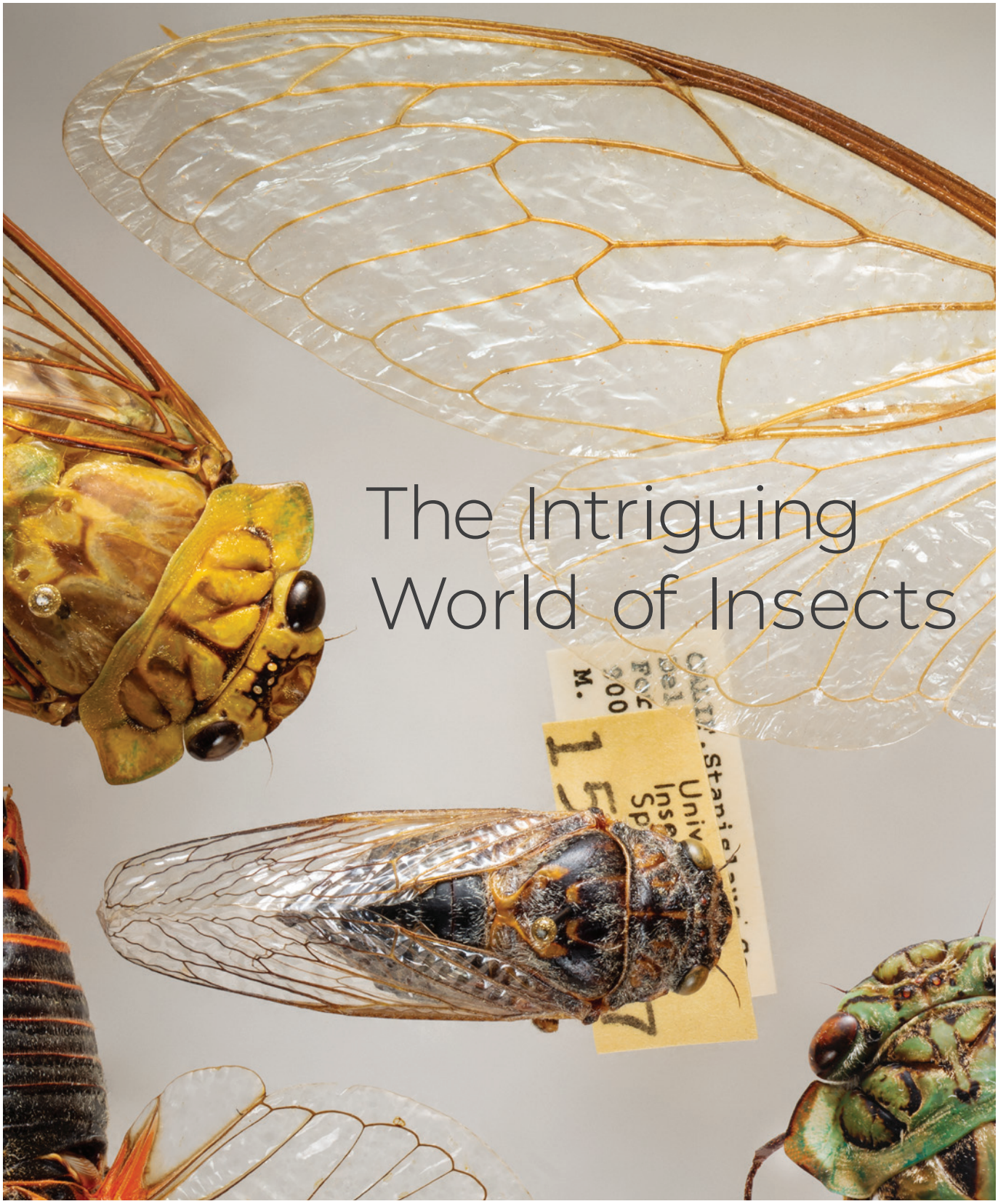
SFO Museum | Education Program



The Intriguing World of Insects

The Intriguing World of Insects

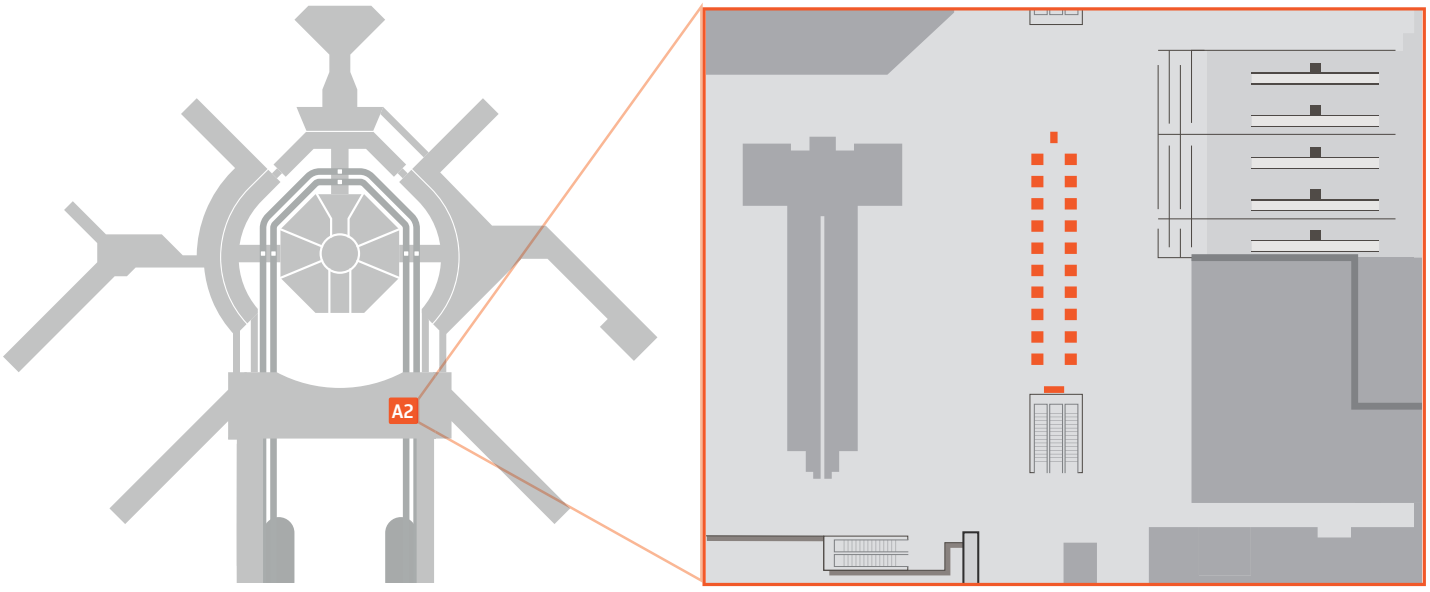
Self-Guided Tour and Supplemental Teaching Materials for K-12 Teachers

Thank you for visiting our exhibition, *The Intriguing World of Insects*.

International Terminal Main Hall A2 20 Cases Pre-Security | Level 3, Departures

This PDF provides parents and teachers with a self-guided tour of the exhibition.

Begin at the large introductory text panel that appears at the start of the exhibition gallery, then work your way through the twenty cases.



The Intriguing World of Insects

Neostylopyga rhombifolia 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.037

Insects are the most diverse macroscopic organisms on the planet. Researchers have identified over one million species of insects and estimate that five to thirty million more are waiting to be discovered. In fact, there are more species of ants than species of birds, and more species of beetles than all species of plants combined. In the United States, about 91,000 species of insects are known. Insects are everywhere—from shoreline to mountaintop, deserts to ponds, deep in the soil to the tips of the tallest redwoods, and they inhabit some of the most extreme environments on Earth.

Insects, spiders, lobsters, and their cousins are arthropods, meaning they have jointed legs and an external skeleton. In order to grow, arthropods must molt or shed their old exoskeleton to allow their new exoskeleton to expand. This is often accompanied by metamorphosis—a change in appearance from one life stage to another. For example, a caterpillar molts into a pupa, which molts into a butterfly. Bees, wasps, flies, and beetles also go through a pupal stage. Other insects, such as cicadas and stink bugs look very similar as nymphs and adults, having no pupal stage.

