
Using Butterflies as Touchable, Retrievable, Photogenic Animal Encounters

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Introduction

The contents of this paper are from a poster presented at the 2012 Association of Zoos and Aquariums annual meeting. The last section offers additional content based on questions asked during the poster section. The purpose of this paper is to introduce Zoos to new possibilities for the use of butterflies and moths, including behavior management to provide new guest experiences.

1 Keeping your own native colony is inexpensive

1.1 Housing should be a small mesh cube

Plastic mesh should be used for caging, which is typically a small cube. Metal mesh will injure the wings and body of the butterfly as they fly and land. Because butterflies fly toward light, overhead lighting will lead to wing wear as butterflies try to fly through their cage ceiling. An opaque cage top, such as a piece of brown paper towel, will prevent wing wear from fluttering at the ceiling. We suggest Painted Ladies, Buckeye Butterflies, Clouded Sulphurs, Cabbage Whites, and Manduca moths.

Wing wear can be reduced, but adds up in long lived, expensive butterflies.



Visitor Expectation of a big butterfly.



Visitor Experience.

Photos courtesy David Muse at Davidmusephoto.com, left. Chris Coleman at Flickr handle iceman2924, right.

1.2 Culturing butterflies is inexpensive and can use “just add water” diet.

Butterflies will lay their eggs on a moist sponge, but more eggs will be laid leaf that is from the same Family or Genus as their natural host plant. If one does not wish to grow a potted plant, one can tear off inedible leaves from supermarket produce (like broccoli leaves for Cabbage Whites,) rub off surface pesticide in flowing water, then present the leaf to butterflies for egg laying. In this way the waste from

feeding other animals can be recycled. Weeds provide excellent egg laying material and are provided to you at no cost by the lawn near your office. For example, Buckeyes will lay eggs on plantain, found in grass lawns, while Clouded Sulphurs will lay their eggs on clover leaves.

Ward’s scientific supply company’s Stonefly diet (a just add water instant caterpillar food) will work for rearing painted ladies, and will result in some mortality in cabbage whites. Other species will grow well on the Stonefly diet with the addition of a single hostplant leaf at a time to munch on for trace minerals and nutrients that reflect their specialized diet. Fourteen hour daylight periods (a table lamp on a timer suffices) or leaving a light on all the time is useful to avoid putting a species into a hibernation period called “diapause.” While this can be useful, such as extending the lifespan of an adult Painted Lady from two weeks to four months, diapause can prevent the life cycle by pausing it at a certain stage. An awful thing is to expect 200 cabbage white butterflies by a certain date, but instead they are paused as chrysalises!

If you choose to mix your own caterpillar diet in house err on the side of too much protein. Too many carbohydrates or fats will result in very fat butterflies whose obese abdomens can’t slide out of the chrysalis! Very fat butterflies cannot fly due to wing load and are great for education, but a high carbohydrate diet is more likely to produce mortality than immobile butterflies (until they burn off the fat, that is.)

Caterpillars need very little space, and can be grown in little plastic sauce cups as one sees from takeout restaurants. One counter top is adequate grow 400 small or medium species caterpillars.

1.3 Small butterflies should be fed with a light by their food.

We have found that small, short lived butterflies’ greatest risk of early death is dehydration and wing damage. Placement of lighting can help both. It is more important that a short lived butterfly have free access to water than to nectar! Well fed caterpillars will have a large supply of fat and nutrition when they emerge as adults but without frequent drinking they die before they exhaust their energy reservoir. Obviously, high humidity prevents dehydration through water loss to the air. To offer drinking water one may mist the cage three times a day, and the butterflies will

ingest droplets from the mesh walls of their caging. Alternately, a light may be placed outside the cage next to a sponge cut to fit in a dish, saturated with water. The butterflies will visit the light and then drink from the sponge. Misting the cage and offering dilute nectar, a sugar sweetened Pedialyte or Gatorade and a dash of soy sauce works well, will provide adequate nutrition for short lived butterflies. Liquid given off by rotting fruit, such as on the surface of old banana slices, offers more protein and trace elements but are more appropriate for long lived species who require high quality nutrition sustain their bodies for months of life. The species we suggest above are short lived.

