

# The Caterpillar Lab

Educational Resources 2016



## BUTTERFLY OR MOTH?

### A NEW APPROACH TO AN OLD QUESTION

*“The difference between moths and butterflies is pretty insignificant. They are all insects in the order Lepidoptera and share common ancestors. They fill a myriad of diverse niches, but share similar life histories and growth patterns. Butterflies can be easily and accurately thought of as one of the many wonderful groups of moths.”*

## What’s the difference between a moth and a butterfly?

This seemingly simple question echoes through each of The Caterpillar Lab’s outreach programs. Differences between moths and butterflies are a common topic of instructional posters in classrooms and exhibits in museums and butterfly houses. So we all know the answer, right? The difference between a moth and a butterfly is \_\_\_\_\_.

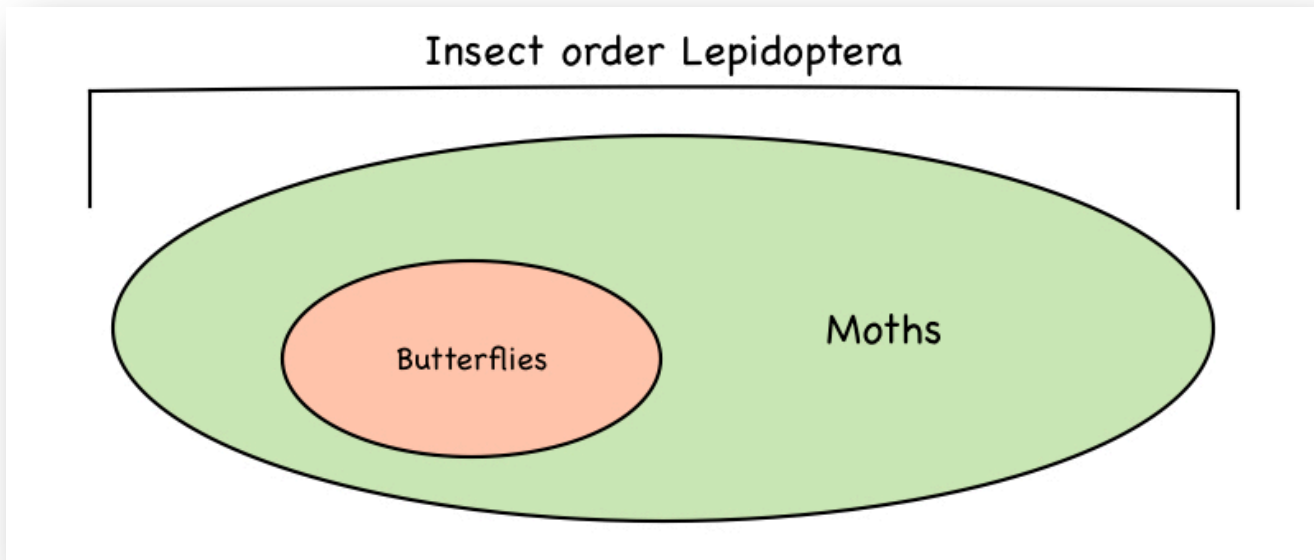
**Not so fast!** Much attention has been given to defining differences between this dynamic duo of flying, scale-winged insects, which are collectively known as the order [Lepidoptera](#). However, the answers you may have encountered rarely approach the truth. How do you define the difference? Perhaps by listing a set of characteristics that are supposed to distinguish one group from the other? Most resources will jump to these *allegedly* defining characteristics:

<i>Butterflies have narrow, threadlike, clubbed antennae</i>	<i>Moths have feathered antennae</i>
<i>Butterflies have relatively narrow, smooth bodies</i>	<i>Moths have stout, hairy bodies</i>
<i>Butterflies fly during the day</i>	<i>Moths fly at night</i>
<i>Butterflies are colorful</i>	<i>Moths are drab</i>
<i>Butterfly caterpillars form chrysalides</i>	<i>Moth caterpillars form pupae inside a cocoon</i>
<i>Butterflies hold their wings closed when resting</i>	<i>Moths hold their wings open when resting</i>

The list goes on...

