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Keep your distance: Close-focusing binoculars bring insects closer, in this case literally so. (JOSHUA PENNINGTON)

the cost against durability, the quality of the image, and the potential need for replacement.

Practice using your binoculars. If you spy an insect, keep your eyes on it, then bring the binoculars up to your face without looking at them. Take your eyes off the bug and you can easily lose track of it.

— *MAGNIFIERS*

A QUINTESSENTIAL TOOL of entomologists, in the eyes of the average person, is the old-fashioned hand lens, the trademark accessory of Sherlock Holmes. The traditional “disk on a stick” magnifying glass has fallen out of favor, however. Prone to breakage and smudging, and heavy to boot, those awkward magnifiers of yesteryear are now considered antiques.

Today, the preferred compact magnifier (loupe) for field use features one, two, or three lenses that fold inside a protective, oval- or pear-shaped case. Glass lenses are preferable over plastic, but cost more. The most affordable loupes, sometimes known as singlets, are made of a single lens. The curvature of the lens necessary to produce magnification causes distortion of the image



Get closer: The proper technique for using a magnifier loupe, in this case to view the details of the claspers on a male damselfly. (KATHY CARROLL)

seen, especially at the edge of the field of vision. A Coddington lens corrects for distortion by incorporating a diaphragm in the lens. Superior-quality lenses correct for distortion by layering lenses together. A doublet lens has two lenses, and a Hastings triplet has three such layers.

Typically, magnification values range from $3\times$ to $14\times$. A $10\times$ magnifier is considered standard for nature study in general. The higher the number, the smaller the field of focus. A magnifier with a value of $20\times$ or above is going to have a substantially smaller “sweet spot.” Beware of knockoffs, and make your purchase from a reputable scientific equipment supply house. Metal cases tend to be more durable than plastic ones.

To use your magnifier loupe correctly, position it about 1 inch from your eye. In most cases, this is accomplished by simply bringing your thumb up against your cheek. If you are able to manipulate the insect, bring it increasingly close to the magnifier until the image becomes clear. Otherwise, move your head and hand to about 1 inch from the subject. It helps to have good light on the insect.

— CAMERAS AND PHONES

TECHNOLOGY IS ADVANCING at such a pace that any generation of products recommended today will likely be eclipsed tomorrow by better models, but here is a primer.

The camera capabilities of many phones exceed the bottom tier of dedicated point-and-shoot and bridge cameras, especially in their abilities to achieve higher resolution and operate in dim light. If you plan to buy a phone to capture images of insects, evaluate the macro (close-up) setting and try it out in the store, if possible. Phones have the advantage of being a device you always carry with you, perfect for when you stumble upon an insect when you least expect to. Phones are also compatible with apps used to share images immediately in social media and/or to identify a mystery critter.

Bridge cameras and “super-zoom” cameras are an excellent choice for the beginner. One can use the zoom feature to focus on an insect several feet away, then switch to the macro setting for a more cooperative specimen at close range. Avoid using digital zoom if you want quality images. Get closer to the subject instead. With bridge cameras, there is no need to switch lenses or dedicate your field time to shooting insects exclusively. Bridge cameras work well for flowers, fungi, birds, reptiles, mammals, and scenic photography, too. There are drawbacks, however. Most do not produce high-resolution images for reproduction in hard copy form because the camera sensor has fewer megapixels than higher-end cameras. Bridge cameras are improving in their ability to perform well in dim light, but they remain inferior to DSLRs and even phones.

DSLR cameras are digital single-lens reflex cameras, used by professional photographers. They are expensive, though most cost is incurred in the purchase of multiple lenses for multiple subjects and circumstances. If you strive for anything beyond documentation through images, DSLR cameras are the way to go, because higher resolution, and the ability to shoot in RAW format, means more pixel density and data for cropping and editing without compromising image quality. Even DSLRs, and lenses for them, are being phased out in favor of mirrorless cameras. (Traditional DSLRs use a mirror to bounce the incoming image onto the viewfinder. When the shutter is pressed, the mirror lifts so that the sensor records the image. Mirrorless cameras permit direct reception of the image from the lens to the electronic viewfinder. What you see in the viewfinder is what you get in the photo. The noise from the flipping of the mirror when you press the shutter is eliminated in mirrorless cameras, allowing them to be quieter.) Focus-stacking capabilities represent another major advancement. (Focus stacking means using the camera to take several images in succession at different focal lengths, such that, in editing later, they can be

THE POCKET CAMERA

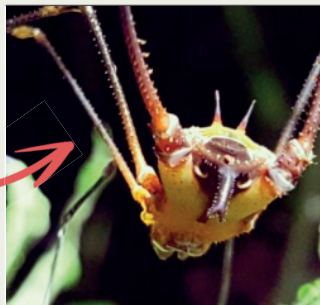
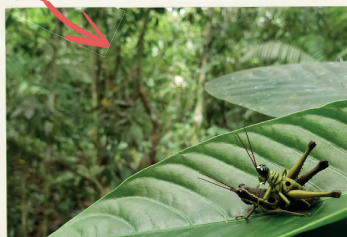
MY phone can do WHAT!?

STRENGTHS

Portable & Versatile

Size: bugs are huge in comparison to small phone lenses. This makes bugs look larger than life in your photos.

Wide Angle: snap the bug and its environment!



There's always a new way to look at the world

Hint many android phones have a pro-mode built in to the native camera to manually control the focus. 3rd party apps are available for iphones.



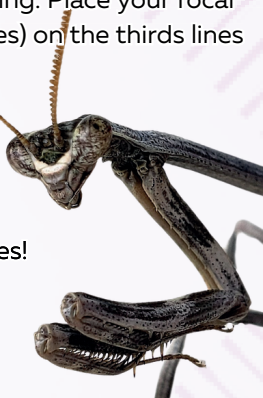
GENERAL TIPS

Rule of Thirds: Images that are off center are considered more appealing. Place your focal point (ex. eyes) on the thirds lines

Diffuse your Lighting

Take pictures on cloudy days or shade your bug for soft highlights.

Eye Contact: Humans like eyes! Make sure the eyes are in focus.



(NANCY MIORELLI)

fused to produce one image with a greater focus depth than one gets from a single image. The subject and camera must remain motionless, however.)

Lighting is a profound consideration, so select flash attachments and diffusers as carefully as you choose the right camera. Only DSLR cameras typically give you anything beyond a built-in pop-up flash over which you have limited control. Diffusers, even homemade versions, help soften and disperse light from flashes, be they built-in or attached.

When photographing an insect, take your first shot from farther away, then slowly move progressively closer. The priority is not to spook the insect. To counteract shakiness, brace your hand on an object like a tree trunk or stone, or use a tripod or monopod. Remote shutter releases are ideal. A remote shutter release is a switch on a cable that plugs into the camera. It allows the photographer to trigger the shutter without touching the button on the camera, thereby avoiding camera shake and image-blurring. Moving insects are best shot with burst mode, to guarantee that at least one image will be in focus and/or that the insect will be visible when it is not ducking under leaf litter. You may want to switch to video instead and grab individual frames later. Your most artistic shots will happen when you are at eye level with the insect, or even below eye level.

If images are out of focus or too dark, do not discard them in the field. A great deal of “error” can be corrected in post-processing with various software programs. Make small changes, not great ones, and avoid gross saturation when adjusting contrast and lighting.

From the standpoint of ethics, the well-being of the subject takes priority. Manipulating a specimen to slow it down or pose it may be unavoidable. Take care in doing so. You may also find it helpful to have a white casserole dish or other background material as a “studio” that can be helpful as a contrasting background to get maximum detail or impact.

