

PLANT IT AND THEY WILL COME

MK TUFFT

A GUIDE TO REARING BUTTERFLIES
AND (MAYBE) OBSERVING THE
MAGICAL MOMENTS OF METAMORPHOSIS



ADULT
BUTTERFLY



EGG



CATERPILLAR
EARLY INSTAR



CHRYSALIS



CATERPILLAR READY TO PUPATE



CATERPILLAR
FINAL INSTAR

PLANT IT AND THEY WILL COME

A GUIDE TO REARING BUTTERFLIES AND (MAYBE) OBSERVING
THE MAGICAL MOMENTS OF METAMORPHOSIS

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REARING BUTTERFLIES 101

Basic steps for rearing butterflies:

- Choose the **butterfly** you want to attract—must be **native** to your geographic area... you may need to do a little research.
- Identify and **provide** its larval plant food (butterflies are picky... each species requires different plants for its caterpillars.)
- Provide **nectar sources**... many choices—lantana (annual), butterfly weed (perennial), butterfly bush (shrub) are a few options
- Get or make an '**emerging case**'... a pop up laundry basket like this one from **IKEA**(bottom left) is an inexpensive option
- Find a **location** with partial shade to house your **emerging case**—near a window, or in a screened-in porch are a couple options
- **Gather supplies** to keep **foliage fresh** in your emerging case—I use small glass or plastic bottles filled with water, covered with plastic wrap secured with rubber bands to poke fresh foliage into. Also need paper towels for moisture and to collect caterpillar dross on bottom of case. Alternately, you may be able to use potted plants of your larval plant food. Some people simply place fresh leaves on damp paper towels... but the leaves dry out faster.

From my personal list of **favorites**—swallowtails and monarchs—**black swallowtails** are probably the easiest butterfly caterpillars to attract and find. All you need is some parsley, and you can even grow that in a pot on your patio. Of course, you need to keep it watered, and you'll need to check it for caterpillars. But black swallowtail caterpillars are pretty easy to spot on parsley, unlike tiger swallowtail caterpillars which blend into the leaves of their host plants.



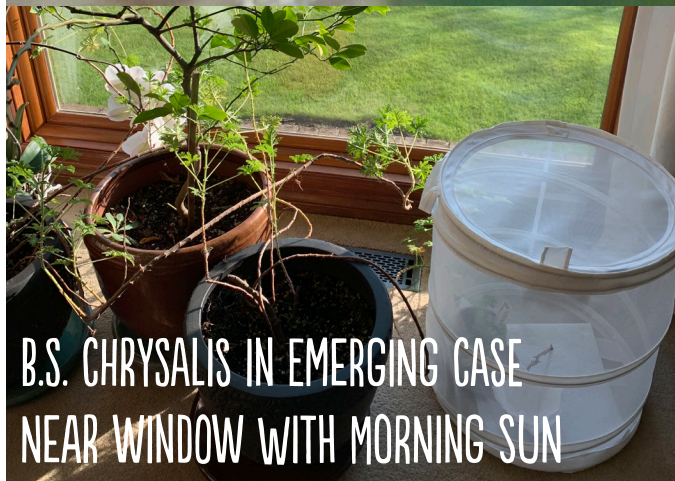
BLACK SWALLOWTAIL FEMALE



B.S. CATERPILLAR ON PARSLEY



B.S. MALE ON BUTTERFLY BUSH (BUDDLEIA)



B.S. CHRYSALIS IN EMERGING CASE
NEAR WINDOW WITH MORNING SUN

EASIEST BUTTERFLY TO OBSERVE THROUGH STAGES OF METAMORPHOSIS

Monarchs are probably the easiest caterpillars to observe through metamorphosis... probably because they are unpalatable to birds—maybe they're less shy as a result. Regardless, I've had my greatest success observing monarch pupate and later emerge. (Check out my photos towards the end!)

