Evolution of Moths and Butterflies

By Cathryn Hoyt

As the days and nights get warmer you'll start to see more and more butterflies and moths. To most people, the distinction between a butterfly and moth is pretty clear: a butterfly is large, bright, and flies during the daytime while moths are small, drab and beat against your windows at night. But in nature, few things are this clear cut—and butterflies and moths are no exception.

So what is the distinction between a moth and a butterfly? Which came first: moth or butterfly? And what do bats and ears have to do with butterfly evolution?

Both moths and butterflies belong to the Order Lepidoptera. The name—Lepidoptera—is derived from the Ancient Greek words for "scale wing." Anyone who has successfully caught a butterfly in their bare hands may remember that their fingers were covered with a powdery "dust" after they released the butterfly. This "dust" was actually thousands of tiny scales that rubbed off the butterfly's wings as it was held. The wings of all Lepidoptera are covered with these tiny scales. It's these scales that create the patterns on the butterfly's wings.

Popular guidebooks will tell you that the distinction between a moth and butterfly is pretty simple. Butterflies tend to be day-flying, sit with their wings folded together over their backs, have a swollen tip to their antennae and are relatively big and bright. Moths on the other hand are most often seen at night (but not always), tend to be small and drab (but not always), have feathery antennae, and have wings that fold flat over their backs.

This is the quick and easy description of the difference between moths and butterflies. Scientists, though, take a slightly more critical approach. Lepidopterists that specialize in the developmental history of the Order Lepidoptera argue that butterflies are simply gaudy, day-flying moths.

Studying the evolution of butterflies and moths is challenging, since fossils are so rare. But the few Lepidopteran fossils that exist, captured in amber or compressed in fine-grained rocks, show an astonishing amount of detail. The earliest Lepidopteran fossils appear in rocks that are about

190 million years old. These tiny fragments of scaled wings and bodies clearly indicate that moths evolved before butterflies.

Compared to moths, butterflies didn't appear on the scene until fairly recently. The earliest butterfly fossils date to the early Tertiary Period, or about 60 million years ago. This is just about the time that volcanic eruptions were creating the Davis Mountains and, more important to our story, bats began to hunt the night skies.

Bats hunt their insect prey using echo-location—a form of biological sonar. Echo-locating animals emit high-pitched squeaks into their environment and wait for the sound to bounce back. The echo can tell the bat about nearby obstacles or help the bat to locate and identify flying prey.

Scientists have discovered that some night-flying Lepidoptera have "ears" on their wings that can detect a bat's echo-location pulses. The "ears" consist of a smooth, taut membrane pressed against an air sac. Sound waves cause the membrane to vibrate, the air sac amplifies the vibration and the vibrations are transduced to nerve impulses that cause the moth to begin a swooping, zigzagging, evasive action- in an attempt to avoid becoming dinner for the bat.

Recently, researchers discovered that a superfamily of night-flying, tropical butterflies also have "ears" on their wings. When pulses of high-frequency sound were played at night, the butterflies responded with a dazzling display of dives, spins and crazy loops. If the butterfly "ears" were clogged with dabs of Vaseline, the butterflies no longer responded to the pulses of sound.

These tests convinced scientists that the existence of moth and butterfly "ears" in nocturnal Lepidoptera were an adaptation against bat predation. But that led to another question: What other adaptations could lead to the avoidance of getting eaten by a bat?

How about squeaking back? Tiger moths make ultrasonic clicks in response to a bat's approach. The reason for these clicks is still not understood well. Can the moth's ultrasonic clicks jam the bat's echo-location system? Or are the clicks simply the auditory equivalent of a day-time insects bright colors—warning the bat that the moth isn't worth catching because it tastes bad?

Clicking and evasive actions are certainly good ways to avoid bats, but some suggest that an entire line of Lepidoptera took a completely different approach to bat avoidance. They simply adopted a daylight lifestyle – and evolved into what we now call butterflies.

Biologists generally agree that moths gave rise to butterflies, but the role of bats in the evolution of butterflies, in the words of one researcher, "remains a tantalizing enigma."

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