If you share someone else’s photo, always ask their permission, and credit them.

— SOUND RECORDING

IT IS REASONABLY easy to record insect sounds with a cell phone, but if you want to devote a professional degree of attention to quality acoustics or record sounds unrelated to singing insects, such as insects feeding or walking, it is necessary to invest in additional gear. Bat detectors, for example, can record the ultrasonic portions of insect songs, as those noises are similar to what bats produce in their echolocation behavior.

Ideally, a directional microphone called a shotgun mic is best because it permits great sound while maintaining a bit of distance from the insect subject

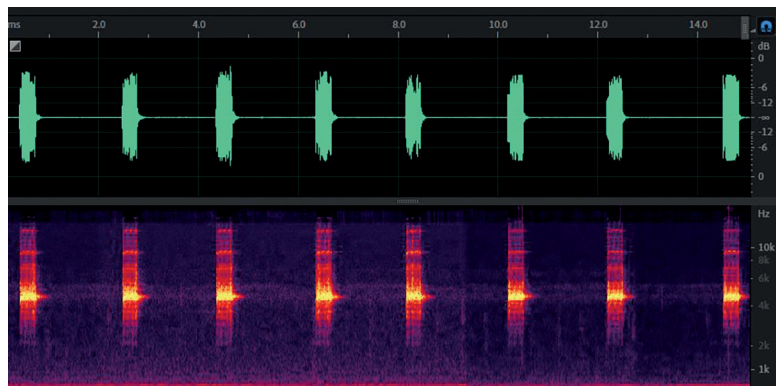


Listening: Lisa Rainsong using recording equipment to document the song of a cricket in Ohio, USA. (BRAD BOLTON)

you are trying to record. Still, any small-diaphragm condenser microphone is adequate. It may be helpful to also confine the insect in a container that helps block ambient noise, though patience is required while the insect acclimates and accepts its enclosure.

— VISUALIZING INSECT SONGS

INSECT SONGS CAN be depicted graphically, too, as waveforms and spectrograms. In both cases, time is shown on the horizontal axis, usually in fractions of a second. The vertical axis of a waveform measures relative amplitude. Silence registers as a straight line on a waveform. The louder the sound, the greater deviation in amplitude above and below the silent norm. In spectrograms, the vertical axis measures sound frequency in kilohertz (kHz). On a spectrogram, silence does not register at all; the louder the sound, the darker the marking on the graph, and the higher the note, the higher up the vertical axis it registers. Spectrograms thus provide more information about the



Turning sound into sight: A waveform (top) and spectrogram (bottom) are two visual representations of an insect song. In this case, it is a Jumping Bush Cricket, *Orocharis saltator*. (LISA RAINSONG WITH ADOBE AUDITION SOFTWARE)

structure and quality of the song. Both waveforms and spectrograms reveal that what may sound like a continuous trill or buzz is, in fact, a rapid punctuation of sound. Hertz (Hz) is a measure of cycles per second; most insect songs register between 2,000 and 15,000 Hz. Human hearing, in our youth at least, ranges from about 30 to 20,000 Hz. Various software programs can produce both spectrograms and waveforms from digital sound recordings.

— NETS

NO ITEM OF field equipment is as symbolic of entomology as an insect net. When convening with others, nothing says “there are my people” quite like it. A long-handled aerial net comes in handy to secure live specimens for a closer look at anatomical characters needed for identification.

Sweep nets, which are sturdier, short-handled nets, are used to “sweep” grasses, weeds, and light foliage for smaller insects and insects concealed by camouflage or otherwise hidden.

Aquatic nets, often with a triangular or D-shaped frame, are the heaviest of nets, used to sample wet habitats, including the bottoms of lakes and streams. The contents of sweep nets and aquatic nets are typically dumped into a white porcelain tray or pan for easy sorting, though some insects will quickly fly or jump away.

Beating sheets, or beating umbrellas, are durable cloth platforms held beneath a branch while the branch is beaten with a sturdy stick. Strike the branch



Beat it: Using a beating sheet at night to dislodge insects from shrubs and trees can be more rewarding than deploying the technique in daylight hours. (ANTON SOROKIN)

sharply, and it will dislodge hidden insects that will rain down onto the sheet. Again, some insects will quickly run away or fly off, but some will feign death or otherwise remain for you to observe.

You can make your own nets or purchase high-quality, durable nets from biological supply houses. An actual umbrella, held upside down, can suffice for a beating sheet, though insects will hide in the ribs.

— MISCELLANEOUS TOOLS

ADDITIONAL USEFUL ACCESSORIES include a notebook for documenting location, date, time, and other aspects of your observations. A global positioning system (GPS) device, especially one that gives latitude and longitude coordinates, is of great advantage in pinpointing remote locations.

A flashlight is helpful, even during the day. Shine it into burrows, holes, cracks, and crevices to see what insects may be hidden there. Other dark situations, such as cave entrances, areas beneath bridges, the interiors of barns and

other outbuildings, and even the forest understory, can benefit from added illumination. Consider a headlamp as an alternative, as it keeps both hands free to manipulate other tools.

Forceps or tweezers are exceedingly useful in extracting insects from crevices, gently grasping venomous species, and manipulating smaller specimens. Soft-touch forceps are less likely to harm insects, especially soft-bodied specimens. A small paintbrush, wetted, is highly useful for gently manipulating

Organism Observed: _____

Corresponding Image/Collection Number(s): _____

Country: _____ State/Province: _____

County: _____ City/Township: _____

Latitude: _____ Longitude: _____

Date: _____ Time Start: _____ Time Finish: _____

Name of Observer(s): _____

Habitat Description: _____

Elevation: _____ Temperature/Weather: _____

Notes: _____

Sample page from field notebook. (ERIC R. EATON)

For general queries, contact info@press.princeton.edu



Field kit: Basic tools for observing and manipulating insects include, clockwise from left, a backpack to carry your gear, an aerial insect net, headlamp, small paintbrush, metric ruler, notebook and pens, illuminated magnifier, magnifier loupe, clear plastic vial, forceps with sleeve, mobile phone with GPS app, and digital camera. (AUDREY SAUBLE)

insects and picking up tiny ones. Calipers are the ideal tools for measuring specimens, but at least consider carrying a small ruler. Containers, such as clear plastic vials with snap-on lids, allow for close examination of live specimens. The author often photographs non-climbing specimens through open plastic vials. Placing the white lid under the bottom of the tube helps amplify the flash. Note that many insects can easily climb out of open plastic containers or even glass jars.

— NATURE JOURNALING

A WONDERFUL METHOD for honing your observation skills is nature journaling. One need not be an artist to embark on this journey. The point is to develop an eye for details, and sketching or painting, along with note-taking, is an excellent way to do that. In the words of John Muir Laws, a preeminent



Sample page from a nature journal: Artistic talent is not a prerequisite. Skills in observation and noticing details, relationships between organisms, and habitat context are all enhanced by this kind of exercise. (AUDREY SAUBLE)

contemporary educator, “Nature journaling will enrich your experiences and develop observation, curiosity, gratitude, reverence, memory, and the skills of a naturalist.”

There are several books devoted to the art of nature journaling, and many online tutorials. There exist many new and improved, portable supplies, too, like markers and pens, and blank notebooks designed specifically for nature journaling.

— *LISA RAINSONG (SHE/HER)*

Hi! I AM a retired music theory professor, so it may come as no surprise that my interests as a bugwatcher are primarily in crickets and katydids. I did not start seeking them in earnest until I was in my sixties, but in these last ten years, I have learned most of our northeastern Ohio species by ear and recorded them for others to learn and enjoy. Now I present educational programs on singing insects throughout Ohio and have created an online field guide for them.

