were unable to escape attack in every case. Sourakov videotaped the experiments and analyzed the results in slow motion.

"From the video, you can see the spider is always very precise," Sourakov said. "In one video, the spider sees a moth that looks like a leaf and it walks very carefully around to the head and then jumps at the head region. The spider has an innate or acquired ability to distinguish the head region very well and it always attacks there to deliver its venom to the vital center to instantly paralyze the prey. Most importantly, the spider is very small, so sometimes its prey is 10 times larger."

The species of hairstreak butterfly and jumping spider used in the experiment are both common in the southeastern U.S., with similar relatives spread worldwide. In nature, the spider and hairstreak come into contact when the butterfly lands on leaves or flowers to rest and feed. Female red-banded hairstreak butterflies lay their eggs in leaf litters, which are often crawling with spiders.

David Wagner, a professor of ecology and evolutionary biology at the University of Connecticut who was not involved with the study, said the research shows scientists need to rethink what drives adaptive coloration patterns because the results suggest that "birds are only part of the story."

"I'm just so impressed with Andrei's experimental protocol and the fact that the jumping spider could not catch the hairstreak butterflies," Wagner said. "His empirical study will do much to cause us to rethink the vision and the visual acuity that certain invertebrate predators have when hunting their prey and how this has really molded how some organisms not only look like, but perhaps how they act, as well."

Unlike other butterflies, hairstreaks constantly move the hind wings that carry the false head pattern, a behavior that seems to increase in the presence of the spider, as if the butterfly is attracting attention to itself, Sourakov said. In museum collections, hairstreak specimens are frequently found with the false-head portion of the wings missing. During the experiments, the spider always attacked the butterfly's false head, thereby avoiding its vital organs.

"The false head hypothesis in hairstreaks has been in circulation for a long time because people always speculated that their tails move around in order to fake out the predators, but there was little experimental evidence," Sourakov said.

Sourakov said he hopes the study encourages behavioral ecologists to further test the idea that evolution in butterflies and moths may be driven by small invertebrate predators.

"This clearly shows it's possible that many spectacular patterns that we find in smaller insects may be due to spider pressure rather than bird pressure," Sourakov said. "The butterfly escapes from the spider – it's a fairytale story."

Provided by University of Florida