

The Caterpillar Lab

Educational Resources 2016



INSIDE THE COCOON: CECROPIA PUPATION DETAILED VIDEO NARRATIVE

BACKGROUND INFORMATION

This document focuses specifically on the video “Inside the Cocoon: Cecropia Pupation. For general information about pupation, check out the [“Pupation FAQs and Teaching Guide”](#) document at the top of our “Pupation” resource web page.

Cecropia (*Hyalophora cecropia*) caterpillars spin a complex double-layered silken [cocoon](#) before they pupate. They spin the outer layer first, which is tough, somewhat baggy, and spindle-shaped. The inner layer is spun second and is harder, more compact, and egg-shaped. Filling the space between these two layers is a volume of loose, tangled silk strands. After completing its inner cocoon layer, a cecropia caterpillar remains still for a couple of days, preparing to pupate.

For production of this video, The Caterpillar Lab staff waited until the cocoon’s inner layer was complete and the caterpillar was preparing to pupate, and then carefully cut the cocoon open. We filmed this video with the [prepupal](#) caterpillar lying inside its opened cocoon, to give you a behind-the-scenes view of its pupation process. Once the [pupa](#)’s exoskeleton [hardened](#), we moved it to our refrigerator to pass the winter.

VIDEO NOTES

At the video’s opening, observe the differences between the prepupal cecropia caterpillar you see on screen and the cecropia caterpillar in the photograph to the right, which has not yet become prepupal. One sign that a caterpillar is prepupal is the shrinking and browning of its [prolegs](#). In this video, you can see the prepupal cecropia’s prolegs are dramatically shriveled and ready to be shed. Can you spot other differences?



For the first 30 seconds of the video, watch how the [creature](#)'s body moves in a wave-like manner. These undulating motions will eventually propel the insect's new pupa form out from within the [old caterpillar skin](#).

At 30 seconds, pause the video and take a moment to observe this close-up view of the creature's body as it begins to [shed](#) its old skin. Its [tubercles](#) have shriveled and faded. Its former legs have become hollow leg-shells. Its outer layer of [skin](#) is pale and semi-translucent and pulling away from the skin underneath. You may have experienced a similar condition if you have ever had a bad sunburn and your skin began to peel!



When you press play, pay attention to the front and rear of the creature's body. As the body undulates, you can see the pupa's abdomen gradually sliding forward inside the old caterpillar skin. Eventually, the fresh pupa's front end begins to crest through the retreating skin and the pupa's head and thorax are exposed for the first time.

At 57 seconds, you get a great view of the new pupa's head. The old caterpillar [head capsule](#) pulls away and the pupa's face begins to be revealed. When a caterpillar pupates, its old head capsule often splits into two pieces. When a caterpillar sheds its skin to continue growing as a caterpillar, its head capsule usually sheds off in one piece.



At 1:27, pause the video again. Protruding downwards from the bright green pupa's face are two long, curved, textured structures. Those will become the moth's feathery antennae!

Also note the two white, ribbon-like structures that are being pulled out from behind either side of the new pupa's head. These were the linings of two of the caterpillar's [tracheal tubes](#), which are used for breathing – sort of like your lungs.



And check out that skin! It is really peeling off now! As you press play, you'll see another ribbon, which is brownish, coming from the middle of the new pupa's head. This is a layer of skin that used to line the inside of the caterpillar's mouth and foregut.

At 1:56, pause to admire the new pupa's body. You get a great view of the antenna structures, which help us identify this creature as female. In a male, the antennae are much wider. When our pupa becomes a moth, she will produce a [pheromone](#) from her abdomen to call in a male to mate with her. He will use his broad, feathery antennae to find his way.



It can be a bit tricky to recognize at first, but you can see the pupa's wing structures from this view as well. Between the pupa's head and her ribbed abdominal segments, look for two wide structures that fold over her upper abdomen. These will become the moth's forewings. They're tiny right now, but when the moth emerges from her cocoon, she will expand her wings. Ultimately, her wingspan will be about five to six inches!

At 2:11, you have a great side view of a wing. Also check out the pupa's [spiracles](#), which are the brown ovals you see on some of the abdominal segments. A pupa uses its spiracles to breathe, just like its caterpillar form did and its adult moth form will do.



