Wyoming 4-H

UW | EXTENSION

Using Digital Macrophotography to Study Entomology

***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.

MACROPHOTOGRAPHY BASICS

Insect macrophotography is just a small part of the overall subject of macrophotography, which is in turn just a small component of the whole world of photography. These are all big topics, and this document cannot contain all of the information needed to become an expert in any of them. Instead, it includes basic information and tips that will allow 4-Hers to capture good images with inexpensive and readily obtainable equipment.

Other Resources

For more detailed instructional advice regarding photography in general, see the official 4-H Photography curriculum.

4-H National Curriculum: Photography
http://4-h.org/parents/curriculum/photography/

Equipment

Many kinds of systems are available for digital macrophotography, and no one system is right for every situation. If a 4-Her already has a digital-camera system that works for them, they are encouraged to use it for these projects. For beginners, here are a few options to consider:

1. **Smartphone + External Macro Lens**
   Many modern smartphones have good built-in cameras, and are an excellent choice for beginning photographers. They are convenient, small, and are able to take detailed, high resolution images. Most importantly, many 4-Hers will already have a smartphone. For macrophotography, an external macro lens is usually needed. Fortunately, these are inexpensive (many are less than $20) and easy to use. Clip-on and strap on models are available, and many of them are compatible with multiple types of phones. Models and brands change frequently, so use internet searches to find a highly-rated model that is compatible with your phone. One of the downsides of using a phone as a primary camera is that it can sometimes be difficult to transfer photos from a phone's onboard memory onto a computer. If a 4-Her is using a phone for this project, it is important for them to learn how to access image files on the phone, or how to save images directly to an internet "cloud" service that can be accessed by computer. Also, compared to some other systems, a phone with an external macro lens will have limited options when it comes to certain technical capabilities, including focusing, depth-of-field, and the use of a tripod or a flash. Most of these problems can be overcome, however, and we will discuss them in more detail in later sections.

This link from April 2017 discusses several models of external lenses for smart phones:
https://wiki.ezvid.com/best-phone-camera-lenses

2. **Compact Digital Camera**
   Most modern consumer-grade compact digital cameras have built-in macro settings (often indicated by a "flower" [⚘] symbol). These settings are usually more than adequate for macrophotography beginners. Compact digital cameras are also relatively inexpensive (around $200 for good models). Compared to a smartphone with strap- or clip-on macro lens, there is little advantage to having a compact digital camera for macrophotography in terms of image quality. However—because they are ergonomically designed and have dedicated photography components—compact digital cameras can be a little bit easier and faster to use. Compared to cell phone cameras, they may also have flashes that work better for macrophotography, and focusing is sometimes easier with a compact digital camera. The removable memory cards that compact digital cameras use may also be more convenient for some users than the storage solutions used by cell phones.

3. **Digital Single Lens Reflex (SLR) Camera**
   SLR cameras tend to be larger and more expensive than compact digital cameras, but they offer greater flexibility. SRL cameras have interchangeable lenses; for this project, a separate macro lens would need to be purchased. SLR cameras do not always have built-in flashes, but separate flashes can be purchased that may work better for macrophotography than the flashes that are built into cell phones and compact digital cameras. The purchase and use of SLR cameras can be a very rewarding hobby, but it can also be complex and costly. This document cannot touch on all of the details that a 4-Her would need to get started with SLR cameras, and for that reason we suggest that beginners should create this project using one of the options mentioned above. If a 4-Her is already familiar with SLR cameras, though, they should be encouraged to use them for this project.