My equipment includes a shotgun microphone and other recording equipment, and a camera with a macro lens. In doing formal surveys, I pick routes that take me into the likely habitats of the insects I’m most interested in observing. This may change throughout the late summer and fall season, as some insects mature earlier than others. I choose trails that will take me safely to those habitats, as this work is done after dark. I make species lists as I go. Meadows, edge habitats, and wetland edges seem to have the most diversity of singing insects.

As a woman, personal safety is a big concern. I walk these areas in daylight first, for familiarity. I feel safer when my wife, Wendy, joins me, and she is also a good bugwatcher and listener. I make sure I have multiple flashlights, headlamps, and extra batteries. I use multiple weather apps on my phone, so I can be alerted to incoming severe storms and lightning. I avoid locations that are after-dark hangouts for locals. I have the numbers for the park rangers in every district I survey. If the preserve is not open after dark, but I have permission to be there, I call the local police or park ranger when I arrive and when I leave.



Lisa Rainsong
(WENDY PARTRIDGE)

I keep the gas tank full and carry extra food and water in the car. *If anything or anyone ever makes me feel uncomfortable, I leave.*

I get most excited by what I can learn from, and contribute to, the greater community of scientists and enthusiasts. Documenting northerly range expansions of some species due to climate change has been a revelation.

To the beginning bugwatcher: I would simply invite you to slow down to a crawl and start looking at everything you see. Observe not only the beauty of insects, but study where they live and what they do—what they eat, how they mate, what plants they may live on then pick a species or a group that particularly enchants you and learn everything you can about them. One insect will lead to another ... and another ...

LISA'S WEBSITE: <https://www.listeninginnature.com/>

FINDING INSECTS

DEVELOPING SKILLS FOR detecting insects takes time and is often a matter of trial and error. Adult and immature insects may occupy wildly different habitats and niches, and may be active at different seasons or different times of the day. Evaluating habitats for their potential for insect diversity helps increase the potential for success in seeking a given insect. Camouflage may be the ultimate challenge to finding insects, as they may masquerade as bits of dry vegetation, twigs, leaves, and even bird droppings

— SPOTTING AN INSECT

Once you see one, you'll see them everywhere.

LAURA SCHARE

THE GREATEST DIFFERENCE between watching vertebrates and watching insects is the size of the subject. Train yourself to think small, even tiny. Most insects are built to escape the attention of predators—they are cryptic as well as minuscule. Ones that announce their presence with bright colors are usually

Be the bird: Birds like this Chipping Sparrow are tuned to the movements of insects like this yellowjacket. Adjust your search image to a smaller scale, and be alert. (ERIC R. EATON)



armed with venom or are toxic in other ways. As with birds and other vertebrates, not every insect can be found in every habitat, during every season, or at any time of day. Do a little research before heading out, and learn where, when, and how to find insects that are of particular interest to you.

To get started bugwatching, simply staring at the landscape is an underrated exercise. Sitting or standing and gazing near or far has many rewards. Camouflaged organisms will begin to resolve themselves from tree trunks, grass-blades, flower blossoms, and sand or soil. Slight movements will become discernible, and fast-flying insects will capture your attention such that you can follow them.

Birders transitioning to bugwatchers lament that they cannot look down and up at the same time. If you want to see aerial, arboreal, and ground-dwelling animals, split the difference. Look at the horizon and let your peripheral vision catch movement both above and below you. Maybe it will be a butterfly's shadow or a jumping grasshopper, but it is possible to be aware of animals that are both above and below you.

It is best to pick a promising situation or location to begin flexing your powers of insect observation. A patch of flowers is a great place to start; so is a mud puddle in an otherwise dry landscape. A sunlit patch in a forest is another location where insects tend to gather. Gazing at leaves of shrubs where field meets forest will deliver basking butterflies, bees, and wasps, as well as herbivorous beetles, caterpillars, and other insects.

Practice noticing movement and following it. Learn the ways insects avoid your vision. Grasshoppers and leafhoppers will quickly shift to the opposite side of a leaf or grass-blade. Beetles will scurry under leaf litter. Slowly reaching behind the insect may coax it back into view. Gently lifting a leaf on the ground might reveal the beetle, now sitting motionless.

It is best to assume that any small object is an insect until proven otherwise by close inspection. Each leaf could hide an insect in plain sight or beneath it. Turn boards and stones, but turn them back once you have taken a peek. Turn larger ones toward you to block any potential strike from a venomous snake or stinging scorpion.

— CAMOUFLAGE

THROUGH CAMOUFLAGE, IT is possible for even large insects to escape notice. That is why slowly moving your gaze over vegetation, up and down tree trunks, and over the ground is a good idea. An insect may even give itself away by moving if it believes you have left the area or that you are a stationary object in the landscape. Insects frequently alight in front of people who are standing still. Sometimes they land *on* people. This is especially true for flies,

butterflies, and sweat bees, for various reasons related to the insect’s appetite or territorial imperative.

Camouflage includes mimicry of inanimate objects, from pebbles and stones to shards of bark to bird droppings. Stick insects look like twigs or grass stems. The caterpillars of geometer moths, popularly called inchworms, are also twig and tendril imposters, adopting a stiff, motionless posture jutting out from a vine or stem until danger has passed. Some treehoppers are thorn mimics. Katydids look like leaves. Some grasshoppers are so perfectly mottled that they resemble a collection of sand grains. Lichens are a favorite model for mimicking insects, too.

— WHEN TO FIND BUGS: SEASONS

WE THINK OF insects as most abundant in spring, summer, and fall, but of course they are present year-round. They may be passing the winter as eggs, larvae, pupae, or even adults, simply hidden from our view. In some places, there are winter-active adult insects. Mourning Cloaks and other species of anglewing butterflies pass the winter as adults and may be seen flying on warm winter days.

Signs of insects are ever present, but more obvious once foliage has fallen. Galls appear as swellings on twigs, leaves, stems, and other parts of vegetation. Cocoons of moths may adorn bare branches. You never knew the yellowjacket nest was in that tree, but there it is, abandoned now.

Insect species with only one generation each year at a given location are called univoltine. Many insects are bivoltine, with spring and fall generations

Commonly observed insects at different seasons of the year. (ERIC R. EATON)

SEASON					
Early Spring		Late Spring– Early Summer	Mid-Summer	Late Summer– Early Fall	Late Fall– Winter
TYPICAL INSECTS	Bees	Everything!	Typically	Grasshoppers	Beetles
	Flies		diverse,	Katydids	True Bugs
	True Bugs	Moths	but lull in	Crickets	Lacewings
	Tiger Beetles	Butterflies	abundance	Mantises	Some Moths
	Some Wasps	Caddisflies		Wasps	Some Flies
	Grasshoppers	Some	Dragonflies	Bees	Barklice
	Some	Dragonflies	Katydids	Flies	Gall Wasps
	Stoneflies		Cicadas	Tiger Beetles	Some
	Some		Antlions	Some	Stoneflies
	Butterflies			Dragonflies	Snow Insects

of adults, or are multivoltine, with more than two generations per year. This is where a little online or book research can help you determine when to go looking. Miss your window of opportunity and you may have to wait until next year.

— OFF-SEASON ACTIVITIES

TRY VISITING AN insect zoo, butterfly house, nature center, or museum. To avoid crowds, see if you can visit in off-hours or get a behind-the-scenes tour. Most facilities are happy to oblige, if not eager to reward someone for their interest in insects.

Universities have collections of pinned specimens, but often captive live specimens, too. Viewing collections can help you discern details that will improve your ability to identify the living version when you encounter it. University libraries also have a large selection of books about insects, as well as scientific journals that offer more detailed information yet.