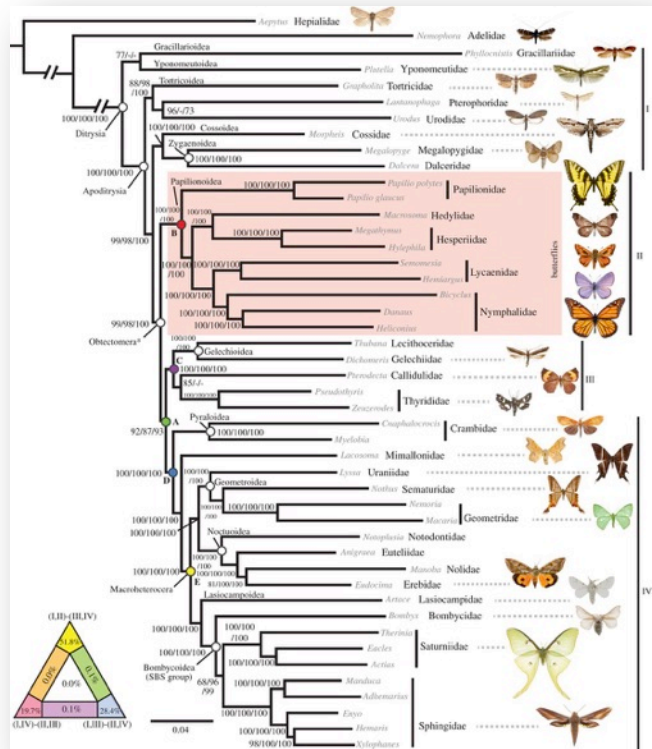
Unfortunately, lists like these attempt to compare moths and butterflies as if they are equal, comparable groups. They are not. **Butterflies** are a well-defined group within the insect order Lepidoptera, and all butterflies are more closely related to other butterflies than they are to any moth. Looking over the list of butterfly characteristics above, some of these qualities do hold true across most butterfly species. **Moths**, on the other hand, are hugely diverse and include many sub-groups that are each just as varied and unique as the entire group of butterflies. There are many members of the order Lepidoptera that, while labeled as moths, are actually more closely related to butterflies than they are to some other groups of moths! This incredibly broad diversity of moths totally dwarfs butterfly diversity, which is reflected in how well the standard list of moth characteristics given above holds up. For any of these characteristics that can supposedly be used to identify a creature as a moth, assume that there are a multitude of exceptions. These exceptions are often ignored, or covered up with misleading words like “most” and “many.”

We have created a simple diagram that we hope will elaborate on how moths and butterflies relate to each other. The group of insects we call butterflies are comfortably nestled within the much larger and more varied group we call moths. Taken together, these two groups comprise the insect order Lepidoptera.



**Below** are two more approaches The Caterpillar Lab often takes to explaining the relationship between butterflies and moths. We hope this elaborated discussion will help clarify any misunderstandings:

The more technical approach is to use a graphic called a [phylogeny](#), which is a tree-of-life drawing. On the next page is a recently constructed phylogeny of all major moth and butterfly [families](#), based on DNA evidence. This phylogeny shows relationships between sub-groups within the [order](#) Lepidoptera. Notice that all butterflies in the world (highlighted in pink) hold together as a tight group. All moths (not highlighted) are more spread out, occurring both above and below the group of butterflies. This graphic demonstrates that all butterflies are a definable, related group. Moths, on the other hand, represent everything left over in the order Lepidoptera after you remove butterflies.



[Akito Y. Kawahara, Jesse W. Breinholt 2014, \*Phylogenomics provides strong evidence for relationships of butterflies and moths\* Proc. R. Soc. B 2014 281 20140970](#)

Another way to approach the discussion is to turn our attentions to puppy dogs instead. Think of some dog breeds you're familiar with. Your list might include retrievers, pit bulls, Chihuahuas, huskies, poodles, hounds, and many more. Butterflies can be thought of as a specific breed - like poodles, for instance. We can identify poodles very specifically and accurately. We know what they're supposed to look like, whether they shed or not, and their temperament. Moths are like the whole lot of all other dog breeds together. It's hard to find many specific features that hold true for great danes *and* shih tzus, especially if you're trying to simultaneously define them in comparison to poodles!



After hearing these explanations, people often ask The Caterpillar Lab’s staff members, **“So... butterflies are just a specific kind of moth?”** That is actually not a far-fetched conclusion. It’s a frustration that we do not have a single common name that includes all moths and butterflies together (outside of the term lepidopteran, which seems to alienate audience members who aren’t biologists). If we want to make moths a valid scientific group that we can accurately discuss using one name, we would have to include butterflies under that heading as well. Why can’t butterflies be “butterfly moths”?