Larval food plant for monarchs include members of the milkweed family of plants:

- **Butterfly weed**—*Asclepias tuberosa* is a native plant in North America, and is available through many garden centers
- **Swamp milkweed**—*Asclepias incarnata*
- **Common milkweed**—*Asclepias syriaca*
- **AVOID tropical milkweed**—*Asclepias currasavica*. According to the **XERCES society**, this plant becomes a problem when planted in temperate areas where it does not die back in winter, causing monarch deaths by interfering with migration, and creating deadly levels of a protozoan parasite. For more info, see: <https://xerces.org/blog/tropical-milkweed-a-no-grow>

Butterfly weed does **double duty** here as both a **nectar plant** and **larval food plant**. Also shown at left is Lantana—grown as an annual here in Cincinnati, and available from garden centers.

My tips for a **great emerging case**:

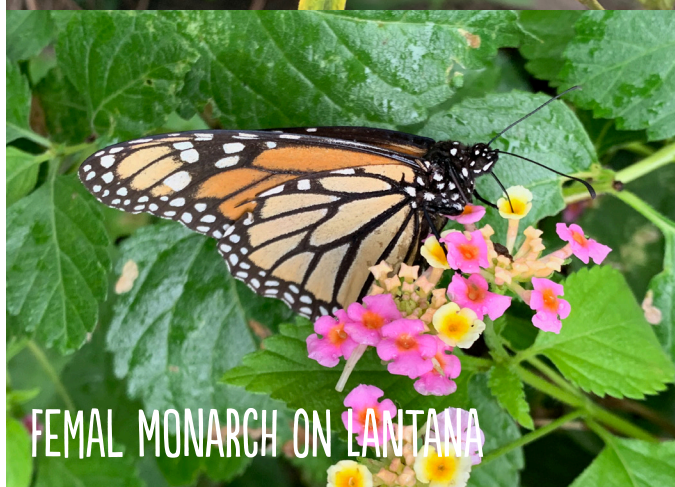
- **Portable**—so you can carry it outside to release your adult butterfly easily
- **Ability to open the top...** for easy release of adults, and to clean out caterpillar dross (poop) on a daily basis
- **Breathable**—mesh top and or sides—to allow air circulation



MALE MONARCH ON BUTTERFLY WEED



CATERPILLAR ON BUTTERFLY WEED



FEMAL MONARCH ON LANTANA



MALE MONARCH ON EMERGING CASE

HOW TO FIND CATERPILLARS

You can't rear butterflies from caterpillars without finding the necessary caterpillars. That can be easier said than done. Butterfly eggs are tiny. Young caterpillars are tiny, too. Many are camouflaged to look like bird droppings in their early instars (growth stages), or blend into the leaves of their host plant.

What are your best options for finding caterpillars? Here are my two best strategies:

- **Observe adult butterflies in your yard.** A butterfly swooping down and landing on foliage plants... even if its not the correct larval food plant... could be a female looking for the right plant to lay her eggs on.
- **Regularly inspect the leaves of any known butterfly host plants in your yard.** You may miss the youngest instars—the ones hardest to see. But for black swallowtail and monarch caterpillars, eventually they'll grow large enough to find. Check at different times of the day... they may hide underneath leaves at times to avoid too much sun or rain.

Some caterpillars have great camouflage, like the Tiger, Giant, and Zebra swallow-tails. Watching a female lay her eggs will show you where to look. Sometimes you may spot a caterpillar by pure luck... if that's the case, try to find a way to mark that branch or leaf so you can find it later. Tying a string or ribbon on the branch might help.

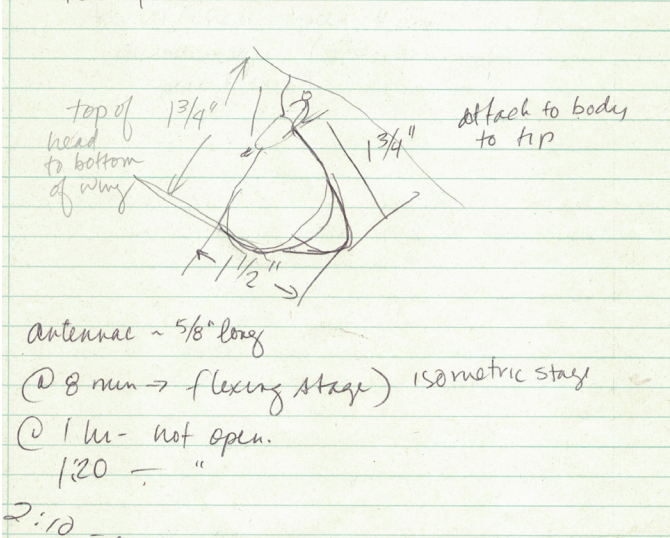
If you're lucky and have a friend who has caterpillars to spare, make sure you have a good source of fresh, pesticide-free foliage to feed them with. If you grow it in your yard, you can control what gets sprayed on it (coordinate with your family), but if you harvest from the wild, you never know if it's been sprayed until it's too late. (Dying caterpillars are a dead give-away).