1.4 Inbreeding depression hits butterflies much harder than other insects and is of concern.

Maintaining a butterfly colony of about 200 individuals without adding new butterflies is much more challenging than adding a few new butterflies to the colony every six months to “refresh.” (Saccheri et al 1996) Scientists have studied how to breed butterflies in order to remove disease caused by genetics. When such a breeding program is complete, one possesses a genetically healthy “inbred line.” We have a decades old moth colony at our university which is inbred and healthy through these techniques. One alternates between two strategies: Purging and line crossing. (Wang 2000) First, butterflies split across several cages are allowed to breed at will until the inbreeding depression becomes so great that the bad genes die off with those who carry them. The surviving butterflies are then crossed with those from another cage. Any bad mutations are allowed to build up and purge themselves, then the lines are crossed again. This continues until the population no longer has any bad mutations. You should be familiar with healthy inbred lines from feeder mice and mealworms, which are both inbred.

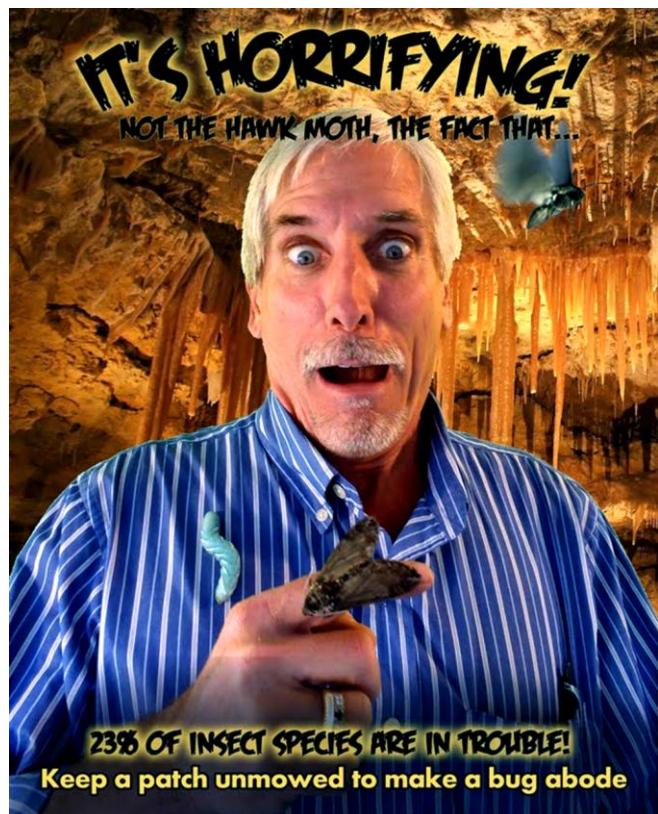
1.5 Since butterflies are delicate animals, they must be moved carefully and properly

Untrained butterflies must be handled properly to avoid harming their small bodies. The proper method of moving an uncooperative butterfly uses flimsy metal insect forceps to grasp the strongest part of the wings just above where the forewings connect to the body. Gently pinching this part of the wings with the fingers may also be acceptable if only done a few times. Using this technique, the butterflies can be transferred from one location to another until they are needed for education.

2 Butterflies and moths generate revenue

2.1 Photo opportunities can be added to a display with almost no overhead.

Photos with butterflies and moths sell well, and are perfect as intimate one to three person face portraits. In our experience butterfly photos are not about vanity for visitors, but about recognizing family. Photos tend to be of young children, grandparents, or parents with children. A habituated butterfly is coaxed onto the handler's fingertip then climbs up onto the subject's nose. Butterflies typically open their wings to bask while slowly walking up the face. This leads to insane amounts of giggling and smiles and can be themed for Easter and other holidays. Or in the case of the example photo, large moths are used for a spooky Halloween theme. The basking behavior of butterflies is very predictable and allows for the photography volunteer to provide education about the predictable responses of the butterfly with minimal training.