You may also need to catch up on curating and posting images from your prior days in the field. Take time to assess what new equipment you will need for the upcoming field season, too.

— WHEN TO FIND BUGS: TIME OF DAY

THERE ARE 24 hours in a day, and insects are active during every one of them. Diurnal insects are easiest to find, but crepuscular species are active mostly or exclusively at dawn and/or dusk. Then there are nocturnal insects that require lights and/or good hearing to locate.

The after-dark soundscape is something to behold, especially in eastern deciduous forests and in wetlands, where a great diversity of katydids and crickets can be found. You may be unable to hear some species because the frequency at which they sing exceeds the range of the human ear. Many singing insects are expert ventriloquists that bounce their songs to throw off predators, making them nearly impossible to locate. You can record the insect songs you hear and play them back later; then try to match them with online libraries of audio files of singing insects.

Insects, being cold-blooded, take time to warm up, and going afield in early morning is a great strategy for finding insects that are awakening from slumber before they become too active to approach or follow. Some solitary bees sleep on or inside flowers. Some solitary wasps pass the night in loose clusters or even tight balls of many individuals, mostly males. They start settling down around dusk, so it is sometimes easier to find them when they are actively seeking a roosting spot.

Many desert insects are crepuscular or nocturnal, in order to avoid overheating during the day. If you go looking, be aware that rattlesnakes may also be on the prowl.

— WHERE TO FIND BUGS

INSECTS ARE LITERALLY everywhere. That said, many of the most elusive species are restricted not only by the seasons and time of day, but by habitat. Endangered and fragile habitats such as bogs, fens, caves, dunes, and remnant prairies offer the bugwatcher a special challenge. Most of these habitats are remote and heavily protected by government agencies, nonprofit entities, or private citizens. Permits are often required for accessing them. Their locations may be known by only a handful of people. It is best to get to know those people, prove you can be trusted, and go afield with them. The fewer visits and human disturbances such ecosystems endure, the better.

Two entomologists explore an oak savanna in southern California. Who says bugwatching doesn't have its scenic rewards? (KIM MOORE)





Close to home: Your local park can be a great place to start observing insects. Here, a Leda Ministreak, *Ministrymon leda*, rests by a fountain at Fort Lowell Park in Tucson, Arizona. (ERIC R. EATON)

— URBAN INSECT HUNTING

CITY DWELLERS AND suburbanites can easily find insects close by or within walking or biking distance. Good habitats include arboretums, the grounds of zoological parks, cemeteries, golf courses, vacant lots, and railyards.

Streets lined with tall buildings are (un)natural flight corridors for insects like butterflies and dragonflies. Lights attract moths and other insects during the night, so watch for those still clinging to windows and doors the next morning. Look in building alcoves. Planters on sidewalks and flowerbeds around buildings and parking lots usually feature bright blooms that draw bees, butterflies, and other flower visitors. Water features are usually home to a diversity of aquatic insects. Fountains frequently contain water boatmen, backswimmers, diving beetles, and dragonfly naiads. The waterfront promenade in many cities is an attractive habitat.

Fences and fence posts are used by insects for basking and hunting for prey, and are convenient perches for mating couples. They are also a surface on which to molt. The exteriors of buildings serve insects similarly to fences.



On the fence: Many insects, like this female Carolina Mantis, *Stagmomantis carolina*, take advantage of human structures as places to hunt, mate, rest, and groom. (ERIC R. EATON)

Stored-product pests like meal moths can be found in the pet food aisle at the grocery. The library may have silverfish and booklice but, if so, alert a librarian. Ants, cockroaches, and bed bugs are found everywhere, including movie theaters, public transit, and any other place with serial human occupancy. Termites, deathwatch beetles, and other boring insects are busy consuming our wooden structures, out of sight.

— INDOOR BUG-HUNTING

YOU CAN FIND a surprising number of insects without leaving your home. Living room, kitchen, bathroom, basement, and attic are all potential indoor ecosystems.

Do not be embarrassed by the cobweb in the corner. Compliment yourself for preserving a living pest control agent. See if you can find evidence of insect victims the spider has trapped. Dusty webs, unable to snare prey any longer, can be safely cleaned. Spiders will change “web sites” if they go long periods without success.

Check your pantry. You may need a snack midway through your hunt anyway, but flour, rice, and other grains may harbor unexpected insects. Drugstore Beetles, Cigarette Beetles, Meal Moths, and spider beetles may be feasting on neglected stored products of vegetable origin. Dry, animal-based foods attract the Larder Beetle and carpet beetles, all members of the family Dermestidae. Wool garments in your wardrobe, and wool blankets, furs, and silks are vulnerable to caterpillars of clothes moths and larvae of carpet beetles. Store them in a cedar chest when not using them regularly.

One rewarding source of insect diversity is a light fixture. You may not want to wait for a light bulb to expire before you examine a ceiling fixture or lamp. Insect specimens quickly die in the hot, dry conditions created by a lamp, and become brittle, faded, and gather dust, making them difficult to identify. It's best to check the lights often. Use your magnifier; many specimens will be tiny.

Windowsills are another bug trap, as insects that have blundered indoors will seek a way out by orienting to incoming sunlight.

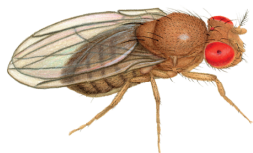
Houseplants host insects on their foliage and in the potting soil. Overwater and you may attract dark-winged fungus gnats (family Sciaridae), the tiny black flies that always seem to die in a soap dish. Their larvae feed on rotting roots and decaying vegetable matter in general. Look for mealybugs and other scale insects on the stems and leaves of plants.

Back in the kitchen, fruit flies, more appropriately called pomace flies or vinegar flies, genus *Drosophila* (family Drosophilidae), may be coveting overripe bananas on the counter or a bit of spilled wine. Scuttle flies, like *Megaselia scalaris* (family Phoridae), are easily mistaken for pomace flies, but run, stop, and run more often than they fly. They might be breeding in the sink's garbage disposal.

Your bathroom is likely not free of insects, either. Drain Fly, *Clogmia albipunctata* (family Psychodidae), feeds as a larva on organic matter in drain traps and elsewhere. The adults resemble tiny moths and are also known as moth flies. The bathtub might be literally hopping with tiny springtails, innocuous non-insect hexapods in the class Collembola.

In the garage, shed, or attic, don't be surprised to find mud dauber wasp nests, paper wasp nests, and various other evidence of insect interlopers, plus more spiders. Beetles and other insects may emerge from firewood you store indoors.

The basement, perennially dark and damp, is probably home to camel crickets (family Rhaphidophoridae), true crickets (Gryllidae), or both, scavenging on dead insects, molds, fungi, and other sources of sustenance. House spiders, house centipedes, millipedes, and woodlice (terrestrial crustaceans we also call pillbugs, roly-polies, and sowbugs) are other arthropods that may be present.



Indoor insects: Among our most common housemates are, clockwise from top left, Varied Carpet Beetle (*Anthrenus verbasci*, adult and larva), Bed Bug (*Cimex lectularius*), Drain Fly (*Clogmia albipunctata*), scuttle fly (*Megaselia scalaris*), pomace fly (“fruit fly,” *Drosophila* sp.), Greenhouse Camel Cricket (*Diestrammena asynamora*), and Indian Meal Moth (*Plodia interpunctella*); and, in the center, dark-winged fungus gnat and springtail.