Instar / Initial ID	Date Found	Location / Site	Location / Stopped eating	Attached to plant w/ prolegs	Pupation / Emerged	Days Emerged	Gender & Name	Comments - Pupation, loc., etc.
P2 Lg on Pearly	8/29/93	8/31/93	9/1/93	9/1/93	9/15/93			Em. Pearly Completed 9/15/93
F2 Lg on Female	8/27/93	8/31/93	9/1/93	9/1/93	9/15/93	11 days	Female Group I	Completed 9/15/93 11 days to pupate on Female prolegs (last year) Completed 9/15/93 11 days to pupate on Female prolegs (last year) Completed 9/15/93 11 days to pupate on Female prolegs (last year)
F3 Sm on Pearly	8/31/93	8/31/93	9/1/93	9/1/93	9/15/93			Completed 9/15/93 11 days to pupate on Female prolegs (last year)
F4 Sm on Pearly	8/31/93	8/31/93	9/1/93	9/1/93	9/15/93			Completed 9/15/93 11 days to pupate on Female prolegs (last year)
P5 Mid on Pearly	9/1/93	9/1/93	9/1/93	9/1/93	9/15/93		Female Group II	Completed 9/15/93 11 days to pupate on Female prolegs (last year)
P6 Mid on Pearly	9/1/93	9/1/93	9/1/93	9/1/93	9/15/93		Female Group II	Completed 9/15/93 11 days to pupate on Female prolegs (last year)
P7 Mid on Female	9/1/93	9/1/93	9/1/93	9/1/93	9/15/93		Female Group II	Completed 9/15/93 11 days to pupate on Female prolegs (last year)



Releasing
 If at all possible, I prefer to allow but to emerge outside. It's easier to photograph outside + sunlight warms their wings.
 I do like to get a photo + check gender (head wings + full spread wing view).
 If I can't be present for the event, I allow them to emerge inside, then, I get them in a butterfly net carefully + release them outside.
 Monarchs - Henry + Liz
 As many King Henrys + Queen Eliz.



KEEP A JOURNAL

If you want to observe the **magical moments of metamorphosis**—when a caterpillar pupates and turns into a chrysalis, and later when the adult butterfly emerges from the chrysalis—then I encourage you to keep a journal.

Why keep a journal? Because you need to play **detective**. No detective worth their salt keeps important details in their head. You never know when something turns out to be important. You need to record your observations, look for trends, and figure out **clues** to when a caterpillar is ready to make its move. For example:

- Keep a **list of your caterpillars**, date found, where found, date brought inside
- Record (and maybe photograph) **instar caterpillar forms and length** by date
- Record date/time caterpillar **left host food plant** and started 'walkabout'—looking for a pupation site, and **length** of the caterpillar.
- Record date and time that you noticed the **pupation completed**... this will help you figure out how to witness the event in future.
- Record date and time when the **chrysalis turns translucent**, and later when it **emerges**, then how long to **first flight**.

You don't need fancy spreadsheets. Do whatever is easiest for you. For me, back in 1993, it was a paper journal. Guess what? Not all the electronic files I kept from that time are still readable. Microsoft Word can't read old Word files from 1993. I *can* open PDF files from 1993.

When I started rearing butterflies again last year, I added my new notes to my 1993 journal. I still had it, and could add to it. Here are a few sample pages. As you can see, I made my own tables for observations, and added sketches and notes as needed.

CATERPILLAR HOUSEKEEPING 101

If you're reluctant to try and rear caterpillars, that's fine. If you're scared that some may not survive your housekeeping skills... that's fair. You may have a few casualties. Learn from it.

