Wyoming 4-H

UW | EXTENSION

Using Digital Macrophotography to Record Insect Life Cycles

***adapted from Kentucky 4-H Publication by Blake Newton, Extension Entomologist**

INTRODUCTION

Macrophotography

Macrophotography refers to the use of special photographic equipment to create larger-than-life-sized images of relatively small subjects. A few years ago, a photographer needed expensive lenses and bulky cameras to accomplish macrophotography. Thanks to modern digital cameras and camera phones, digital macrophotography is now accessible to almost anyone. This resource guide encourages 4-Hers to use consumer-grade macrophotography equipment to study insects and their biology.

Almost anything can be the subject of macrophotography, but some of the most popular subjects are small animals, especially insects, which are important in Wyoming agriculture. 4-H members can use a variety of macrophotography techniques to study different aspects of entomology. Consider entering a macrophotography project in the fair this year instead of or in addition to collecting bugs.

Goals:

4-Hers will use macrophotography to study the diversity of insect life in Wyoming by creating a digital collection of insects. Each insect will be identified to Scientific Order and Common Name.

4-Hers will use macrophotography to study life cycles of Wyoming insects. 4-Hers will photograph and identify various insect life stages, including two examples each of insect eggs, insect nymphs, insect larvae, and insect pupae. Then, 4-Hers will use macrophotography to capture the behaviors and adaptations of insects. This project will include “action” shots of insects as they exhibit behaviors and use adaptations. Each behavior and/or adaptation will be identified.

4-Hers will use macrophotography to create a digital album of Wyoming insects, in the act of interacting with the human world. Examples may include pests (like invasive species and insects that infest homes), and beneficial examples (like pollinators and predatory insects). Each insect will be identified, and notations will also include comments about the impact that the subject has on the human world.

4-Hers will document different interactions between insects and plants. Interactions may include pollination, herbivory, seed-dispersal, and other examples. For each photograph, the 4-Her will write a small description of the interaction, including the name of each insect and plant and will give evidence to support their identification of a particular interaction.

4-Hers will use digital macrophotography to study entomology in a creative or investigative way. Projects may advance the previous goals of the project in some way, or 4-Hers can use macrophotography to study some other aspect of entomology. Arachnids and other non-insect arthropods may be the primary subjects of this goal. Photographs captured by the 4-Her in other states and countries may be the focus of this project. Other media may also be incorporated.

Examples may include, but are not limited to:

- Long term photographic investigations of the plant-insect interactions in a certain area
- A photojournalistic piece, with a written component
- A video documentary that incorporates macrophotography
- A prepared slideshow with images and text

Record Keeping

As students advance through this curriculum, it is crucial that they document the photographic equipment and techniques that they use for each photograph. Not only will this help to eliminate the possibility of plagiarism, it will also encourage 4-Hers to keep track of the tools and techniques that worked the best in different situations. Records will include: type of camera used; type of lens used; macrophotography techniques used; date, and location of the original photography. These records should be kept in a notebook. This notebook could be submitted or used as a reference tool during fair judging.

*FOR BASIC MACOPHOTOGRAPHY TIPS PLEASE REFERENCE "**Using Digital Macrophotography to Study Entomology"**

MICROPHOTOGRAPHY FOR INSECT LIFE CYCLES

General: the depicted life stage should be briefly described at the bottom of the notation box in each image. The description should indicate whether the image shows an egg, a nymph (simple metamorphosis), larva (complete metamorphosis), or pupa. For instance, if the image shows the caterpillar of a monarch butterfly, the notation box may read:

Newton, Fayette, Lot 6026, Class 688B
7/8/18, Raven Run Nature Sanctuary, Lexington, KY
Nikon Coolpix p900
Built-in lens, default settings, no flash used
Lepidoptera – Monarch Butterfly
Larval stage of a Monarch Butterfly, an insect with complete metamorphosis