At 2:27, see why the pupa is still wriggling? She is freeing the tip of her abdomen from her shed skin. You'll notice her body is beginning to turn brown. When pupae first emerge from their shed skin, their bodies are soft and quite delicate. After they're exposed to air long enough, their outer layer of skin darkens as it hardens and becomes more protective. This process is called [sclerotization](#).



Hyalophora cecropia

The Cecropia giant silk moth is one of the largest flying insects in North America. It lives throughout the east coast and central states from Florida to Ontario. Cecropia moths produce one generation of caterpillars per year. In New England, they pupate by late summer and spend winter as pupae within their cocoons. In May or June, they will emerge as adult moths. Though often uncommon, Cecropias are occasionally found in urban areas and seem to be more resistant to pesticides than other similar species. Cecropias are in the Saturniidae family of moths and are closely related to several other large, familiar moths, including luna and polyphemus moths.

GLOSSARY OF TERMS:

Cocoon: A shelter that some caterpillars construct and then pupate inside. Depending on caterpillar species, cocoons may range from a few leaves tied loosely together by silk, to complex and rugged silken structures. Not all caterpillars construct cocoons. It is important to distinguish the non-living cocoon from the living **pupa**.

Creature: During periods of transformation, it may be difficult to assign an organism to a well-defined life stage such as larva, pupa, or adult. There is a technical vocabulary that deals with these in-between states, but for our purposes we will refer to the transforming insect simply as "the creature".

Head capsule: The caterpillar's hardened, **sclerotized** head exoskeleton, which contains the eyes, antennae, mandibles, and other sensory and feeding structures.

Hormone: A chemical an organism produces that acts within its own body, which changes its organs' activities and regulates its physiology and behavior.

Pheromone: A chemical an animal produces and secretes, which changes the behavior of another animal of the same species. Pheromones are capable of acting outside the body of the secreting animal.

Prepupal: A caterpillar that has finished growing and feeding as a larva and is preparing to shed its skin and become a **pupa**, a transitional stage between its larva and adult forms.

Prolegs: The soft fleshy legs along a caterpillar's abdomen. These legs aid in a caterpillar's locomotion, are lost when caterpillars pupate, and are absent in the adult butterfly or moth. Prolegs are not to be confused with a caterpillar's six **true legs**, which are mounted under the caterpillar's thorax. True legs are hardened, pointed, and maintained through all stages of **metamorphosis**.

Pupa: The middle stage between the larva (such as a caterpillar) and adult (such as a moth or butterfly) forms of an insect. The pupa stage is the creature's body itself, not a case or covering. Pupae are not mobile and they do not eat. Many species overwinter or wait out inclement seasons as pupae. All insects that go through complete metamorphosis go through a pupa stage, including butterflies and moths, beetles, flies, wasps, bees, ants, and others.

Sclerotin/Sclerotized: A component of insects' skin that makes it more rigid and tough. The harder structures of a caterpillar's body are sclerotized, including the head capsule and true legs. Pupae are heavily sclerotized.

Shedding: The process of casting away an old exoskeleton to expose a newly grown exoskeleton beneath. All insects must shed their exoskeletons – including certain internal structures like the **tracheae**, foregut, and hindgut – as they grow. There are many vocabulary words associated with shedding that generally mean the same thing, including **shedding**, **moulting**, and **ecdysis**.

Shed Skin / Old Caterpillar Skin: The remains of an old layer of insect skin that has been replaced through the shedding process by a fresh, new layer. This discarded or soon-to-be discarded skin is called the **exuvia**.

Skin: There are many vocabulary words associated with an insect's skin, including **cuticle**, **integument**, **epidermis** and **exoskeleton**. These words may have subtle differences in when and how they are best used, but for our purposes here they may be considered synonymous.

Spiracles: The visible oval-shaped openings along an insect's body that allow it to breathe. Spiracles are attached to **tracheal tubes** or **tracheae**, which disperse atmospheric air to all parts of the body.

Tracheal tubes / Tracheae: A series of branching, hollow tubes that lead into an insect's body and deliver oxygen throughout. The lining of the tracheae must be shed each time an insect sheds its skin, to allow these tubes to grow with the insect.

Tubercle: A small, knob-like structure on a caterpillar, often bearing **setae**. Tubercles often look like rounded short horns or spines. Cecropia caterpillars are adorned with many brightly colored tubercles.