INSECT MACROPHOTOGRAPHY: GUIDELINES, TIPS, AND TECHNIQUES

1. **Focus on diversity.** The first goal of the 4-H insect macrophotography project is "Diversity," which refers to the diversity of insect orders and species that live in Wyoming. It is suggested that when competing this goal that the images represent at least four correctly-identified insect orders.
2. **One species, one image.** When sharing your insect photos it is suggested that you only submit one image of same species. You should be taking lots of pictures of the same insects and then using your decision making skills to chose your best image of each insect. The one exception is for species that have multiple, distinct forms. For instance, male and female stag beetles look very different, so in this case both images would be an important part of your collection. Another example would be the Eastern Tiger Swallowtail, which has distinct "dark" and "light" forms; if these are properly indicated on the "common name" field on the image, both images would be considered important.
3. **Adult insects and arthropods.** For a high quality display 4-Hers should have images of adult insects (and adult non-insect arthropods like spiders, crayfish, etc.), especially when looking to achieve the goals of collecting insect photos only. Images of insect larvae, nymphs, eggs, or pupa will be important when reaching more advanced goals. Later units will include some of those other life-stages. An insect is defined as any invertebrate (that is, any creature without an internal skeleton) with six jointed legs in the adult stage. Sometimes it may be difficult to determine if an insect in an image is an adult or not. With few exceptions, an adult insect will not be worm- or caterpillar-like. Also, most adult insects have wings (exceptions include some adult ants, adult aphids, adult fleas, and a few other creatures). When labeling insects should be identified to "Order" while non-insect arthropods should be identified to "Class."
4. **Correct identification.** As mentioned above, the insects in this project should be correctly identified to the proper scientific insect order, this is especially important if you turn them in for judging at the fair. Insect common names are also an aspect of identification. In fact, one of the goals of this project is for 4-Hers to familiarize themselves with insect orders. Learning the basics about insect orders—how to tell an ant (Order Hymenoptera) from a termite (Order Isoptera), for instance—is both an agricultural skill and a basic life skill, with applications in farming, gardening, home ownership, and even safety. Although there are about 400 species of insects in Wyoming, all of these insects belong to one 24 orders. Most 4-Hers find that, with a little practice, identification to the order level is not very difficult. Common names are a little more challenging, but once you know the insect order name, the common name can be found more easily.

   This document does not include detailed information about insect identification, but here are some useful resources:
   a. Discover Life is a Lucid Key (interactive, fully illustrated identification tool) that is easy to use. This site also have information and links to learn more specific information on insects and spiders. https://www.discoverlife.org/mp/20q?guide=Insect_orders
   b. The state of Wyoming does not have a specific insect identification site, but the state of Montana is closest to the insects you will find in Wyoming. Montana has a web site for general, regional insect ID. http://fieldguide.mt.gov/displayOrders.aspx?class=Insecta

c. **Bugguide.net.** Bugguide is a very popular website that is maintained by entomologists and photographers from all over the United States. It is likely to contain properly-identified images (including order names and common names) of every insect that a 4-Her will find in Kentucky. It contains thousands of images though—including images of creatures that do not live in Kentucky—so finding what you are looking for can be challenging.
http://bugguide.net/node/view/15740

Where Can 4-Hers Find Insects to Photograph?

There are more species of insects than all other plants and animals combined, and insects can be found in almost every ecosystem in the world. And yet, sometimes they can be difficult to find. Many species are small, secretive, and camouflaged. Here are some tips for finding insects for the 4-H macrophotography project.

1. **Spring, Summer, and Fall**. Some insects are active all year in Wyoming, but most types are easiest to find on warm, sunny days from late Spring to early Fall. Plan accordingly: if a 4-Her wants to complete an insect macrophotography collection for display at the fair in July, for example, they should consider starting in July the year before, so that there will be a full season to search for subjects.
2. **More plants = more insects.** Scientists know that insect diversity is related to plant diversity: the more kinds of plants and trees live in an area, the more kinds of insects will live there. Gardens also tend to have lots of different kinds of plants and flowers, which attract many insect species (both pests and beneficial species).
3. **Insects love sunshine.** Because insects are cold blooded, they often thrive in warm, sunny places. Waist-high grasses, weeds, flowers, and garden plants that receive lots of sunshine are often swarming with insects. Sunshine is also helpful for macrophotography.
4. **Insects love edges.** In biology, an "edge" is a place where two ecosystems meet. Edges often have very high plant diversity. An example of an edge would be a place where a field crop (like corn) is planted next to a forest. Such an area would have all of the plant diversity of a crop (including weeds and the crop itself) and a forest. Forest edges also tend to receive more sunlight than forest interiors, which increases both plant and insect diversity. Other "edges" include: a garden next to a wooded stream; a farm next to a lake or pond; a meadow next to a wetland.
5. **Warm days, cool mornings.** On cool mornings in late Spring and early Fall, insects can sometimes be found resting on flowers and leaves as they wait for the sun to warm them up. This is often a great time to take a picture.