1. You will look to capture images showing the eggs of 2 different species of insects. Egg sacs or egg cases will work. Eggs of non-insect arthropods may be included, but at least 1 of the 2 images should be from an insect. All eggs, egg cases, or egg sacs must appear to be "unhatched." Because egg identification is very difficult, correct identification may not be possible, but members should do their best to try to make correct identification.
2. You will look to find images showing the immature stages of at least 8 different insects with "simple" or "incomplete" metamorphosis. Immature stages of non-insect arthropods could also be included. The immature insects with simple or incomplete metamorphosis are called "nymphs" (or "naiads" for aquatic species). For non-insect arthropods, it is often difficult or impossible to determine what life stage the creature is in, so 4-Hers should not include immature spiders, centipedes, or other non-insect arthropods for this part of the project unless they are certain that the image shows an immature. For this part of the project, correct Order (or Class for non-insects) identification is expected in the notation field of each image.
3. You should look to find at least 8 images showing the larval stages of different insect species with complete metamorphosis. No non-insect arthropods may be used for this section because there are no non-insect arthropods that exhibit complete metamorphosis. For this part of the project, correct Order identification is expected in the notation field of each image.
4. You should look to collect at least two images showing the pupal stages of species with complete metamorphosis. No non-insect arthropods may be used for this section because there are no non-insect arthropods with pupal stages. For this part of the project, correct Order identification is expected in the notation field of each image.
5.

Adaptations and Behaviors:

General: For this part of the, 4-Hers will collect images that showcase <u>different</u> insect adaptations and behaviors of <u>different</u> kinds of insects. Non-insect arthropods may be used for this part of the project. Immature stages may be used. Identification to Order (or Class for non-insects) is required for each image, in addition you should try to identify Common Names.

Notation Box: as with the life-stage images, each behavior/adaptation image should contain the basic notation information along with a brief description at the bottom of the adaptation or behavior featured in the image. For instance, if an image shows a mantis sitting on a plant, the notation box might read:

Newton, Fayette, Lot 6026, Class 688B
8/22/18, Jacobson Park, Lexington, KY
Nikon Coolpix p900
Built-in lens, default settings, no flash used
Mantodea – Chinese Mantis
The green and brown colors on this mantis are adapted for camouflage on vegetation.

Life Cycles: Tips and Other Information

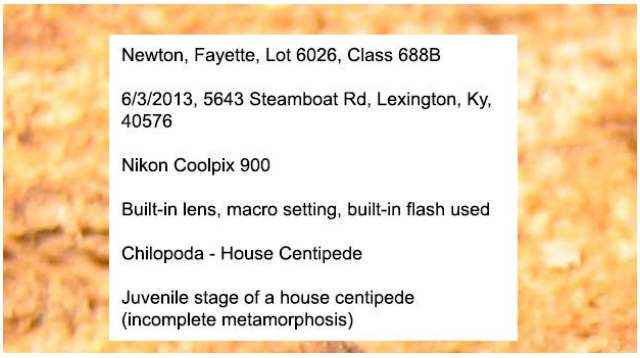
Eggs: it can be a challenge to find eggs of insects or non-insect arthropods. They are often small, camouflaged, and hidden. Look on the stems of plants, the undersides of leaves, trunks of trees, and on the sides of man-made structures. Note that egg cases or egg sacs may be used for this part of the project as long as they appear to be intact and unhatched. Watch out for plant seeds: they will sometimes resemble insect eggs.

Examples of insect and arthropod eggs: lady beetle (Whitney Cranshaw, Colorado State University, Bugwood.org), mantid egg mass (Whitney Cranshaw, Colorado State University, Bugwood.org), gypsy moth egg mass (Karla Salp, Washington State Department of Agriculture, Bugwood.org), house spider egg sac (B. Newton, UK Entomology)

Nymphs and Naiads: The immature stages of insects that undergo simple or incomplete metamorphosis are called nymphs. The word "naiad" may be used for those insects that have aquatic nymphs (like mayflies, stoneflies, dragonflies, and damselflies). Remember that insects with incomplete metamorphosis do NOT change completely between the nymph and the adult stages, and there is no pupa or cocoon stage. Usually, the nymphs live in the same places as the adults and look very similar to the adults except that the adults will often have wings while the nymphs will not. There are a few exceptions, such as certain roaches that lack wings as both nymphs and adults, and large nymphs of some insect species will have non-flying "wing pads." Because nymphs look very similar to adults, it is usually possible to determine the order and common name of nymphs. All of the insects in the following orders undergo incomplete metamorphosis: Collembola, Thysanura, Ephemeroptera, Odonata, Orthoptera, Phasmida, Mantodea, Blattaria, Isoptera, Dermaptera, Plecoptera, Psocoptera, Phthiraptera, Hemiptera, Homoptera, Thysanoptera.