(SAMANTHA GALLAGHER)

In the bedroom, inspect for bed bugs regularly. The same advice applies to the sofa and recliner, bookshelves, bedroom furniture, and baseboards, and to spaces behind wall decor. Adult bed bugs are no larger than the average apple seed. Immature stages are smaller still, and some are nearly transparent. You will likely see signs of bed bugs before encountering the insects themselves. Should you find some, resist the temptation to blame your spouse, roommate, visiting guest, or the tenants of the next-door apartment. Some authorities believe that one out of every four US residences has bed bugs or will have them. *Cimex lectularius* thankfully poses no major medical threats to the average healthy human that modern science is aware of. The biggest problems stem from litigation over infestations and the costs of eradication.

Again, a little digging, in the homework sense, can help you to learn what habitats are best for the insects you want to see. Public gardens may be great for butterflies and bees. The artificial lake or pond at the park is probably good for dragonflies. Glance at the paved bike path now and then for crawling or basking insects or dazed flying bugs that collided with a cyclist.

— TWELVE “MUST SEE” SITUATIONS FOR BUGWATCHING

1. **Public Gardens, Zoos, and Cemeteries.** Botanical gardens and zoological parks typically include landscaping with something in bloom during every season of the year, save winter. Cemeteries, especially older ones, often enjoy similar plantings.
2. **Sunlit Patches in Forests.** Many insects take advantage of illuminated areas in otherwise shady forests for purposes of basking and grooming, and for males to display to females. Watch for hovering flies, bees, wasps, and basking butterflies.
3. **Aphid Colonies.** Aphids, as well as scale insects and treehoppers, exude vast amounts of sugary liquid waste called honeydew. This material attracts a host of other insects. The aphids themselves are also a ready snack for many predatory insects.
4. **Fresh-cut Timber.** Slash piles of freshly cut trees, wind-broken limbs, and recently burned timber attract many beetles that are seldom seen in any other circumstance. Parasitoid wasps and horntail woodwasps also flock to these meccas.
5. **Rest Stops at Night.** Illuminated roadside rest stops, the more isolated the better, are often a treasure trove of nocturnal moths, beetles, and other insects at night. Be careful, and look just beyond the edges of illumination, too.

6. **Mud Puddles.** Water is a scarce commodity in most habitats, especially arid lands, so take advantage of its brief appearance. Stake out mud puddles for visiting butterflies, moths, wasps, bees, and flies imbibing water and dissolved minerals.
7. **Sap Flows.** Wounded trees and plants exuding sap are sure to attract a wide variety of insects, especially if the ooze is fermenting and/or few flowers are in bloom to compete with this carbohydrate source.
8. **Open Summits of Hills, Buttes, and Outcrops.** Male insects, especially butterflies, flies, and some wasps, seek the highest points in the landscape to survey for females carried upslope on the wind. (See “Hilltopping,” page 113.)
9. **Cliffs and Cave Entrances.** Many nocturnal insects seek shelter during the day, and diurnal insects want to escape the heat of the midday sun. Cliff overhangs and cave entrances afford protection. Large moths, some dragonflies, and various flies can be among those insects.
10. **Decaying Plant and Animal Matter.** The pile of grass clipping from mowing your yard, the compost heap, or a random deceased animal will all harbor unique insects. This is not an exercise for everyone, and take sanitary precautions when examining such things. Wear gloves, use a stick or other implement to probe, and use hand sanitizer afterward.
11. **Vertebrate Excrement.** Fresh feces from vertebrae animals represents a windfall of nutrients eagerly sought by many insects. This includes the output of livestock as well as wild birds. Break off a twig and use it to see what beetles lurk under fresh manure.
12. **Fungi.** Combine your love of mushroom hunting with entomology and sift through fleshy and woody fungi for various beetles and fly larvae that may be living within.

— WHAT IS A SLIME FLUX?

A SLIME FLUX is a bacterial infection of an injury to a tree or other plant. It typically manifests as a copious amount of oozing liquid that may be bubbling, fizzing, or otherwise showing signs of fermentation. Such gross, weepy wounds are highly attractive to insects, especially some flies and beetles. Most are small, so you have to look closely to see them. Some are found only in situations like the one shown overleaf, such as wounded-tree beetles (family Nosodendridae) and aulacigastrid or sap flies (Aulacigastridae). Pomace flies (Drosophilidae) and sap-feeding beetles (Nitidulidae) flock to slime fluxes, too. Look both day and night.



Slime time: A slime flux will attract many insects that enjoy fermented “beverages.” Clockwise from top left are a picture-winged fly (*Pseudotephritis vau*), a Picnic Beetle (*Glischrochilus fasciatus*, with the larva of another sap beetle in front of it), a Winter Ant (*Prenolepis imparis*), two sap flies (*Aulacigaster* sp.), a wounded-tree beetle (*Nosodendron unicolor*), and an odiniid fly (*Traginops irroratus*). (SAMANTHA GALLAGHER)

— WATCHING WASPS

STINGING INSECTS MAY be the last thing on your list of bugs to observe, but they are fascinating to watch. Most species are solitary and will flee your approach instead of defending their nest. Social wasps are generally placid if you keep a respectful distance.

If you are walking a trail or other area with mostly bare soil and you flush a wasp, then stop. Did the wasp land again a short distance away? Back up a few steps, and see if you disturbed her while she was digging a nest burrow. If so, she will make her way back to the spot and resume her activities. Sit, crouch, or stand (not atop an ant nest!), and watch. Is she a “carrier” like *Ammophila*, that digs with her jaws, then backs out of the burrow carrying a load of soil beneath her head? Maybe she is a “kicker,” like *Bembix* sand wasps, using the row of spines on each front leg (tarsal rake) to kick sand beneath and behind her.

You might notice tiny flies flitting and landing near a digging wasp. Those are female satellite flies, family Sarcophagidae, subfamily Miltogramminae, looking for an opportunity to deposit their larval offspring inside their nest. Those maggots will kill the egg of the host wasp and consume the prey the mother wasp furnished for her offspring.

Paper wasps in the genera *Polistes* and *Mischocyttarus* are social. Their nests are uncovered paper combs suspended under eaves and other man-made structures. You can witness the female wasps feeding their larval siblings and each other, cooling the nest by fanning their wings, and other amazing behaviors. If a wasp stands on tiptoe and flares her wings, then it is time to back away until she relaxes again.

— LEAF FLIPPING AND HUNTING CATERPILLARS AT NIGHT

DURING THE HOTTER hours of the day, many insects seek shelter from the heat, hiding beneath various objects, especially on the underside of leaves. Locate those insects by walking beneath low-hanging foliage and looking up; that way, you are not disturbing the insects. Otherwise, try leaf flipping, simply turning over a leaf to see if there is an insect hiding there. Leaf flipping is especially recommended for locating caterpillars, sawfly larvae, many true bugs like lace bugs, and adults and larvae of many beetles. Be careful, as aphids and other true bugs feeding beneath leaves are often guarded by ants that will aggressively attack perceived threats to their “herds.”