But... be aware that only a small percentage of caterpillars make it to adult butterfly in the wild. Odds are, they'll still have a better chance with you... the exception being if you take day-old caterpillars inside. It's much easier to rear caterpillars that are already an inch or more in length.

This is another reason to keep a journal! Track the length of your caterpillars to see how they're growing.

For those who are game to try their hand at rearing caterpillars, here's what you're getting into:

- Provide **moisture/humidity**... I use damp (not wet) paper towels in the bottom of the emerging case, spread out underneath the bottles of water holding fresh foliage. If I'm lucky to have potted plants, I use an old dish or a saucer underneath the pot(s). Chrysalises need humidity too.
- Clear out **caterpillar dross** (poop) at least once a day. For me, that means swapping out fresh paper towels. Or, you can use washable towels.
- If your emerging case does not have a waterproof bottom, **protect your floor from the dampness of the papertowels**. You could line the bottom with a plastic bag, or use another barrier.
- Make sure your caterpillars get **daylight**, but also have the option to **choose shade**—either from **foliage**, or being **out of direct sun**.
- **Don't use chemicals** around around your caterpillars, or to clean your emerging case!



Butterfly weed stems for monarch caterpillar inserted into small glass coke bottle, filled with water & covered with plastic wrap secured with a rubber-band. Poke a hole into the plastic wrap with a toothpick and insert stem.



Above left—Pawpaw seedling carefully dug up with earth & put into plastic cup for young Zebra swallowtail caterpillar. Holes punched in bottom for drainage. To the right, a branch from a Pawpaw tree cut for additional food and shade. The zebra caterpillars wouldn't touch the older, tougher leaves. They only ate leaves from young seedlings.



Caterpillar dross. For young caterpillars, it's hard to tell the difference between dross and dirt, but as the caterpillars grow, so does the pellet size. Clean it out daily to keep your caterpillars healthy!



BLACK SWALLOWTAIL CATERPILLAR
READY TO PUPATE ON LAVENDER



GREEN CHRYSALIS ON LAVENDER



ZEBRA SWALLOWTAIL CATERPILLAR ON
PAWPAW SEEDLING



MONARCH
CHRYSALIS ON
EMERGING CASE

PUPATION SITES...

One more thing to talk about... **providing acceptable pupation** sites for your butterflies. Each species may have its own preferences and peculiarities.

One of my very first black swallowtail caterpillars crossed the patio and pupated on a **potted lavender plant!** That made me a little braver about bringing them inside to rear. Another pupated on a piece of fennel—also its food plant.

When I started bringing caterpillars inside, I used a tall glass aquarium, no lid. So, those caterpillars were **free to roam the room.** One monarch pupated on a **silk peace lily.** One black swallowtail pupated on the **pipng of the couch cushion!** Another—which I didn't find until it was too late—pupated on the **electrical cord** behind the TV. That was the caterpillar I wrote about in my book, *Putney and the Magic eyePad.* Yeah, it really happened. I didn't make that part up. Another pupated on the decorative **wood 'watering can' container** that housed a scented geranium. One of my monarchs pupated on a leaf of that same **scented geranium.** It was a lucky plant/pot for me.

Last year, my monarch pupated on the emerging case top rim (so the IKEA laundry basket I use is caterpillar-approved), but my zebra swallowtail chose to pupate on a Pawpaw leaf. I was concerned the leaf might not have enough stiffness to let it split its skin and later emerge, so I used push pins to secure the leaf to a piece of balsa wood. It worked. Not sure if it was needed.

My last black swallowtail caterpillar didn't like the mesh of my portable emerging case, bamboo, or a wood stir stick. I finally cut a piece of a tree branch for it, and then it was happy. So be ready to test some things out. You've got a day or so to figure it out, once your caterpillar goes 'walkabout'.

BLACK SWALLOWTAIL STAGES

Early caterpillar instars (top left) often look different from their last instar form. If you track your caterpillar length, you'll soon learn when it's big enough to pupate.

Swallowtail caterpillars anchor their feet on a silken pad called a **cremaster**, then spin a silken **girdle** to support the upper body. Black swallowtail chrysalis color depends on its surroundings, and can be **green** or **brown**. This one started out green and yellow (it pupated over a parsley plant), but later changed to tan/brown when the parsley was removed. What can you observe?



