The Caterpillar Lab

Educational Resources 2016

HICKORY HORNED DEVIL PUPATION
DETAILED VIDEO NARATIVE

BACKGROUND INFORMATION

This document focuses specifically on the hickory horned devil pupation video. For general information about pupation, check out the "Pupation FAQs and Teaching Guide" document at the top of our "Pupation" resource page.

Hickory horned devil, or regal moth, caterpillars (*Citheronia regalis*) pupate underground in the wild. They do not build a cocoon, but instead rely on the soil to help shield them from predators and keep them warm. In our lab, we move prepupal regal caterpillars to a box of damp shredded paper towels to pupate.

Hickory horned devils no longer live in New England, though they used to be native to this area. We feel that the story of their decline and eventual extirpation is important to share.

The Caterpillar Lab staff began filming this video a little late in the game. We noticed the caterpillar had already begun to shed into a pupa and decided to record the remainder of the process.

VIDEO NOTES

When the video opens, observe the differences between the creature shown and the still-growing hickory horned devil caterpillar in the photograph to the right.

One difference you may notice is that the whole body of the creature in the video doesn't look full—towards its rear end, its skin looks shriveled and empty. That's because it is! This creature's transition to a pupa has already begun.

See how yellow the fuller portion of the prepupal caterpillar's body looks? That is the color of the newly formed pupa's skin, visible through the old caterpillar skin.

As the video begins, watch the slow, undulating motion of the creature. As its body moves like a wave from abdomen to head, you can see the old caterpillar skin pulling away and shedding.

Also notice the white, ribbon-like lines along the creature's side. These ribbons were the outer layers of the caterpillar's old tracheal tubes, which are used for breathing—sort of like your lungs. These tubes get pulled out from inside the creature's body through its ovular spiracles, which are breathing holes located along the creature's sides. The tracheal system is now being upgraded to suit the new pupa form.

20 seconds in, watch an amazing shot of the old tracheal tubes being pulled out of the creature's body, through a spiracle. Can you imagine what it would be like to shed off the lining of your lungs??

At 45 seconds, watch the new pupa's head emerging from the old caterpillar skin. Within 10 seconds, the pupa's head is completely exposed.

At 1:10, pause the video. You have an excellent view of the pupa's head and antennae structures. See those two tentacle-like objects pointing down from the pupa's head? Those will eventually become the moth's antennae!

Folding down from behind the pupa's head and over the ribbed segments of the abdomen, you can see a wing structure. Beneath that are two brown ovals on the pupa's side. These are the pupa's spiracles, which it (like the caterpillar and adult moth) uses to breathe.

As you press play, keep an eye on the pupa's head, antennae, wings, and spiracles. Watch them emerge out from under the shed skin!

At 1:47, check out the overhead view of the pupa's head, antennae, and wings. A keen observer might even notice the pupa's six leg structures, folded up under the head and inside the antennae's outline. The antennae are now flat against the pupa's body, which is streamline and compact.

At 2:20, the pupa is still freeing its abdomen from the shed skin. This work looks exhausting!

By 2:33, the pupa has finally finished shedding, and you have a gorgeous view of the full pupa, still wiggling and turning from its side to face down. Notice that the pupa is beginning to turn brown? Right now, its yellow-green body is extremely soft and delicate. As its body hardens, it will turn brown. Within a few hours, the entire pupa will be shaded dark brown and its outer layer of skin will have become rigid and protective.

Citheronia regalis

The hickory horned devil, regal moth, or royal walnut moth is one of North America's largest flying insects. Its caterpillar form is particularly impressive—it can reach the size of a small hotdog and has long, curving red horns. Regal moth caterpillars are often found in the late summer, wandering the forest floor looking for a place to burrow underground and pupate. Unfortunately, regal moths and many of their close relatives in the giant silk moth family (Saturniidae) have declined dramatically over the last fifty years. Regals used to be found in some New England states, but were sadly extirpated here by the 1980's. Reasons for their decline may include non-native parasitic flies that prey on caterpillars, light pollution, pesticides, and habitat loss.

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

Extirpation: Regionally or locally extinct.

Head capsule: The hardened, **sclerotized** exoskeleton that covers a caterpillar's head, which contains 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.