How Can A 4-Her Get Close Enough to an Insect for a Photograph?

Insects—especially the ones that are good fliers—are often very alert and very fast. When a person approaches them with a camera, they will often take flight or even drop straight to the ground before the photographer can get close enough. Here are some tips to help you get a little closer.

1. **Patience.** Often, a photographer will not be able to get close enough before an insect flies or scurries away. Keep trying. There are lots more insects, and they all have to rest sometime. Often, if you see one insect in an area, there will be more of the same type around, so there will be more opportunities to capture an image. One strategy is to sit close to a flower or other spot that an insect might visit and wait for one to land there.
2. **Approach slowly.** Insects are likely to flee if something approaches them quickly, so a photographer should approach with stealth.
3. **Manage your shadow.** Insects often react when a shadow falls over them. A photographer can note the sun's angle and keep their shadow off of the insect as they approach.

How Does a 4-Her Format an Image the could be used for Submission?

1. **Use image-editing software to prepare images.** All images used for this project will require at least some digital editing. Most home computers and laptops will have basic image-editing programs built in, and these programs will have the basic tools needed to prepare an image for submission. A "select" tool for instance, will allow a 4-Her to select and "cut out" a 400x225 pixel white space for the notation box. A "text" tool will allow a 4-Her to select a font and a font-size to write notations within the box. A "crop" tool allows the user to shave the edges of an image to meet the 1920x1080 pixel size requirement. A "resize image" tool will allow a 4-Her to enlarge or

reduce images. More powerful tools may be found on advanced image-editing software. These programs are easy to use with a little practice but can be costly.

2. **Images should be 1920x1080 pixels for official submission to a fair.** It is acceptable to crop, reduce, or enlarge images to match these dimensions, but be aware that too much enlarging will lead to blurry or pixilated images.
3. **All images should be in .jpg format.** If a 4-Her's camera takes photos in another format, they should converted to .jpg. This can be accomplished easily with most photo-editing software. Jpg are standard and easy to look at using a variety of sources.
4. **If submitting for the fair consider using a single USB storage-device.** Images could be submitted on a USB memory device (such as a "thumb drive") that is formatted for PC/Windows devices with no other data except for the images and a single folder. The USB device should be identified externally with a tag or label, showing "4-Her's last name, Club, and County," -County-Lot Number-Class Number." Example of a list of files submitted for this project. These files will be contained in a single folder on a USB storage device, and will be the only files on the device.
5. **All images in your collection should created and edited by you, the 4-Her.** It is not acceptable to submit images from other photographers, including relatives, friends, or images obtained from the internet. All cropping, editing, and other digital manipulation must be also performed by the 4-Her, although help from adults and peers during this process is encouraged.
6. **All images must include a formatted "notation box" in the image.** Each image should include a 400X225 pixel, white notation box with important information about the photo. The 4-Her will use photo-editing software to place this notation field anywhere inside the image. The following information could be included in the notation field:

   [4-Her's Name, County]

   [Date of original photograph]/[Location of original photograph. Location may be in the form of a street/city/zip code address or GPS coordinates.]

   [Brand and type of camera or camera phone]

   [Settings, including type of lens, relevant camera settings, and "flash" or "no flash," any digital enhancements]

   [Insect Order – Common Name]

Examples


Newton, Fayette, Lot 6026, Class 687B
May 25, 2016/4293 Steamboat Rd, Lexington, KY, 40514
Nikon Coolpix 950
Macro setting, built-in lens, no flash
Diptera - Soldier Fly


Newton, Fayette, Lot 6026, Class 687B
June 5, 2016/104 Timber Lane, Morehead, KY, 40351
Nikon Coolpix 950
Macro setting, built-in lens, no flash
Coleoptera - Scarab Beetle

How Can a 4-Her Take Better Photographs of Insects For This Project?

Just like all skills, macrophotography takes practice. Macrophotography is even more challenging when the subject is an insect; insects are unpredictable and can move out-of-frame at any time. Here are some tips and techniques that will help 4-Hers as they learn, and that will help them to achieve a higher score when the project is submitted for judging.