EARLY INSTAR



FINAL INSTAR

CATERPILLAR ATTACHED TO BRANCH
SUSPENDED OVER PARSLEY



CATERPILLAR ATTACHED TO BRANCH



CHRYSALIS AFTER PUPATION NEAR PARSLEY



CHRYSALIS A FEW DAYS AFTER PARSLEY REMOVED

Above. Black Swallowtail caterpillar formed silken girdle on brance suspended above potted parsley plant. When the caterpillar pupated, it was green and yellow (above).

After a couple days, the parsley plant was moved out, and the chrysalis changed color to tan brown to match the branch. (3 views show, left)

MONARCH STAGES

Monarchs have beautiful **jade green chrysalises** with gold accents. Even more amazing, they turn **translucent** about 24 hours before the butterfly emerges... and you can clearly see the **forewing** of the butterfly through the chrysalis!

Back in 1993, when I was working on my Ph.D. in materials engineering, I raised about 8 monarchs. Watching with the eyes of an engineer, I was amazed by what I saw. The monarch forewing is roughly shaped like a right triangle. The hypotenuse measured $\sim 5/8$ " in the chrysalis, but expanded to about 2.1" after emergence, **an elongation of over 330%**!

The wings come out **soft**, and are pumped up with body fluids. I observed a few drops of meconium, or colored waste products, about 5-10 minutes after emerging, followed by drops of clear fluid ~ 28 minutes after emerging, and continuing over the next 1-2 hours until they are sufficiently hardened for first flight. This is possibly a **rapid polymerization process**.

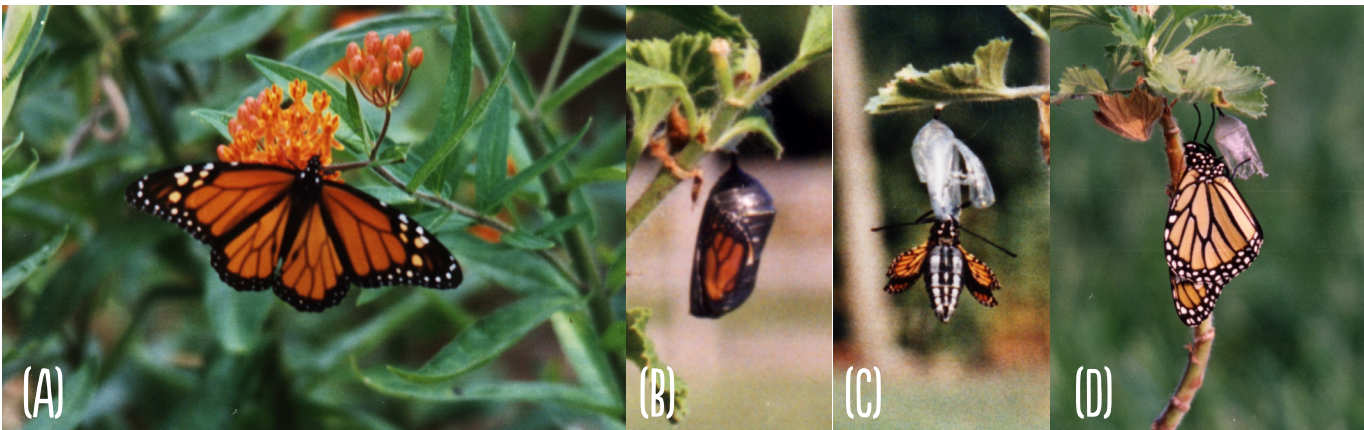
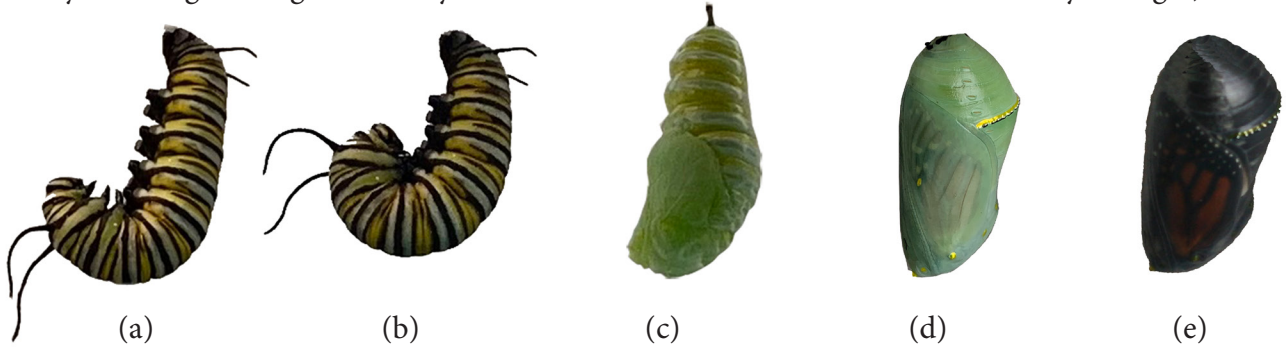
The monarch butterfly is truly an amazing engineering marvel... from chrysalis to first flight in **under 3 hours!**