Left: Example of a large grasshopper nymph, showing non-flying wing pads (Joseph Berger, Bugwood.org)
Right: Example of a large stink bug nymph, showing non-flying wing pads (Russ Ottens, University of Georgia, Bugwood.org)

Example of a juvenile house centipede. It is possible to identify this as a juvenile because juvenile house centipedes have fewer legs than the adults. This image also shows proper formatting for a second-year image, including 1920X1080 dimensions and the white notation box.



Close up of 400X300 notation field, showing proper formatting for a second-year "life stage" image.

Larvae: The immature stages of insects that undergo complete metamorphosis are called "larvae." A larva completely changes its form when it enters the pupal stage and metamorphoses into the adult stage. For this reason, insect larvae often look nothing like the adults and sometimes live in different places and eat different kinds of food than the adults. The identification of insect larvae can be a challenge, but visual identification to the order level is often possible. Some resources for identification are listed below. Larval types associated with different groups of insects sometimes have special names (like "caterpillars" for butterflies and moths, "maggots" for certain flies, or "grubs" for certain beetles); those special names may be used for this project, but the term "larva" is always correct. In general, it is easier to find insect larvae during warm months in Kentucky, but some can be found in water and inside rotting logs during cold months. All of the insects in the following orders undergo complete metamorphosis: Neuroptera, Megaloptera, Coleoptera, Mecoptera, Diptera, Siphonaptera, Trichoptera, Lepidoptera, Hymenoptera.

<u>Identification tips for the larvae of select orders:</u>

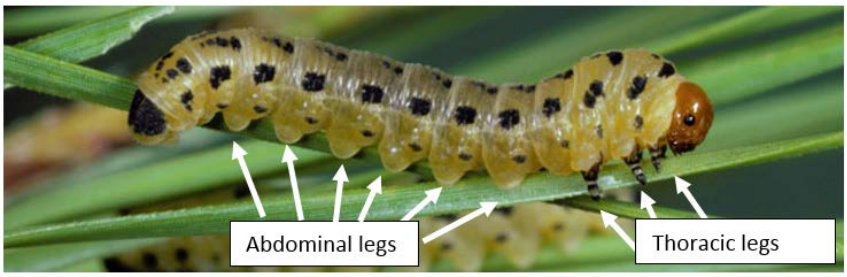
Neuroptera: green lacewing larvae are very common in gardens and wild areas. Their long, sickle-like mandibles are distinctive. Antlion larvae are also common. They can be found in small sandy or dusty "pits" that they dig in dry areas under the eaves of houses, barns, and natural rock overhangs.

Megaloptera: these are fishfly and dobsonfly larvae. They are common under rocks in running streams and can be very large. They have elongated bodies (resembling centipedes) with multiple filaments along the abdomen.

Coleoptera: this is the largest order of insects in the world, and so there is a wide variety of shapes and sizes exhibited by the larvae. Beetle larvae generally have six fully-formed front legs and (unlike moths and butterflies) no abdominal legs. Look for beetle larvae inside rotting wood and under rocks and logs. Ground beetle larvae, lady beetle larvae, firefly larvae, and scarab grubs can be commonly found around yards and gardens.
Diptera: the larvae of flies are typically legless. Many species are found in moist habitats, such as wet soil, decaying wood, or decaying plants or animals. Some species are fully aquatic. Fly maggots can be commonly found inside trash cans. Mosquito larva are common in backyard water containers, such as pails, birdbaths, and dog bowls.
Lepidoptera: moth and butterfly larva are called caterpillars. There are many common species in Kentucky. Caterpillars of many species are often found feeding on leaves out in the open in Kentucky. Some are very colorful and make excellent photography subjects. Some are smooth, some are covered with hair or spines. Moth and butterfly caterpillars are generally soft-bodied, elongated, and have 5 pairs of abdominal legs, also called "prolegs." Prolegs resemble suction cups and are not considered true legs: they disappear during the pupal stage. Caterpillars also have 3 pairs of thoracic legs. These are considered "true legs" because they are hard and articulated and because they are retained during the adult stage. Note that a few wasp larvae (called "sawflies") also have prolegs and strongly resemble moth caterpillars, but sawfly larvae will have more pairs of prolegs (see below).