An actual Zoo Boo portrait by the authors using *Manduca* moths. Kids and adults love handling the giant caterpillars!

The guests *give us their e-mail and phone number*, as well as checking a box giving us permission to re-use the photos. We then e-mail the photos with an e-mail form letter, eliminating overhead caused by printing. Email addresses that

don't work are fixed over the phone. Using Photoshop "macros" on can easily and automatically overlay educational messages so the butterflies are educational tools instead of glamor props. "Freebie" photos are posted on Facebook and can only be retrieved if the subject of the photo "friends" the organization's Facebook page.

Butterfly portraits sell well, but species used will affect the portrait quality.



Small butterflies allow for a clear portrait.

Big butterflies obscure faces in photos.

Photos courtesy of Robert Pyle

2.2 Surplus butterfly stock can be sold to others as learning aids.

Butterflies can be sold to schools and families. In the United States butterflies bred from individuals caught in a state may be transported within state, and they may be sold, traded, or transferred within state at any part of their lifecycle. The laws governing butterfly use are under USDA APHIS PPQ regulation. Butterflies bred from in-state wild caught individuals may be legally released into the wild, though the authors do not suggest that.

2.3 You can use surplus and retired butterflies as highly visible animal enrichment.

Butterflies are fantastic prey animals. They are attractive to visitors when added to enclosures and promote natural hunting and education about predator behavior. Imagine servals on exhibit running around and batting at butterflies, or a water monitor tongue flicking at the butterfly on its head. (We like to feed them to mantids and birds)

3 Butterflies CAN be trained and freeflown

3.1 Habituation training allows butterflies to be handled by children without flying away.

Butterflies bred in captivity can be trained to accept handling through habituation training. During the first few days of the adult life, the butterflies will exhibit skittish behavior until they learn what is normal, and should not be handled until at least the second day after emergence when they will be somewhat calmer and their wings will have hardened

completely. Handling butterflies repeatedly over the course of a few minutes will habituate them, meaning make them ignore the stimulation being applied (Schowalter, 2006, p. 553). It can take hours or days for habituation to wear off so a habituated butterfly will accept handling with fly offs, but much less frequently. Stimuli to habituate includes being cupped in the hand, shadows, movement of a perch, puffs of air, and stepping up and down from the hand. Waving shadows in front of the butterflies, coaxing them on to the hand and waving the hand around, blowing on butterflies, and having the butterflies step down onto angled surfaces can be done in a few minutes. For example, butterflies habituate to puffs of air, usually by puff 3 to 5. Allowing older children to reach into a "bug hut" style cage and coax the butterflies onto their fingers will usually achieve habituation goals.

3.2 Butterfly activity levels can be controlled with temperature.

Butterflies' bodies adapt to temperatures they emerge into. Butterflies temporarily presented in a cooler environment remain at rest more frequently. The cooler environment may also promote basking behavior in the butterflies in order to warm their bodies in the cooler temperature. A basking butterfly that is habituated to light changes and being moved around is "bullet proof" and simply *does not* fly away



It's possible to produce a butterfly that won't fly away, even during sudden motions.

