Study confirms classic theory on the origins of biodiversity

9 September 2009, By Krishna Ramanujan

Before eating a common milkweed leaf, a newly hatched monarch butterfly caterpillar trims leaf hairs and cuts the leaf's veins to drain poisonous latex before feeding on the leaf tissue inside the circle. Image: Anurag Agrawal

(PhysOrg.com) -- A Cornell study on the diversity of milkweed plants has used new techniques to prove an old theory that explains how the arms race between attacking insects and defended plants led to great diversity of both.

The widely accepted 1964 theory, proposed by population control advocate Paul Ehrlich and botanist Peter Raven, outlined a process called adaptive radiation -- when species rapidly multiply and diversify for a time as they colonize new resources and then level off. For example, plants may diversify as they develop new chemical defenses to ward off foraging insects. In turn, insects adapt to the new chemicals and then diversify as they exploit new niches of chemically similar but distantly related plants.

The Cornell study, appearing online this week in the Proceedings of the National Academy of Sciences *(PNAS) Early Edition*, is one of the first to test the adaptive radiation theory proposed 45 years ago.

Using molecular techniques developed in the past decade, the researchers found that adaptive radiation did occur in milkweeds with a rapid burst followed by a plateau of new species in response to highly specialized caterpillars, including monarchs, that eat them. As milkweed plants developed prickly, hairy leaves, highly toxic chemicals (cardenolides) and gooey white latex that gums up a predator's mouth, the caterpillars evolved to become immune to the toxins, learned to cut the veins in the leaves to drain the latex before they ate them and shaved off leaf hairs with adapted mouths.

However, the study also found that instead of continuing to adapt and develop more defenses, as the adaptive radiation theory proposed, milkweed defense traits then declined; instead, the plants increased their ability to grow leaves back quickly, which the researchers said may be a more cost-effective strategy.

"The consistent decline in these defense traits is exactly opposite to what Ehrlich and Peters had proposed," said Anurag Agrawal, associate professor of ecology and evolutionary biology and the paper's lead author. "The surprising result is that the defensive declines in milkweed occurred early on in diversification and then slowed down. Adaptive radiation theory predicts this early change, but we did not expect the consistent declines," he added.

Using molecular genetic data on milkweed species, the researchers built a treelike classification diagram (a phylogeny) that reveals lineages of plant species branching off as they diversify from a common ancestor.

The study is one of a series -- organized by Agrawal and also published in PNAS -- of nine papers on applying modern phylogenetic approaches to study the history of life. In an introduction to the series, Agrawal and former

Cornell undergraduate student Douglas Futuyma review the co-evolution of plants and insects and how their interactions led to greater diversification of both groups.

"We estimate there are somewhere between five and 10 million species on the planet," Agrawal said, excluding the relatively unknown world of bacteria, fungi and viruses and other species too small to see with the naked eye.

Of those larger organisms, there are about 5,000 known mammals and 10,000 birds, but perhaps 300,000 flowering plants and likely more than 3 million herbivorous (plant-eating) and up to 9 million total insect species.

"It's still a mystery why there are 300 times more herbivorous insects than bird species, but now we are able to implicate traits of both plants and insects that have given rise to so many species," said Agrawal. "The interaction between plants and insects has been part of their adaptive radiation."

Provided by Cornell University (news : web)

APA citation: Study confirms classic theory on the origins of biodiversity (2009, September 9) retrieved 28 October 2021 from https://phys.org/news/2009-09-classic-theory-biodiversity.html