Common Lepidoptera Larvae: Monarch Butterfly (Steven Katovich, USDA Forest Service, Bugwood.org), Armyworm Moth (Frank Peairs, Colorado State University, Bugwood.org), Giant Leopard Moth (Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org)

Hymenoptera: the larvae of most wasps, bees, and ants are legless often look similar to fly maggots. Look for them inside hives and nests, but care must be taken when investigating active wasp or bee nests, especially by people who have reactions to stings. The inside of mud dauber tubes, for instance, often have pupae inside, and are a much safer option than a paper wasp or hornet nest: mud daubers are not very aggressive do not attack and sting as a group like paper wasps, hornets, and honey bees. Ant larvae can often be found under rocks among their colonies; some ant species are able to sting or bite, but an ant colony is much less dangerous than a bee or wasp hive, since worker ants cannot fly. One noteworthy group of hymenopteran larvae are the sawflies. Sawfly larvae are common in Kentucky and they resemble moth caterpillars, except that most sawfly larvae will have six or more pairs of abdominal legs while moth and butterfly caterpillars will have five pairs or less.



Sawfly Larvae resemble moth or butterfly caterpillars, but have more abdominal legs. Moth/butterfly caterpillars have 5 pairs of prolegs or fewer, while sawfly larvae have 6 pair or more. Like most larvae, caterpillars and sawfly larvae also have 3 pairs of thoracic legs. (Gerald J. Lenhard, Louisiana State University, Bugwood.org)

Example of a horse fly larva image with proper formatting.

More Examples of Common Insect Larvae (left to right, top to bottom): Green Lacewing Larva, Dobsonfly Larva, Firefly Larva, Ground Beetle Larva, Fire-Colored Beetle Larva, Wireworm, Scarab Beetle Grub (Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org), Lady Beetle Larva (Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org), Crane Fly Larva, Mosquito Larva (Ary Farajollahi, Bugwood.org), Fly Maggot (white) & Pupa (brown) (Mohammed El Damir, Bugwood.org), Mud Dauber Larva (Whitney Cranshaw, Colorado State University, Bugwood.org), Honey Bee Larva (Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Bugwood.org)

Pupa: Many insects transform into pupae in concealed locations. Also, the pupal stage does not last a very long time in many insect species. Because of these factors, finding insect pupae for photographs can be a challenge. Pupa are also difficult to identify to the order and common name level—pupal stages are seldom depicted in insect field guides, for instance. There are a few specific types, though, which can be easily found and identified to the order level. Beetle pupa, for instance, are common inside rotten logs. They are distinctive because their pupae often have exposed, distinct legs, antenna, and other body parts. Fly pupae are common inside garbage cans. Fly pupae are typically shaped like a smooth "pod" with no distinct, visible body parts and faint segmentation. Butterfly and moth cocoons are common in the summer and fall on trees, shrubs, and other plants. A moth pupa will not have exposed legs or antennae, but its abdominal segments will often be visible. Moth pupa are often found inside silk cocoons. A butterfly pupa is called a "chrysalis" and is similar to a moth cocoon. The pupae of wasps and bees often resemble beetle pupae (with distinctly visible legs and antennae) and are common inside hives and nests, but care must be taken when investigating active wasp or bee nests. Ant pupa can be easy to find in ant nests under rocks and logs. Ant pupa resemble wasp pupae but are often wrapped in a cocoon.