Caterpillars of many moths feed most actively at night, on the underside of leaves or along the edges of leaves. You can find them with an ordinary flashlight, but many species are well-camouflaged to match foliage and twigs. You

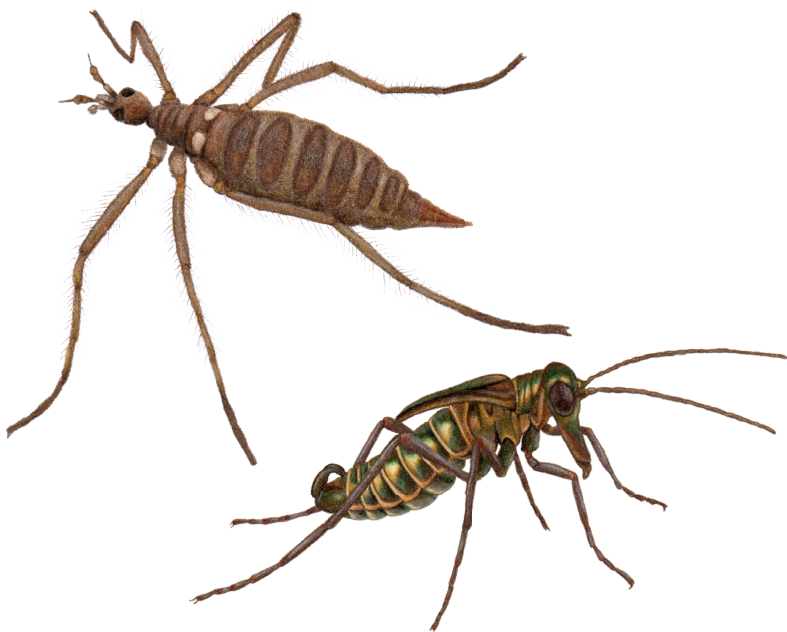


Glowing pillars: Caterpillars can be found rather easily at night because many will fluoresce under blue light. At left are larvae under normal light. At right, they are fluorescing under blue light. (DEBORAH BRUSCO)

may gain an advantage by using an ultraviolet (UV) flashlight. It turns out that chitin, the main structural molecule in the exoskeleton of terrestrial arthropods, fluoresces under ultraviolet light. This is especially true for cuticle (exoskeleton material) that is not heavily pigmented or is thin. Many caterpillars, beetles, ants, and at least one grasshopper and one dragonfly species will fluoresce when excited by wavelengths in the ultraviolet end of the light spectrum; that is, they glow like a neon sign, usually white or green. Do not settle for the least-expensive UV flashlight. Do wear UV-blocking glasses or goggles with this search method. Why do some insects fluoresce? Research is under way, but it may be a way for the creatures to avoid detection by predators, especially birds.

— SNOW INSECTS

SNOW FIELDS in alpine areas are often littered with slow-moving insects, especially in spring, as insect activity ramps up. The insects become grounded when they fly or are blown onto the cold, accumulated precipitation. It is a great opportunity to find a diversity of species. Even in winter, though, there are insects to be seen that are adapted to the cold.



Snow bugs: Some insects, like the female wingless crane fly (*Chionea* sp.) at left and the male snow scorpionfly (*Boreus* sp.) at right, are adapted to thrive in winter. (SAMANTHA GALLAGHER)

Two peculiar snow insects are snow flies and snow scorpionflies. Snow flies are small, wingless crane flies in the genus *Chionea*. They exist mostly in the gap between snow blankets and leaf litter, but are occasionally seen on the snow surface. Equally diminutive, at only 2–4 millimeters, are snow scorpionflies in the family Boreidae. Easily recognized by their long, downward-pointing face, they feed on the leafy parts of mosses and liverworts.

“Snow fleas” are winter-active springtails in the genus *Hypogastrura*. Though tiny, they can form conspicuous masses, especially at the base of trees, where snow tends to start melting first. They graze on decomposing organic matter, mostly from leaf litter. If you see what looks like spilled pepper on the snow, look more closely.

Various small stoneflies in the superfamily Nemouroidea can be found from late fall to early spring, immediately adjacent to clean, fast-flowing streams. Look on rocks, foliage, and bridges for the adults, all of which are less than 15 millimeters in length.

— CHRIS KLINE (HE/HIM)

Hi! LIKE MANY entomologists and insect enthusiasts, I got my start bugwatching as a small child. My favorite insects to catch were grasshoppers. There's no better drum solo than a grasshopper banging against the plastic lid after it's hopped inside a coffee can.

Today, at over sixty years of age, I am more concerned with documentation than entertainment. I am working, with the help of iNaturalist, on a complete listing of the insect fauna for our 21-acre property in Ohio. My family and I have well over one thousand species so far. We also take our moth lighting rig on the road to different county parks and festivals, when invited, to teach others the beauty and wonder of moths.

We have landscaped with native vegetation on our property to enhance biodiversity. We do a butterfly transect (sample area) at the beginning of each month, documenting every butterfly we see on the 1-mile trail. We put out bait sticks with our own secret recipe to attract butterflies and other insects. We are fortunate to have friends who excel at identifying moths, so we illuminate light stations at various locations on our land.

The greatest challenges we face are when we venture off our property. Public land in Ohio is scarce, and the parks are crowded, making quality observation of insects nearly impossible. Meanwhile, private property is vigorously defended, even to the degree of gunpoint. Further, as I have aged, arthritis and other health issues have made it difficult to walk long distances like I used to.

As a person of faith, I frequently find myself ostracized by both churchgoing believers and the scientific community. Many religious people consider nature study to be cult-like, worshipping the creation instead of the Creator. At the other extreme, many scientific colleagues are quick to demean those who do not subscribe wholeheartedly to the theory of evolution, even though I have a strong understanding of the principle.

We get the most personal enjoyment out of bugwatching when we find "new to me" species, like the first Xami Hairstreak butterfly we saw. We also get profound satisfaction from opening the eyes of others to the interesting and beautiful insects we share our space with, insects that are frequently overlooked. We do that through our private, for-profit facility, Butterfly Ridge, located on our property.



Chris Kline (CHRIS KLINE)

CHRIS'S WEBSITE: <https://www.butterfly-ridge.com/>

BRINGING BUGS TO YOU

EMPLOYING BAITS AND traps to attract and hold insects, and keeping and rearing insects in captivity, are endeavors that entail pros and cons in terms of labor and ethics. Meanwhile, landscaping with native plants, shrubs, and trees has the potential to rewild your neighborhood and increase biodiversity that supports all forms of desirable wildlife.

— YOU ARE THE ATTRACTANT

IT DOES NOT take much to turn yourself into an insect magnet. Simply standing there and sweating may do the trick. A surprising variety of insects are drawn to the salts and minerals in human perspiration. Aptly named sweat bees, mostly solitary bees in the family Halictidae, frequently



Sweat sippers:
Sweat bees, family
Halictidae, live up to
their name by lapping
up your sweat. You can
gently brush them off
or enjoy watching
them. (ERIC R. EATON)



alight on people's exposed arms and legs to sip their sweat. These are small bees, frequently iridescent bronze, copper, or brilliant green. Many types of sweat-seeking flies will make a nuisance of themselves. Those include the House Fly, *Musca domestica*, various tachinid flies (family Tachinidae), flesh flies (Sarcophagidae), flower flies (Syrphidae), lance flies (Lonchaeidae), and others. Even the males of some butterflies, like the Hackberry Emperor, *Asterocampa celtis*, find sweat irresistible.

Some insects are after buried treasure in the form of blood. We all know mosquitoes, family Culicidae, and you should actively repel them, given the disease organisms they can transmit. Other blood-eaters are black flies (Simuliidae), biting midges, also called punkies or no-see-ums (Ceratopogonidae), deer flies, horse flies, and clegs (Tabanidae), the Stable Fly, *Stomoxys calcitrans* (Muscidae), and sand flies (Psychodidae). Tabanids can carry diseases, too, and many people are severely allergic to their bites.

Then there are fleas and lice. While most flea species are specific to other mammals and birds, they will settle for blood from a human in the absence of your pet. Lice are still a scourge, especially head lice. Avoid sharing hats, scarves, and clothing to minimize the risk. Since lice are highly host-specific, there is no possibility of getting them from pets.