\* \* \*

Our explanation of the relationship between moths and butterflies almost invalidates the question, “What’s the difference between a butterfly and a moth?” since the two groups we’d be comparing are unequal and incomparable. However, if you have a lepidopteran in front of you, and want to know what it is, we’d still like to help. In the following paragraphs, we will list the best features you can use to help distinguish between butterflies and moths. We will also explain how reliable each of these features is.

Let’s examine the characteristics we listed at the beginning of this treatment one by one and see of how much use they can be:

*Butterflies have narrow, threadlike, clubbed antennae*    **\*Valuable trait**

This is an excellent and reliable characteristic. Butterfly antennae--with their narrow, threadlike stalks and smoothly clubbed tips--are remarkably consistent across butterfly families, and rare in moth families. Be aware that some moths do have clubbed antennae, including wasp moths and cane moths, though the trait is comparatively rare.



*Moths have feathered antennae*    **\*Unreliable trait**

We often see the claim that *all* moths have feathered antennae. This is not true. As we have discussed, moths are an **incredibly diverse group**, which is reflected in the variability of their features. Moth antennae may be feathered, linear, flattened, irregular, or even clubbed like butterfly antennae.

However, with our knowledge of butterfly antennae, we can at least say that while not all moths have feathery antennae, all lepidopterans with feathery antennae are moths.



*Butterflies have relatively narrow, smooth bodies* \*Unreliable trait

This statement is untrue. Though the hairiest, fattest moths are indeed hairier and fatter than butterflies, both groups demonstrate considerable variation in body size. One group of butterflies, called skippers, may be stout-bodied and hairy compared to the average moth.

*Moths have stout, hairy bodies* \*Unreliable trait

Moths are just **too diverse a group** to define with a single trait. Some moths are indeed very hairy – the Wookies of the insect world. But entire lineages of moths are narrow-bodied and have less hair than typical butterflies. The geometrid or inchworm moth family has many members that are sleeker-bodied and less hairy when compared to butterflies.

*Butterflies fly during the day* \*Valuable trait

This behavioral characteristic is amazingly consistent across butterfly species. There are some butterflies that fly in the evenings and a few that will fly at night. Sometimes butterflies even turn up at porch lights, fluttering around alongside moths. However, the vast majority of butterflies are daytime insects. In fact, many nighttime butterfly sightings are considered accidental wanderings, rather than life history traits.

*Moths fly at night* \*Unreliable trait

This is one of the most overstated and inaccurate characteristics listed here and must be put aside for good. There are many individual species from **a diverse range of moth groups** that fly, feed, and breed during daylight hours. Of course, many moths are most active during the night. Anyone who takes a look beneath a porch light in summer will see evidence of that. But moths, as a group, are far from limited to flying during any particular time of day. Next time you visit a field full of milkweed blossoms or inspect a backyard butterfly bush during the day, take note: moths are present.

*Butterflies are colorful* \*Unreliable trait

Saying that all butterflies are bright and colorful is to overlook a significant portion of butterflies, which are more subtly beautiful and camouflaged. The brown and burnt-looking orange skippers are hardly gems of color. Countless leaf-mimicking species are no brighter than similar leaf-mimicking moths. Alpine butterflies often look like drab lichen-covered rocks and woodland species appear as dappled shade, mud, and rough bark.

*Moths are drab* \*Unreliable trait

Moth lovers everywhere take offense at this often-used but completely false distinction. Throughout the **impressive diversity** of moths, there are countless examples of species that rival even the most decorated butterflies. Additionally, moths that we may at first designate as drab are often quite spectacular under closer inspection. A moth is just as likely to be beautiful, colorful, or intriguing as any butterfly.

*Butterfly caterpillars become chrysalides* \*Valuable trait

Butterflies' pupation strategy is consistent across most butterfly families. Butterfly caterpillars tend to pupate in the open, exposed to the environment, with no cocoon or other structure protecting them. Because of this, butterfly pupae have evolved all sorts of colors, textures, and decorations to help them survive under the eyes of hungry predators. These "pretty" pupae have caught our attentions and earned them the special name of *chrysalis*. However, a few lineages within the butterflies do make primitive cocoon-like structures, or seek out shelter before pupating, so this characteristic is not 100% reliable.

*Moth caterpillars pupate inside a cocoon* \*Unreliable trait

This is another sadly inaccurate statement. Moth caterpillars pupate in ways **as diverse as the moths themselves**. Some moth caterpillars spin cocoons of silk and pupate inside them, while others dig into the ground before pupating. Quite a few species bore into wood to pupate, and even more just crawl into the leaf litter. There are even species that pupate within a plant stem or between the top and bottom layers of a single leaf blade. Watch out, because a few moth species also pupate exposed to the environment and their pupae may resemble butterfly chrysalides! However, if you find a cocoon in the wild, it still most likely belongs to a moth species.