1. **Take lots of pictures.** Thanks to digital cameras and large-capacity memory cards, a photographer can take hundreds of pictures without running out of space. When a 4-Her sees an insect that they would like to photograph, they should take more than one picture, especially in challenging conditions, such as low light or tricky backgrounds. It might also be a good idea to capture images of the same insect from different angles and from different distances. This way, a 4-Her will have a choice of images for the final project.
2. **The insect should be the subject.** Remember that this project is about entomology first, photography second. The insect should be the subject—in other words, the most important part--of each photograph. That doesn't mean that the insect needs to always be in the exact center of the image, or that all of its parts need to be in perfect focus, or that it needs to take up the most space, but it should be the most important part of the image.

In this image, a bee fly is shown visiting a flower. But the fly is out of focus and only takes up a small portion of the image, while the flowers are in focus and dominate the image.

This image also shows a bee fly, but here the insect is in focus and it dominates the image. The flower actually takes up more of the image than the insect, but because it is out of focus it is not the most important part of the image.
Image: Whitney Cranshaw, Colorado State University, Bugwood.org

3. **It must be possible to identify the insect.** 4-Hers must use images that show enough of the insect so that it is possible to identify it to Order and Common Name. Quality can be improved by capturing as much of the insect's body as possible (it is acceptable though, for parts of the body to be out of the frame, such as tips of legs or antennae). Also, most images should either be "overhead," showing the insect's back, or "three-quarter," which would show parts of the insect's back along with the head (other angles might work as well). For butterflies, avoid images that show the undersides of the wings rather than the tops of the wings.
4.

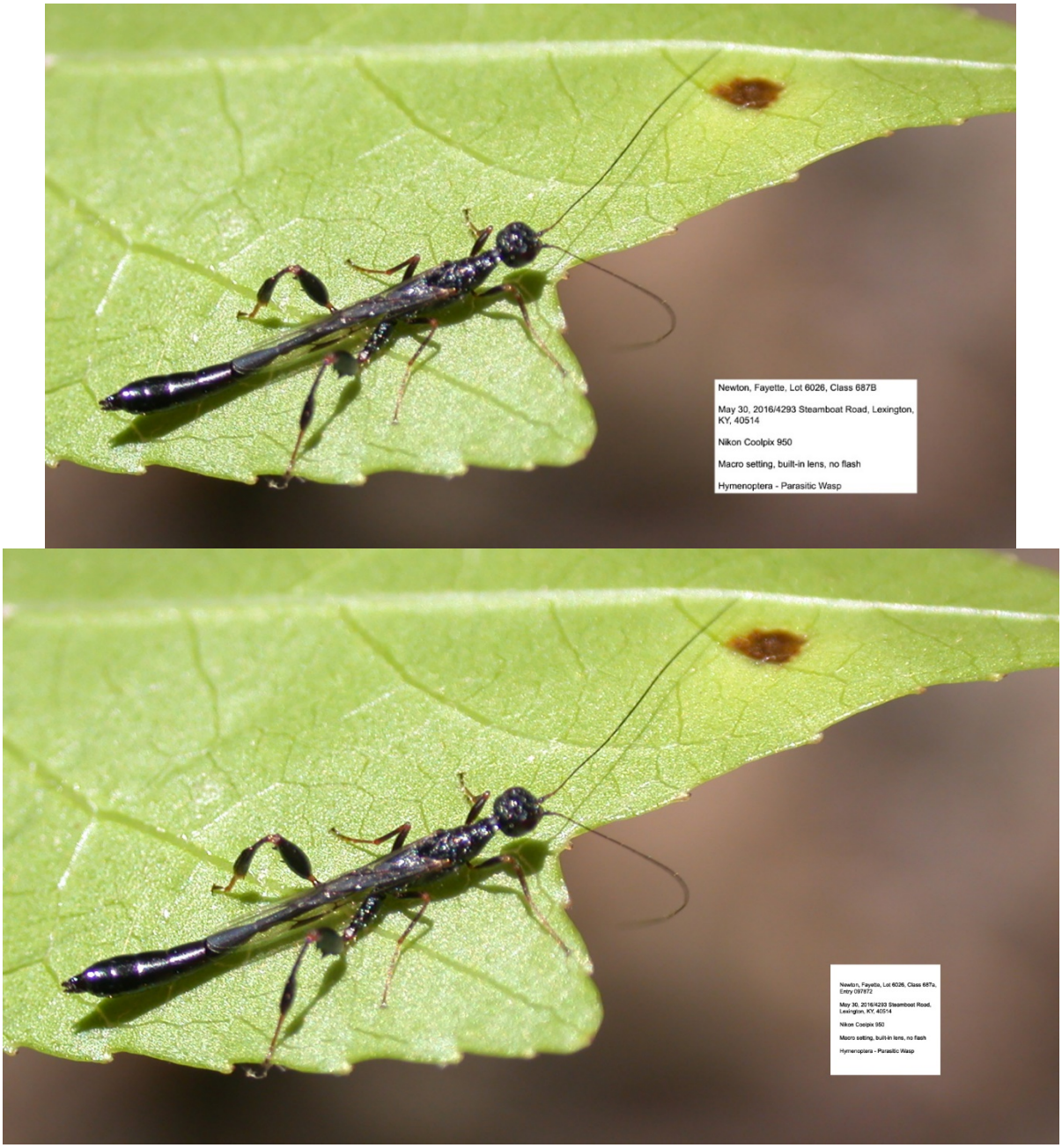
This image shows an overhead view of the beetle's back. This is often a good angle for easy identification of an insect.