FEMALE MONARCH SHOWING PROBOSCIS



Monarch pupation progress - (a-b) caterpillar in J position - does isometrics to break skin at curve of J, (c) chrysalis shortly after shedding caterpillar skin, (d) green chrysalis final shape, (e) translucent chrysalis (can see butterfly forewings through side, chrysalis turns translucent ~ 24 hours before butterfly emerges)



(a) Male Monarch, (b) translucent chrysalis, (c) butterfly just after emerging, (d) butterfly with wings expanded

MONARCH PUPATION SEQUENCE

When a monarch is ready to pupate, it will attach its feet to a silk pad called a **cremaster**, and hang upside down in a **'J' position**. It may hang in that position for a day or so.

As it is getting ready to pupate, it will start flexing... **curling** into a **tighter 'J' position**, then **uncurling**. The objective of this exercise is to spit the skin behind its head.

Once the skin starts to **split**, the chrysalis continues to wriggle, causing the skin to roll up. When it's rolled up all the way to the top, the chrysalis gives a big kick to dislodge the skin.

The **naked chrysalis is very lumpy** and mis-shapen at first. Over the course of a couple hours, it changes shape into the **final classic shape** of the monarch chrysalis (bottom right).

If you want to try and observe a monarch caterpillar pupate, it may take you a few tries to figure out when it's going to do it. You have to use your **detective skills**, observe your caterpillars, look for trends. Make a **hypothesis** or two... and test it.

In 1993, I kept my caterpillars in a room with morning sun (northeastern exposure). My monarchs pupated early morning. I got up early—around dawn one day—got into a comfortable position, and waited until it started to move. I was able to successfully photograph the sequence at left.

In 2019, I had one monarch caterpillar that I kept in a room with southwestern exposure (afternoon sun) because it was next to the patio. That monarch pupated close to 4 pm in the afternoon. I didn't camp out to watch it as fanatically as I had in 1993, so I missed the actual pupation.

So... you need patience, good observation skills, and dedication to catch these events in person. Figure out a good place to settle down, and have something handy to help keep you occupied while you keep an eye out on your butterfly!

It's a magical moment you'll never forget! You can read books, or watch someone else's you-tube video, but there's nothing quite like witnessing the event yourself, because you figured out how to do it!



ABOVE LEFT... CHRYSLIS GIVE A FINAL KICK TO DISLODGE THE ROLLED UP SKIN. NEW CHRYSLIS TAKES A COUPLE HOURS TO REDISTRIBUTE AND SETTLE INTO ITS FINAL SHAPE

MONARCH EMERGING FROM CHRYSALIS

Don't blink... you won't want to miss this! When the monarch butterfly is ready to emerge, it **cracks open** the back of its chrysalis like it's **peeping out of a door**. Then it slowly slides its body down and out, until its belly flops out.

It looks like a fat ballerina with a tiny tutu at first! Then it starts to **twist back and forth**, shaking its wings out as it pumps fluid from its abdomen into its wings, expanding them.

The sunny side expands faster, and the twisting motion seems to help even out the expansion process.

If you watch carefully, you'll see drops of fluid being emitted from its abdomen. The first drops have a dark reddish orange color, but this is followed by a clear fluid.