...Even if a six year old jumps up and down with excitement, "MOM! The butterfly LIKES me!!" A week old habituated butterfly raised at 85 degrees Fahrenheit and cooled to 68 degrees will ride around on a fingertip during



Release, freeflight, recall, and retrieval using a spot light.

school presentations for some hours (schools in temperate climates are often quite cool during winter.) What is most important is not to temperature adapt butterflies to cold temperatures. Butterflies that eclose from the chrysalis and live at 67 degrees may adapt for flight at those low temperatures. A two week old butterfly adapted to 67 degrees will be *very active* at warm temperatures! (Fischer et. al 2010)

3.3 Using natural responses to light, butterflies can fly to a station or be immobilized.

It is not possible to train a “solid” freeflying butterfly as one expects from a reliable hawk or parrot. Fly offs are inevitable, though they can be greatly reduced. Using light, it is possible to immobilize or recall butterflies for catch up. Butterflies will move toward light (Kolligs 2000) and will not fly in dim conditions. A hand held spot light can be used to cast a bright spot on a surface as long as it is brighter than the room lighting. Loose butterflies will fly to the bright spot where they can be coaxed onto the hand. A light

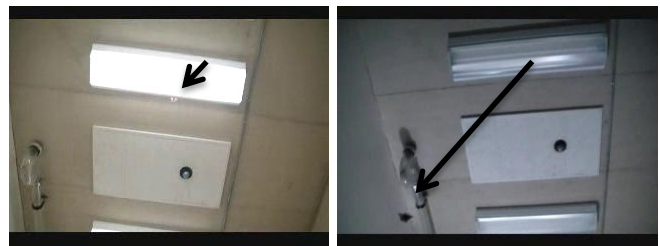
trap, with a funnel and box can catch up butterflies while the handler is doing other things. Butterflies that are flying around a high ceilings level will come down to the floor if the light is suddenly dimmed. In very dim light the butterfly cannot see and will cease flying. A keychain flashlight allows the handler to see detail and scoop up butterflies that have come to rest on the floor. Red lights, as are used in nocturnal exhibits will be invisible to some species, such as Painted Ladies, but be very visible to other species, such as Swallowtails. Different species have different color vision systems so light tricks used with vertebrates may not work! (Butterflies that can see ultraviolet will also gather around a black light to great effect, as that light is invisible to people.)

4 Frequently Asked Questions

4.1 Can they learn to station?

Butterflies can be fed nectar colors within their vision range for a few days and then will preferentially fly to those colors if they are released and are hungry. Dr. Martha Weiss of Georgetown University has been applying butterfly color learning to classroom presentations. However, they need a diet of host plants, not cooked diet to achieve normal vision as they need carotenoid vitamins not present in diet.

Moths raised on host plant diets can learn to fly to a certain shape (such as black and white bullseyes) and scent, though they are nocturnal so their activity cycle has to be shifted with a light timer. Large, heavy moths at room temperature take a long time to warm up through shivering before they are ready for flight. We tend to let large Manduca



A butterfly at a light drops to the floor when the room is dimmed. Blocking overhead light prevents wing wear by reducing contact of wingtips and solid surfaces.

moths warm up during handling and spontaneously fly, catching them up with light after they zoom around for a while.

For small species, where station training is impractical due to short lifespans, we just use a bright spot of light and they flutter over.

4.2 Are there any really big moths of butterflies that don't need special treatment to be handled?

Large, heavy moths at room temperature take a long time to warm up through shivering before they are ready for flight. Large moths that are too cool for flight are excellent for education without any special care. We suggest hornworms from the Genus *Manduca* as the adults may live for weeks if well fed on nectar. They are also very charismatic flyers, hovering and testing every fuzzy surface for nectar.

4.3 How much lead time is needed to breed butterflies and moths?

Large species grow more slowly, but growth is temperature dependent for most species (though some are also dependent on the number of light and dark periods they experience.) For example, if we raise Painted Ladies at 90 degrees they will go through a life cycle in a little over two weeks. But, if raised at 65 degrees some will die but the rest will take a little over two months to go through a lifecycle.