This image shows a "three-quarter" view: enough of the insect's head and back are visible to allow the identification of this as Order Diptera, Common Name Robber Fly.

5. **Watch out for over- and underexposure.** When taking pictures of insects, it is easy to over- or underexpose an image. Overexposure means that there is too much light on the subject. Underexposure means that there is not enough light. With insect macrophotography, overexposure is generally less of a problem than underexposure, but there are ways to avoid both problems. **Overexposure** occurs very commonly in macrophotography when using flashes that are "built-in" with phone cameras and compact digital cameras. This is because the flashes are often not designed to work "close up." Instead, if a 4-Her needs extra light to photograph an insect, it is sometimes best to use a portable light that can positioned wherever it is needed. These are sold in photography stores—it is important to use a model that emits light that mimics natural sunlight. Overexposure can also occur in very bright direct sunlight. In general though, **underexposure** is a more common problem in insect macrophotography than overexposure. This for two reasons. For one, insects are often found resting in shady places. Also, it is difficult to keep an image from becoming blurry at low light levels. A portable light can help with this. It is also very important for a photographer to stay very still when taking images at low light levels, and also to take several images from the same angle in case some of the image are blurry. In some cases, effects may be applied in digital editing software to help with over- and underexposure, but it is always best to capture a sharp, properly-exposed image in the first place.

Underexposed: Because of low-light conditions, the insect is indistinct from the background. The image is also blurry because the camera was moving while taking the image.

Overexposed: Because of low-light issues, a flash was used. But because built-in flashes are typically not optimized for close-up photography, there is too much light in the image. The light turns parts of the insect and the background into solid colors—all detail is lost.



Proper Exposure: The same insect was photographed in a better situation with lots of natural light, so that a flash was not needed.

6. **Manage the background.** Sometimes, a background can help to highlight and frame an insect subject. Sometimes it can distract from or obscure the subject. When a 4-Her is getting into position to take an image, they should take a moment to notice the background. Will it overpower the image, either with brightness or with a complex pattern? Would it be a good idea to take a picture from a multiple angles to try different backgrounds? In some cases, a 4-Her can insert a custom background behind the subject by placing a piece of colored construction paper (a large leaf will often work as well) in the area behind the insect that is just out-of-focus. Often, a background that is out-of-focus and simple in color and design can help to highlight a subject.

Overpowering Background: This dragonfly image has some good qualities: the insect dominates the image, it is in focus, the exposure is good, and it is possible to identify the insect. But the background is a mix of colors, textures, light, and shadow. The insect would be more distinct on a simpler background, or even if the current background were out-of-focus.

Managed Background: The dragonfly image also features a complex background, but because the background is out-of-focus, the dragonfly is more distinct and makes a better subject.