Common Insect Pupal Types (left to right, from top to bottom): Lady Beetle Pupa (Bruce Watt, University of Maine, Bugwood.org), Longhorn Beetle Pupa (Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org), Sphinx Moth Pupa (Whitney Cranshaw, Colorado State University, Bugwood.org), Monarch Butterfly Pupa (Herbert A. 'Joe' Pase III, Texas A&M Forest Service, Bugwood.org), Fly Pupa (Petr Kapitola, Central Institute for Supervising and Testing in Agriculture, Bugwood.org), Honey Bee Pupa (Pest and Diseases Image Library, Bugwood.org)

Ant colony found under a rock, showing adult ants, larvae (white), and cocoon-wrapped pupae (cream colored).

Life-Cycle Resources:

- **Recognizing Insect Larval Types:** https://entomology.ca.uky.edu/ef017
- **Know Your Insects:** http://www.knowyourinsects.org/index.html
- **Caterpillars of Eastern Forests:** this free PDF shows many of the common moth and butterfly caterpillar. **https://www.fs.fed.us/foresthealth/technology/pdfs/Caterpillars_of_Eastern_Forests.pdf**
- **Bugguide:** contains images of many insect larvae, eggs, and nymphs for species all over North America. Because there are so many images, the site can be a challenge to use, but, with patience, the life stages of many common insects can be found. The images of the immature stages are sorted with the adult stages in most cases, but there is a separate section for moth and butterfly caterpillars: https://bugguide.net/node/view/3/bgpage
- **Butterflies Through Binoculars: The West – A field Guide to the Butterflies of Western North America** by Jeffery Glassberg
- **A Field Guide to Butterfly Caterpillars of North America** by Thomas Allen, James Brock and Jeffery Glassberg

Adaptations and Behaviors: Tips and Other Information

For this part of the project, 4-Hers will photograph a selection of insect adaptations and behaviors. It is important for each image to show a different adaptation or behavior, and to show a different species in each image. Note that diversity, which was the focus of the first macrophotography publication, is still important here. 4-Hers will see during this part of the project that there is much overlap between the concepts of adaptations and behaviors, and some images will likely show multiple kinds of adaptations and behaviors all at once. For this reason, it is not necessary in the notation field to identify the image as an "adaptation" or a "behavior." Instead, the 4-Her should identify the body part or behavior by name and describe its function, or describe what may be happening in the image.

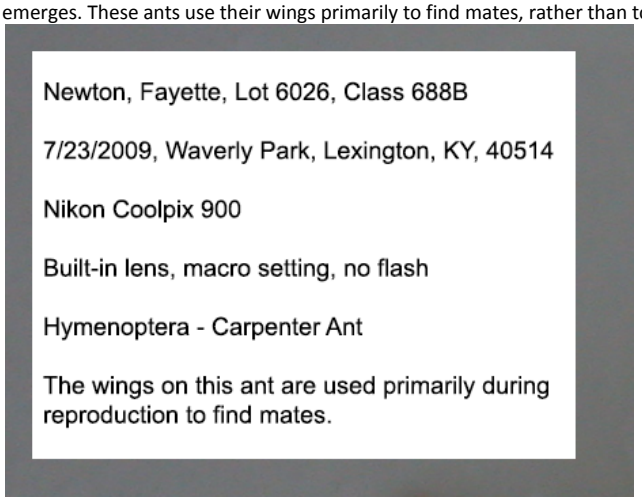
What is An Adaptation?

For insects and other arthropods an adaptation is body part or biological feature that helps it survive in its environment. The possible examples of insect adaptations that might be captured in a photograph are nearly endless: *every* body part or biological feature on an insect could be considered an adaptation. The challenge for 4-Hers is to find adaptations that can be seen in a photograph and to also learn and describe what the adaptation is called and what its function is.