*Butterflies hold their wings closed when resting* \*Unreliable trait

This is a misleading characteristic. Butterflies may hold their wings open or closed. Most butterfly species can be observed holding their wings in a number of different positions, depending on what they are doing. Sunbathing butterflies hold their wings open; sleeping butterflies hold their wings closed. The camouflage and other defenses of certain species may depend on butterflies holding their wings in a certain way. You can't show a potential predator your scary false eyespots if your wings are always closed! There are some wing positions that butterflies never use. For instance, butterflies never fold their wings across each other over their backs, as many moth species do.

*Moths hold their wings open when resting* \*Unreliable trait

Moths hold their wings in an even wider range of positions than butterflies. Taken as a whole, the group shows **such a diversity** of wing positions that this characteristic barely warrants discussion. However, when we look into specific moth groups, some trends are revealed. Many noctuid moths fold their wings over each other across their backs. Many geometrids hold their wings open and flat as a board. Many prominent moths roll their wings into a tube formation.

## **PUTTING IT ALL TOGETHER**

If someone asks you what the difference between a moth and butterfly is, you can't always answer with a lecture or hand them a pile of detailed papers. It is always nice to have a short but clear explanation ready. What can we distill from all of the above material to accurately answer this question on the fly? Here is our best concise answer:

### **So... what are butterflies?**

Butterflies are a group of closely related insects in the order Lepidoptera that share some physical and behavioral traits in common. Most butterflies are active during the day and they all share the trait of clubbed antennae. Butterflies are not inherently different from moths in any meaningful way, and perhaps it would be best to consider butterflies simply as a particular kind of moth.

### **So... what are moths?**

Moths are everything else left in the order Lepidoptera when you subtract butterflies. Moths are made up of many groups, each as diverse as the butterflies, and these groups are not always closely related to each other. Moths cannot be compared to butterflies by any single characteristic – the group is just too diverse for that. Saying that moths fly at night, hold their wings open at rest, have feathery antennae, or look drab discounts the richness of moth diversity. We need to stop searching for features that distinguish all moths from butterflies, because they just don't exist. Moths showcase the diversity and variability of the order Lepidoptera—let's celebrate that!

### **So... then, what is the difference?**

The difference between moths and butterflies is pretty insignificant. They are all insects in the order Lepidoptera and share common ancestors. They fill a myriad of diverse niches, but share similar life histories and growth patterns. Butterflies can be easily and accurately thought of as one of the many wonderful groups of moths.

## GLOSSARY OF TERMS:

**Biological Classification System:** A system of ranked categories, which helps us sort out how organisms are related to each other.

**Kingdom:** All life is divided into five or six kingdoms including the Archaeobacteria, Eubacteria, Protista, Fungi, Plantae, and Animalia. Moths and butterflies fall into the kingdom *Animalia*

**Phylum:** Each kingdom of life is further subdivided into phyla. Moths and butterflies fall into the phylum *Arthropoda*, alongside other insects, arachnids, and crustaceans.

**Class:** Each phylum of life is further subdivided into classes. Moths and butterflies fall into the class *Insecta*, alongside all other insects.

**Order:** Each class of life is further subdivided into orders. Moths and butterflies fall into the order *Lepidoptera*, which only includes moths and butterflies. Other orders include other recognizably distinct insect groups, including the beetles, flies, dragonflies, mantids, earwigs, and more.

**Family:** Each order of life is further subdivided into families. There are many families of moths and butterflies. Some examples include the Saturniidea, or giant silk moths; the Noctuiidea, or owlet moths; and the Nymphalidea, or brush-footed butterflies.

**Genus:** Each family is further divided into genera. Butterflies and moths within the same genus likely share many traits in common. Some individual species within a genus may be difficult to tell apart! A commonly recognized butterfly genus is the *Papilio*, which includes the swallowtail butterflies

**Species:** Genera are further divided into a series of species. A species is a group of similar organisms that can exchange genes or breed together. Each species has a Latin name, which consists of its *Genus* and *species* names in italics.



**Lepidoptera:** The order of insects that includes all moths and butterflies. There is no common name for the group that encompasses both butterflies and moths, so the term “lepidopteran” can fill this gap.

**Phylogeny:** A branching diagram that shows evolutionary relationships among organisms, based on similarities and differences in their physical or genetic characteristics. Organisms linked together in the tree are thought to have descended from a common ancestor.