7. **Challenges with focus.** It is important for the insect in a photo (or at least parts of it) to be in focus. With macrophotography—and especially with cell-phone based macrophotography—there are some unique challenges related to focus. When a photographer gets very close to a small object (like an insect) with a macro lens, it is very difficult to get the whole subject in focus. There are several ways to deal with this; two are highlighted below.
    a. **Shallow focus.** In macrophotography, it can be helpful to limit the focused area to just the most important parts of the subject. For insects, this is usually the back and the head (especially the front of the head, or the "face"). Since it is difficult or impossible to adjust the focus on a cell-phone (depending on the type of add-on macro lens), the way to adjust focus is to move back and forth and check for proper focus on the screen, then capture the picture when proper focus is achieved. A photographer will often need to take several pictures of the same subject in this manner, and then choose the best when looking through the images later. Getting just the most important parts of a subject in focus has some advantages, including a higher level of detail and (often) a more aesthetically pleasing image. The disadvantage is that it is often difficult to get close enough to an insect to get this type of image before the insect leaves or moves into a new position. Also, when a photographer gets closer to the subject, low light levels tend to have a greater potential to create blur.

Shallow Focus: In this image, the back and the head of the mosquito are in sharp focus, while the legs and the leaf are just out of focus and the background behind the leaf is wholly out of focus. Bright sunlight contributed to a strong overall image.

b. **Deep focus.** If a photographer has difficulty with the above method, they can try standing a little further away from the subject. This may allow a 4-Her to get more of the insect in focus even in conditions where light levels are not optimal. Then, when editing the image on a computer, the 4-Her can zoom and crop the image to highlight the insect. The disadvantage of this method is that, while the whole image may will be in focus, no part of the image will look particularly sharp. Also, zooming and cropping can will lead to an image that has relatively low resolution, and may appear blurry or pixelated. Often, it is best to take multiple images using both this method and the method above and then select the best image later.

Deeper Focus: This image was taken relatively far away from the subject. Most of the beetle is in focus, rather than just the head and the back, but because of zooming and cropping, no part of the image is particularly sharp.

TASKS

These Next-Generation Science Standard (NGSS) aligned tasks can be used by a 4-Her to gather a body of work for an insect macrophotography project. Even though these task will have specific goals, 4-Hers should keep the submission guidelines in mind while they are creating images. These tasks are designed to provide ideas for places to take pictures of insects and may provide insight on insect identification and biology.

Task #1: Using photographs as evidence, construct an argument that insects have external structures that function to support survival, growth, behavior, and reproduction.

NGSS Performance Expectation: 4-LS1-1

Instructions: Using the macrophotography techniques that you have learned, create photographs that will help you make each of the following arguments:

Photo Set 1 –"Moving Parts" of Five Different Insects. Insects have structures that allow them to get from one place to another. Points to consider: Why is it important for most insects to move frequently from one place to another? What structures shown in your photos help with movement? Can an insect have more than one structure—or more than one *kind* of structure—that helps with movement?

Photo Set 2 –Tools of the Trade for Five Different Predatory Insects. Predatory insects have structures that help them to capture and eat insects and other prey. Points to consider: Which structures in your photos might help catch prey? What are some common patterns that you see between different structures that are used to catch prey?

Photo Set 3 – Defensive Structures of Five Different Insects. Many insects have structures that help them to defend themselves against predators. What structures in your photos help to defend the insects? How do they help defend the insects?

Follow up questions and tasks:

- Do any of the insects in the photos have a structure that could be used for more than one function, such as a structure that can function for both prey-capture and defense? How about a structure that can function for both defense and movement?
- Did you actually observe any of the insects that you photographed using their structures for movement, prey-capture, or defense?

Repeat the same task—gathering photos to show structures that function for movement, prey-capture, and defense—except with animals that aren't insects. Birds, spiders, or mammals might be good places to start. While you do this, compare the structures with those of insects. What are the similarities and differences?

Task #2: Using macrophotography to study and compare the distribution of insect orders in multiple habitats.

NGSS Science and Engineering Practices: Asking Questions and Defining Problems, Planning and Carrying Out Investigations

Introduction: All of the insects in the world are divided into about 30 different orders based on their evolutionary relationships. However, entomologists believe that most of the insect species in Wyoming belong to just a few of those 30 orders. In this lesson, you will be investigating insect orders, making predictions about which orders are the most common in Wyoming, and using photographs as a way to sample insect order diversity in multiple habitats.