Examples of Adaptations

There are thousands of examples of insect adaptations. Some of them may not be visible in a photograph. For instance, insects have an internal tracheal system for delivering oxygen to their cells and tissues. This is an important adaptation for insects because they do not use blood to transport oxygen. However, this adaptation cannot be seen in a photograph of a living insect. However, it is sometimes possible to see an insect's "spiracles". These are small holes on the outside of an insect that draw air into the body, and are a good example of a visible adaptation. Every visible body part is an adaptation. The 4-Her should select which insect to photograph, try to take the photo in such a way as to emphasize the selected adaptation, and then interpret the function of the adaptation in the notation box. Examples might include: mandibles of a grasshopper (used for chewing leaves), fly wings (used to fly to food sources and away from threats), front legs of a mantid (used to capture prey), coloration of a bee-killer robber fly (used to mimic bumble bees). 4-Hers may sometimes be able to interpret the function of the adaptation by just looking at it, but sometimes research into the insect's biology is required. For instance, when viewing a winged ant like the one pictured below, a person might suppose that the wings are used to escape from predators. But, unlike many fast-flying flies and wasps, most winged ants do not have a strong escape response and are not strong fliers. Instead, winged ants are a reproductive stage produced by the colony to find new mates. The winged ants can fly slowly and for long distances to find mates, but they are generally not well-equipped to evade predators. Other adaptations to explore: eyes, antennae, legs, claws, wing-covers, segmentation, gills, hair, spines, moth and butterfly scales, coloration.

Example of a photo showing an adaptation. In this case, the notation field mentions the wings on this ant. Ants are unusual because they usually do not have wings, but sometimes a winged "reproductive stage" emerges. These ants use their wings primarily to find mates, rather than to find food or escape from threats.



Close-up of notation box from the image above, showing the brief description of the adaptation.

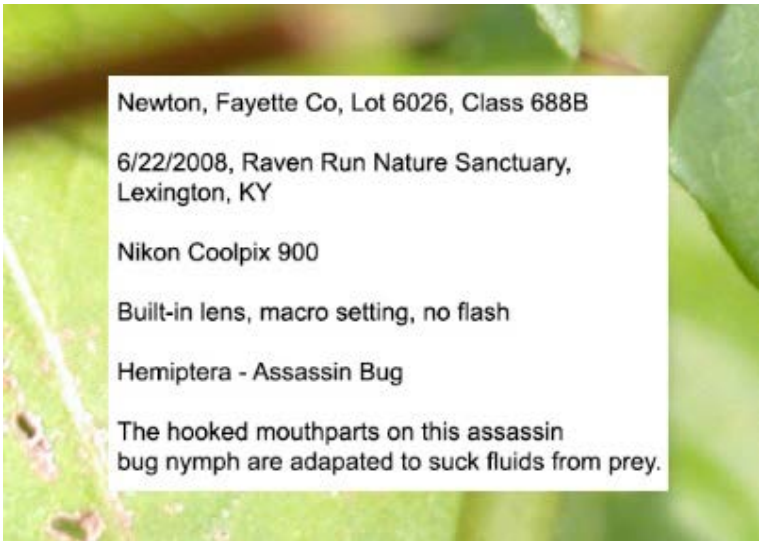
What is a Behavior?

A behavior is a type of adaptation. A behavior is set of actions or reactions that an animal (including an insect) produces in response to a particular circumstance. 4-Hers should look for behaviors that can be easily seen and interpreted in a photograph. Some behaviors to explore: predation, ambush, trap-building, feeding, tasting, grooming/cleaning, swimming, flying, digging, climbing, hiding, mating and mate-attraction, defensive postures.

Photography Tips

For this part of the project, 4-Hers may want to use "up close" views or unusual angles in their photographs to showcase certain adaptations or behaviors. While this is sometimes desirable, 4-Hers should make sure to show enough of the creature to allow the judges to determine if the order and common name information is correct. Also be aware that very close-up images of insect body parts can be a challenge to capture in focus. Remember not to use broken or "found" body parts from dead insects in photographs: this project is about images of living creatures.

This image shows the nymph stage of an assassin bug. In the image, the assassin bug's mouthparts are visibly extended and are captured in the act of feeding on prey. This image shows both an adaptation (hooked, piercing-and-sucking mouthparts) and a behavior (predation) while still showing the whole insect's body, allowing for identification.



Close-up of the notation box from the above image.