Now the butterfly starts isometric exercises, what I call the clap and fling pre-flight (it's a butterfly flight thing, see bottom row of photos), alternating which side of the wings its abdomen is on... but that's for another paper.



MONARCH EMERGING FROM CHRYSALIS, CONTINUED

Top left—the clap. Wings tight behind the back of the butterfly.

Top center—looking down on the butterfly. The paper below shows the colored meconium, surrounded by a clear liquid.

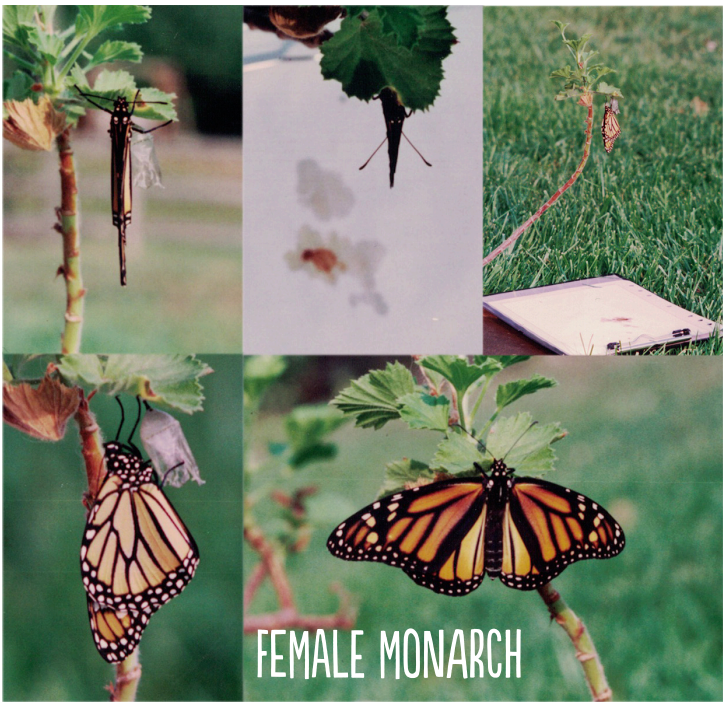
Top right—butterfly suspended from its chrysalis, over the clipboard with paper (used to capture the fluid emitted by the butterfly).

Center left—side view of butterfly, clinging to its chrysalis.

Center right—newly emerged female monarch butterfly. You can tell males from females by their hind wing markings. Females also have thicker forewing veins.

Bottom left—males have a dark spot on each hind wing made of specialized scales.

Curious about butterfly flight dynamics? Keep an eye out for more content coming soon!