Part 1 – Research. Using the internet and reference books, find lists of insect orders along with the approximate number of species in the world for each order (along with numbers of species in North America if you can find it). From these lists, compile a "top six" list of what you think are the insect orders that have the most species in the world. If you find different numbers of species from different references, take an average. In the "other information" column, cite the place where you found the species numbers. This would also be a good place to list other relevant information. For percent of total species, assume that there are 1,000,000 total world insect species. For instance, you might be able to find the number of species from certain U.S. states. To get you started, we have added Coleoptera, the beetles, as number one: it is generally accepted that the insect order Coleoptera has the most species in the world with about 350,000 known species.

Rank	Insect Order	Common Name	World Species / U.S. Species (apx)	Percent of total world insect species	Citations and Other Information
1.	Coleoptera	Beetles	350,000 world/ 25,000 U.S.	35%	Number of world estimated from Wikipedia (400,000) and Bugguide.net (390,000). U.S. species estimated from Bugguide.net.
2.					
3.					
4.					
5.					
6.					

Part 2 – Order Characteristics. What are some basic characteristics of each of the "top six" orders? You can find this information in some of the same places where you found numbers of species.

Rank	Insect Order	Life Cycle	Wings	Food & Mouthparts
1.	Coleoptera	Complete	4 wings total, 1st pair of wings are a hard shell that folds over to protect the 2nd pair, which are used for flight	Many beetles eat plants, many are predators that eat other insects; the larva and the adults often eat the same thing. Adult and larval insects have hard chewing mouthparts.
2.				
3.				
4.				
5.				
6.				

Part 3 – Pick Habitats to Sample. Pick two habitats (or more if possible) to sample and write them down below… these are places where you will go and take pictures of insects. You will go into each habitat for 1 hour and take as many photos of insects as you can. Try to pick places that that might have a lot of insects. Think of specific places that you will go—either an address, GPS coordinate, or a name. Pick places that are at least five miles from one another. Explain why you think that they are different from one another and why you think they might have a lot of insects. Habitats might include "pond," "vegetable garden," "city park," "forest," "farm," etc.

Habitats	Addresses
1.	
2.	

1. Why do you think that the habitats that you chose might have lots of insects? What are some examples of habitats that might not have many insects, and why?

2. Do you think that the habitats that you picked are very different from one another, or are they all similar? Why might it be good to pick either similar habitats, or very different habitats, or both?

Part 3 – Make Predictions. Based on the information that you gathered above, make some predictions before you go and take photographs.

1. Which 2 insect orders do you think you will take the most pictures of in each habitat? Will they be from the "top six" that you identified above? If not, why not? Did you learn about a different insect order that might be more likely to occur in certain habitats?

Habitat	Order with the most photos	Order with the 2nd most photos
1.		
2.		

Defend Your Predictions: If you think that certain orders will be more common in certain habitats, why? What characteristics do those orders have that might make them more common in certain habitats?

2. When you are done taking all photos in all of your habitats and combine all of the numbers together, what do you think your "top six" will be? Will it be the same as the "top six" in the world that you researched above? If not, why not?

Rank	Insect Order
1.	
2.	
3.	
4.	

Defend Your Predictions: If you think that your "top six" will be different from the "world top six," why? Do you think that there is something unusual about Kentucky or about the habitats that you picked that might lead to a different top six? Is there something about taking photographs that might influence which insects you are able to sample?

Part 4 – Take Photographs. Go to each of the three habitats that you selected. In each location, take as many photographs of insects (using the macrophotography techniques discussed in this guide) as you can in one hour. Try to go on sunny, warm days—this experiment will work the best in late Spring, Summer, or early Fall in Wyoming. What are some other things that you can do—such as choosing times, dates, or weather conditions--to make this a fair experiment at each location? Use the next sheet to write down your data for each location, including the number of each type of insect order that you photographed. In other words, if you took pictures of 5 different beetles during one hour at one of your locations, write down the insect order name "Coleoptera" and the number five. For the "Rank" column, rank the orders based on which ones you took the most photos of, once you've counted them all up. Make copies of the next page so that you will have one sheet for each location (you may want to make extra copies in case you find more than fifteen orders at some locations).

MACROPHOTOGRAPHY SURVEY: INSECT ORDERS IN DIFFERENT WYMOING HABITATS

Habitat Type and Description:

Date: **Time:**

GPS Coordinates and/or Address:

Insect Order Scientific Name	Insect Order Common Name	Number Photographed	Rank
Coleoptera	Beetles		