What you wear, in terms of clothing and fragrance, can enhance your attractiveness. Bright colors and floral prints can catch the attention of bees and wasps, for example. Various perfumes, colognes, hair-care products, and lotions are even more appealing. There are anecdotes about cosmetic aromas that smell enough like the pheromones of certain moths that the person wearing it will be followed by an entourage of male moths.

Your vehicle can attract insects, too. When parked, its reflective surface is frequently mistaken for a body of water by aquatic insects, and they can crash into it by mistake. When your car or truck is in motion, horse flies and deer flies will surely be in pursuit, believing it to be a large mammal with blood to feed on.

— “SUGARING” FOR MOTHS

IT TURNS OUT that insects like alcohol as much as we do. Entomologists and insect collectors have taken advantage of this for centuries, brewing various concoctions to attract moths in particular. All it takes is a base of stale (flat) beer and a lot of brown sugar. After that, recipes vary greatly by region or even from one cook to the next. If you live in the American Southeast, you might add a fermenting peach to your stew. An overripe banana is a staple of many sugaring formulas. Some folks spike the whole thing with vanilla extract or a favorite fruity liquor, stale orange soda, or honey or maple syrup. Some people

(continued...)

media accounts, or create your own. Make better memes. Most memes are overly simplified, with no sources indicated for further investigation by the audience. Enroll your artistically inclined friends in your campaign. Post images of insects you find, with a brief explanation of what makes the species “cool” and valuable.

— *ADVOCACY*

MOST CONSERVATION ORGANIZATIONS are constantly battling against “development” of wildlife habitat. This needs to be a bigger concern and activity for bugwatchers, too. Your favorite spots could be bulldozed for housing projects; existing parks could be encircled by subdivisions and business or shopping centers. Speak out against such projects, if it makes sense, and especially if you have data to back up your assertions. Maybe the only population of a dragonfly species in the entire state resides at that location, for example. It may fall on deaf ears, but try anyway. You may recruit more people to bugwatching and conservation as a result.

We should encourage parks agencies, outdoor outfitters, and tourism providers to give equal weight to “passive” nature recreation, instead of continuing

Backpacks to lend: Audubon of Kansas provides libraries with “Adventurepacks” filled with nature-study equipment, for lending to those who cannot afford to purchase their own gear. We need more initiatives like this. (DR. JACKIE AUGUSTINE)



to prioritize recreation that is “nature conquering.” Mountain biking, rock climbing, and trail running are examples of destination-oriented pursuits that can be destructive to natural resources.

Natural areas, parks, and attractions need to be accessible via public transportation. Transit currently focuses on getting people to work, shopping centers, and park-and-ride hubs. This needs to change in the interest of public health alone.

— DIVERSITY AND INCLUSION

BESIDES THE SUGGESTIONS offered in chapter 7 on Social Bugwatching, there are additional ways to expand the community of bugwatchers and drive progressive initiatives:

- RECOGNIZE INDIGENOUS EXPERTS as equal partners and custodians of biodiversity knowledge. Give them the power to decide what information they share with the group or organization.

Butterfly smiles: Dr. Jana Johnson and her team celebrate the release of captive-bred Palos Verdes Blue butterflies by giving the American Sign Language sign for “butterfly,” with one maverick “moth” sign at left.

(DR. JANA JOHNSON)



- IN THE NAME of human inclusion, endorse efforts to correct common English names of organisms that currently reflect animosity toward various ethnic groups or that are named after individuals known to be slave owners, racists, misogynists, and bigots.
- ENCOURAGE AND SUPPORT Indigenous initiatives for Rights of Nature legislation. Ecuador, Bolivia, Panama, New Zealand, and India have recognized rights of nature at the national level. In the United States, it has been largely at the level of towns and sometimes cities, like Pittsburgh, Pennsylvania.

— WHAT NOT TO DO

CERTAIN STRATEGIES AND practices in the conservation of insects cannot continue. Further, the influence of the pest control industry is out of control,

Languishing in obscurity, the Palos Verdes Blue butterfly, *Glaucopsyche lygdamus palosverdensis*, is far more endangered than the Monarch, but does not benefit from the same degree of publicity. (MAX A. SPRUTE)





No Mow May is a convenient and catchy slogan, but the tactic does not apply everywhere. The best solutions for preserving and enhancing insect diversity are more complex and labor intensive. (ANNE READEL)

and technology is both a blessing and a curse. Bugwatchers must play a role in driving necessary change.

There is a belief that a single-species focus—such as on particular butterflies, like the Monarch—is the way to protect adjacent species and the habitats they dwell in. This results in a disproportionate amount of dollars and personnel that could better serve an array of species, or preserve habitat through acquisition, conservation easements, and other methods, or rehabilitate and restore habitat of marginal quality.

Similarly, butterflies are imagined as “flagship species” that provide a gateway to an appreciation of other insects. This is rarely effective. Anyone engaged in public outreach hears questions such as “How do I get rid of the other insects eating the milkweed I planted for *my* Monarchs?”! Honey bee propaganda is worse, in any arena other than agribusiness, where these insects are necessary for crop pollination at the unsustainable scale that currently exists.

Slogans, quick fixes, and fads are meme-able, but problematic. “No Mow May” and “Leave the Leaves” are catchy phrases, but the reality is more nuanced. Often, such campaigns are rolled out prematurely, before enough studies prove their effectiveness. People receive conflicting advice, and end up doing nothing because they cannot determine the best course of action.

Artificial Intelligence (AI) is a mixed bag in relation to bugwatching. *Pattern-recognition AI* is likely to improve algorithms used to identify insects, interpret their behaviors, and predict trends in abundance and diversity. On the other hand, *generative AI*, such as Dall-E and ChatGPT, already generates images of insect “species” that do not exist, among other forms of misinformation that is all too easily widely broadcast at the expense of real science.

— SKYE AUSTIN (*THEY/THEM*)

HELLO! I’VE BEEN a bugwatcher since I was a small child. We had this giant butterfly bush in our backyard that was buzzing with insect diversity—bees, butterflies, flies, spiders, you name it! It was mesmerizing to watch, especially when the evening light hit it just right. I’ve maintained my love of bugs throughout my K–12 schooling and into university, where I learned that you can make a career of studying them! As an undergraduate, I was quickly picked out as the bug person, and I loved getting messages, texts, or people coming up in person to ask, “Skye, what is this thing!?”



Skye Austin (SKYE AUSTIN)

One way I bugwatch is to pick a spot and sit for a while; also, I wander around vegetated areas. Method one can be particularly useful in urban areas; I used this method on my college campus, as I didn’t have a car until the end of my senior year, so transportation to natural sites was difficult. I’ve had great success sitting in the grass under trees. This approach is especially helpful on higher-pain days, when I want to go outside but wandering around much isn’t feasible. Method two is better for large expanses of greenspace, like a park, a riparian buffer, a meadow, or a garden. On a quick stroll, you’ll see larger insects—bumble bees, butterflies, and some larger beetles. If you take it slow and look closely at vegetation and other landscape elements, you’ll notice smaller organisms like leafhoppers and smaller wasps, bees, and ants.

The main challenge I face is accessibility—I use a combination of forearm crutches and a wheelchair to get around, and many natural areas are far from

wheelchair accessible. I think it's also worth noting that some of the more rural areas of the United States are outright dangerous for people of color and visibly queer folk.

Using crutches in the field can be tricky, especially if I'm carrying equipment, but I've gotten the hang of it. As people work to lower barriers to the field of ecology, accessibility of field sites has become a topic of conversation; however, there's a lot of work to be done. As the conversation evolves, I hope that positive changes can occur to make ecology and field biology accessible to as many people as possible.