4.4 I'm intrigued, where do I start?

Well, you can email us for a consult! But if you want to experiment on your own, start with a Painted Lady classroom kit from Ward's Scientific supply. If you keep all your tools clean you will easily produce 30 butterflies with very minimal effort and no loss. Bacteria can be of concern, so don't talk over the diet (tiny spit bits will get on it), and sanitize your hands with alcohol before making diet. The process of rearing butterflies and moths has a lot of steps, but none of them are very hard. With a little specialized knowledge you can easily breed and keep several species simultaneously.

4.5 How can I tell if butterflies are inbred?

Like vertebrate species, physical deformity and reduced fertility are obvious signs. The proboscis (tongue) will often be forked, and butterflies will have trouble eclosing from the chrysalis, leading to death or crumpled wings. Be aware of neurological problems such as butterflies with "tics" that twitch their heads, shiver their wings when already warm, or whack themselves in the face with their front legs. If you get unhealthy inbred stock from a breeder, demand a refund. Responsible animal breeding is paramount.

5 Outdoor Release Presents a Conflicting Message

Keeping native butterflies in captivity is important. Through SSPs zoos act as genetic arks, and quarantine to prevent disease. But butterfly releases conflict with the concept of sound genetics and disease control. Here are some notable quotes used with permission.

"When celebrants are misled into thinking that they are doing something ecologically acceptable, even positive, by tossing monarchs into the void at their events, they are in fact party to scientific vandalism; rather than acting 'green,' they are helping to undermine our ability to correctly interpret the response of wild monarchs to all the challenges they face." *From Robert Pyle's "Under Their Own Steam: The Biogeographical Case Against Butterfly Releases"*

"Why doesn't the Zoo release their butterflies? There is a potential threat of spreading disease to the wild populations of butterflies. [...] The parasite may not show up for several generations, so diseased butterflies may be released before the discovery of a harmful parasite. 'Farmed' butterflies from other states are also genetically different from our native wild butterflies. Releasing farmed-raised butterflies could therefore change, or 'muddy' the genetics of our local population, which would not be beneficial." *Minnesota Zoo website*

"In order to conserve butterflies we need to understand their natural distribution. Butterfly releases make this impossible to do. Butterfly farms are under no legal obligation to screen butterflies before they ship them. Some butterfly farms have disease epidemics. If these butterflies are released they might spread disease to natural populations. Although this has not yet been proven in wild butterflies it has been in honey bees and salmon. Regardless of disease status laboratory populations can alter gene frequencies" *From the Xerces Society Butterfly Release Policy*

6 References Cited

Fischer, K., Dierks, A., Franke, K., Geister, T. L., Liszka, M., Winter, S., & Pflücke, C. (2010). Environmental effects on temperature stress resistance in the tropical butterfly *bicyclus anynana*. PLOS ONE, 5(12)

Minnesota Zoo, Butterfly FAQ: Why doesn't the zoo release their butterflies. Retrieved 8/16/2012, 2012, from http://www.mnzoo.com/animals/animals_bfly_faqs.asp

Jervis, M. A., Boggs, C. L., & Ferns, P. N. (2005). Egg maturation strategy and its associated trade-offs: A synthesis focusing on lepidoptera.30(4), 359-375.

Kolligs, D. (2000). Ecological effects of artificial light sources on nocturnally active insects, in particular on butterflies (Lepidoptera). Faunistisch-Oekologische Mitteilungen Supplement, (28), 1-136.

Pyle, R. (2010). Under their own steam: The biogeographical case against butterfly releases. J Lepidopt Soc 4:397–411.

Saccheri, I. J., Brakefield, P. M., & Nicols, R. A. (Oct 1996). Severe inbreeding depression and rapid fitness rebound in the butterfly *bicyclus anynana* (satyridae).50(5), 2000-2013.

Schowalter, T. D. (2009). Learning. In *Insect ecology: An ecosystem approach*. (Second ed., pp. 553-555) Elsevier.

Wang, J. (2000). Effects of population structures and selection strategies on the purging of inbreeding depression due to deleterious mutations.76, 75-86.