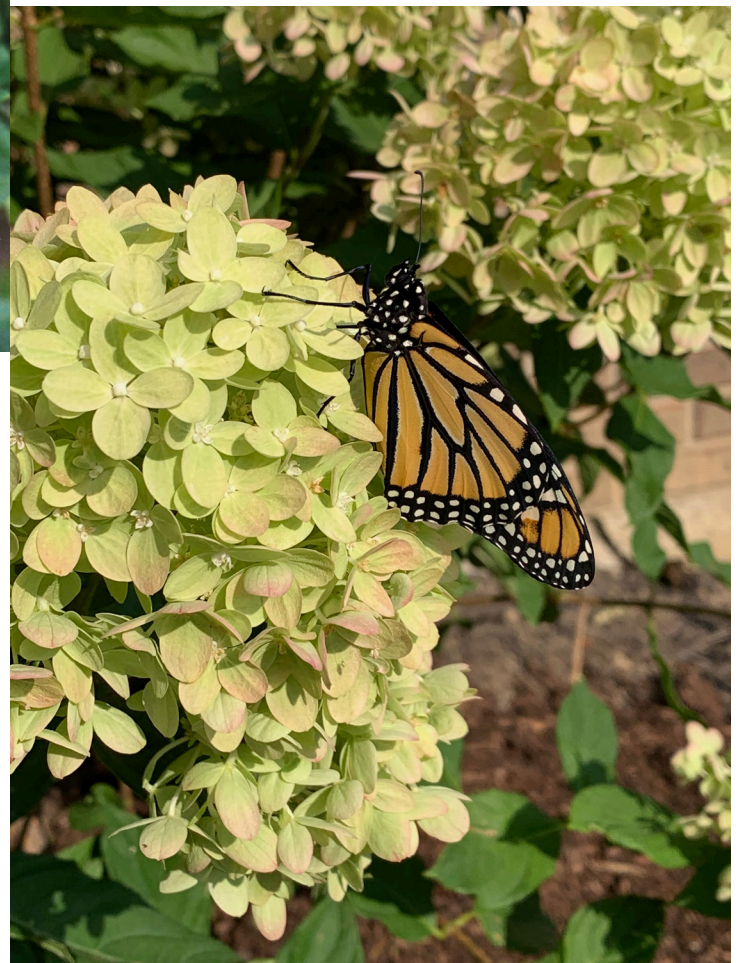


FUN FACT...

I name my butterflies. I call my male monarchs 'Henry' because there were more King Henry's in England than any other name. The females I call 'Elizabeth'... similar reason, and they also happen to be the best known Queens of England.

Black swallowtails are **Fred and Ginger**, after Fred Astaire and Ginger Rogers—the famous dancers. He danced around all 4 sides of a room—floor, side, ceiling, other side—using a very clever filming device. Also because he often wore a tuxedo and top hat.

My zebra swallowtail I named **Zephyr**... a gentle breeze. I can't tell the difference between males and females from wing markings, so one name will do.



ZEBRA SWALLOWTAIL STAGES

The front page also shows a zebra swallowtail egg and the major life stages. This page shows **additional caterpillar instars**, as well as some additional photos of adult zebra swallowtails.

The zebra swallowtail is a **'kite wing'** butterfly, and has the **longest tails** of any North American butterfly.

I designed and flew a **zebra swallowtail kite** for fun... just to see if I could. **What projects can you think of?**





FYLLEN

Laundry basket, 21 gallon

\$7.99

★★★★★ 3.8 (58)

Emerging Case option—IKEA pop-up laundry basket

<https://www.ikea.com/us/en/p/fyllen-laundry-basket-white-20408017/>

FYLLEN laundry basket, white, 21 gallon, 7.99

SUPPORT THE MONARCH MIGRATION...

If you're interested in butterflies, consider planting **Butterfly Weed** (*Asclepias tuberosa*) in your yard—it's a great nectar plant, and you'll be supporting the great **Monarch Migration** at the same time by providing a necessary food source for these amazing flyers.

You'll want **other nectar plants**, too. **Lantana** is an annual here in Cincinnati, but that also means it has a longer bloom season. It attracts **hummingbirds**, too.

INTERESTED IN LEARNING MORE ABOUT THE MECHANICS OF BUTTERFLY FLIGHT?

Check out my paper on “Material Selection for a Butterfly Wing Design, with extensions to scuba fin design and other applications... coming soon, just have to finish the formatting. This was a paper done for a graduate course in materials engineering in 1993. After witnessing so many monarch pupate, then later emerge from their chrysalis and take first flight, I was amazed and wanted to learn more. It was a bit tongue-in-cheek... not really being feasible to design replacement wings for butterflies. But my professor pointed me in the direction of books and papers studying insect flight and I was hooked!

I learned so much. I've given several graduate seminars on my paper as a result at the University of Dayton. It never fails to inspire others.

It also inspired me to create the **quilt**, middle left. The monarch butterfly is a 36" wide hand-pieced applique, using hand-marbled fabrics.

What will observing butterflies inspire you to do?

RESOURCES

The main thing you need to rear caterpillars is an **emerging case**. I used the IKEA laundry basket, left, to rear a monarch and a zebra swallowtail last fall. Light weight, portable, simple. One is currently housing a black swallowtail chrysalis that I overwintered.

Books—there are too many to name. **Audubon field guides** have great pictures of adult butterflies, and list the range, and larval plant foods in the back pages.

The Butterfly Book by Donald and Lillian Stokes/Ernest Williams, Little Brown & Company is another favorite.

<https://www.amazon.com/dp/0316817805>



**MONARCH
WATERCOLOR**

BY MK TUFFT

showing life stages from caterpillar on butterfly weed (*asclepias tuberosa*), pupation (J position, green chrysalis, translucent chrysalis), to adult (male shown at left)