Seeing a bug I haven't seen before is so amazing! I see fun new bugs all the time; I love bending down and saying, "Oh, hello! Who are you?"—much to the confusion of anyone around me. Watching bugs crawl or fly around, minding their business, also brings a smile to my face, especially if they land on me. Bugwatching moments that have made me feel proud are being able to identify something from its gestalt or purely off of "vibes," and holding large moths. There's something so goofy about them—they're such a joy!

A FINAL WORD

THE AUTHOR CAN trace his own fascination with insects and related animals to the influence of his kindergarten teacher. She was a talented artist and had drawn a trapdoor spider on the blackboard one day. Her explanation of its behavior was captivating. As an only child, I felt disconnected from my peers. I couldn't easily stand up for myself, but I could learn about spiders, bugs, bats, snakes, and sharks, and tell the other kids why *those* creatures were cool. It was a kinship with the underdog that has only gotten stronger.

What kind of social lens should we be looking through in our relationships with other species and each other? Do we have a proper respect and reverence for all the players? Are we willing to make ourselves vulnerable in order to attain higher collective goals? These are the kinds of deep and relevant questions we need to be asking. We will never succeed at conserving and protecting biodiversity if we do not respect and accept *human* diversity.

The power of narrative cannot be overemphasized. Facts are great, but storytelling brings those facts to life and complements the scientific with the sacred and the personal. It is through stories that we best connect with one another and develop respect and empathy.

Hang in there, like these gall midges suspended on a spider thread. The more time you devote to the pleasures of bugwatching, the more you will be rewarded. (KIMBERLY R. FLEMING)

Hang in there!



We can do better at facilitating accessibility for all. Why can't we have field guides in languages other than English, and as audiobooks? Widespread, affordable broadband service is needed to bridge the digital divide.

Conservation organizations should continue enlarging their spheres of emphasis to include insects and related arthropods. They must also actively expand their comfort zone of human demographics. We need all hands, all eyes, indeed all senses, and personal strengths, directed toward common goals. It is the only way forward if we seek to grow public understanding of the natural world and accelerate positive, lasting impacts on the ecosphere. Think big, think "bug."

It is the author's hope that this book has given the reader food for thought, sparked fond memories, answered unspoken questions, and inspired a brighter vision of stewardship for the planet. Go forth, now. Walk slowly, look closely, and be curious.

RECOMMENDED RESOURCES

— BOOKS

- Brown, Tom, Jr. 1987. *Tom Brown's Field Guide to the Forgotten Wilderness*. New York: Berkley Books. 222 pp.
- Cavalier, Darlene, Catherine Hoffman, and Caren Cooper. 2020. *The Field Guide to Citizen Science: How You Can Contribute to Scientific Research and Make a Difference*. Portland, Oregon: Timber Press. 187 pp.
- Dethier, Vincent G. 1992. *Crickets and Katyids, Concerts and Solos*. Cambridge, Massachusetts: Harvard University Press. 140 pp.
- Evans, Howard E. 1968. *Life on a Little-known Planet*. New York: E. P. Dutton. 318 pp.
- Hatch, Warren A. 2020. *In One Yard: Close to Nature Book 2*. Portland, Oregon: Warren Hatch. 215 pp.
- Preston-Mafham, Rod, and Ken Preston-Mafham. 1993. *The Encyclopedia of Land Invertebrate Behaviour*. Cambridge, Massachusetts: The MIT Press. 320 pp.
- Russell, Helen Ross. 1971. *Winter Search Party: A Guide to Insects and Other Invertebrates*. Nashville, Tennessee: Thomas Nelson. 171 pp.
- Stokes, Donald W. 1983. *A Guide to Observing Insect Lives*. Boston: Little, Brown. 371 pp.
- Teale, Edwin Way. 1937. *Grassroot Jungles*. New York: Dodd, Mead. 240 pp.
- Voisard, Lisa. 2024. *Insectorama: The Marvelous World of Insects*. Lausanne, Switzerland: Helvetiq. 224 pp.

— FIELD GUIDES

- Abbott, John C., and Kendra Abbott. 2023. *Insects of North America*. Princeton, New Jersey: Princeton University Press. 585 pp.
- Eaton, Eric R., and Kenn Kaufman. 2007. *Kaufman Field Guide to Insects of North America*. Boston: Houghton Mifflin. 392 pp.
- Eiseman, Charley, and Noah Charney. 2010. *Tracks & Sign of Insects and Other Invertebrates: A Guide to North American Species*. Mechanicsburg, Pennsylvania: Stackpole Books. 582 pp.
- Evans, Arthur V. 2008. *National Wildlife Federation Field Guide to Insects and Spiders of North America*. New York: Sterling. 497 pp.
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- Will, Kipp, Joyce Gross, Daniel Rubinoﬀ, and Jerry A. Powell. 2020. *Field Guide to California Insects* (2nd edition). Oakland: University of California Press. 521 pp.

— ACTIVITIES AND PROJECTS

- Allison, Linda. 1988. *The Wild Inside: Sierra Club's Guide to the Great Indoors*. Boston: Little, Brown. 144 pp.
- Brenner, Kelly. 2023. *The Naturalist at Home: Projects for Discovering the Hidden World Around Us*. Seattle, Washington: Mountaineers Books. 222 pp.

- Brown, Vinson. 1968. *How to Follow the Adventures of Insects*. Boston: Little, Brown. 201 pp.
- Headstrom, Richard. 1963. *Adventures with Insects*. New York: Dover. 221 pp.
- Imes, Rick. 1992. *The Practical Entomologist*. London: Aurum Press. 160 pp.
- Lawrence, Gale. 1986. *The Indoor Naturalist; Observing the World of Nature Inside Your Home*. New York: Simon & Schuster. 210 pp.
- Nardi, James B. 1988. *Close Encounters with Insects and Spiders*. Ames: Iowa State University Press. 185 pp.
- Tallamy, Douglas W. 2019. *Nature's Best Hope: A New Approach to Conservation That Starts in Your Yard*. Portland, Oregon: Timber Press. 254 pp.
- Vogt, Benjamin. 2017. *A New Garden Ethic: Cultivating Defiant Compassion for an Uncertain Future*. Gabriola Island, British Columbia: New Society. 179 pp.

— ONLINE

— COMMUNITY SCIENCE AND CONSERVATION

- Bugguide: <https://bugguide.net/node/view/15740>
- iNaturalist: <https://www.inaturalist.org/>
- Moth Photographers Group: <https://mothphotographersgroup.msstate.edu/>
- Odonata Central (dragonflies & damselflies): <https://www.odonatacentral.org/#/>
- Singing Insects of North America: <https://orthsoc.org/sina/i00abt.htm>
- Songs of Insects: A Guide to the Voices of Crickets, Katydid & Cicadas: <https://songsofinsects.com/>
- Xerces Society Community Science: <https://xerces.org/community-science>

— DIVERSITY, EQUITY, AND INCLUSION IN NATURAL SCIENCES

- Birdability: <https://www.birdability.org/>
- Entomologists of Color: <https://www.entopoc.org/>
- Field Inclusive, Inc.: <https://www.fieldinclusive.org/>
- Hearts for Sight Foundation: <https://heartsforsightfoundation.org/>
- Idea Wild: <https://ideawild.org/>
- Nature for All (Los Angeles, California): <https://lanatureforall.org/>
- Out in the Field (OITF), an initiative of the Wildlife Society: <https://wildlife.org/out-in-the-field/>
- Outdoor Afro: <https://outdoorafro.org/>
- Outdoors for Everyone: <https://www.outdoorsforeveryone.org/>
- The Venture Out Project: <https://www.ventureoutproject.com/>
- Seeing the Forest for the Queers: <https://foreststewardsguild.org/seeing-the-forest-for-the-queers/>