The first insects appeared around 400 million years ago and evolved wings over 300 million years ago. Fossils of dragonfly ancestors, called griffinflies, had wingspans of over sixty centimeters. In contrast, the tiniest insects today have wingspans of less than one millimeter. But not all insects have wings. Some species, like silverfish, never evolved wings, while others, like camel crickets, lost them millions of years ago. Insects have three body regions: a head, thorax, and abdomen—with antennae on their heads and three pairs of legs attached to their thoraxes. Insects display varying mouth parts that allow them to chew, pierce and siphon, or lap up their food.

Insects play integral roles in ecosystems. They are important food sources for other species, and they keep plant and insect pests at bay. Insects such as termites recycle nutrients by decomposing organic wood debris on forest floors. Insects also produce wax and honey and pollinate the flowers of countless fruits and vegetables. For instance, honey bees may travel up to sixty miles in a single day, passively pollinating billions of dollars' worth of agricultural crops in the United States each year. Due to their small size, ability to fly and adapt to various habitats, and prolific reproductive abilities, insects permeate the Earth's surface. This exhibition illuminates the extraordinary world of insects through the collection of the Essig Museum of Entomology at the University of California, Berkeley.

Edessa fuscidorsata 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.034

This exhibition was made possible through a generous loan from the Essig Museum of Entomology, University of California, Berkeley. Special thank you to Peter Oboyski, Curator, Essig Museum of Entomology and photographer David Garnick.

Vocabulary words

macroscopic: visible to the naked eye

prolific: plentiful, appearing in large quantities, able to produce a large number of offspring

Review questions

Approximately how many known species of insects are there in the United States?

91,000

What do all arthropods have in common?

They all have jointed legs and an external skeleton

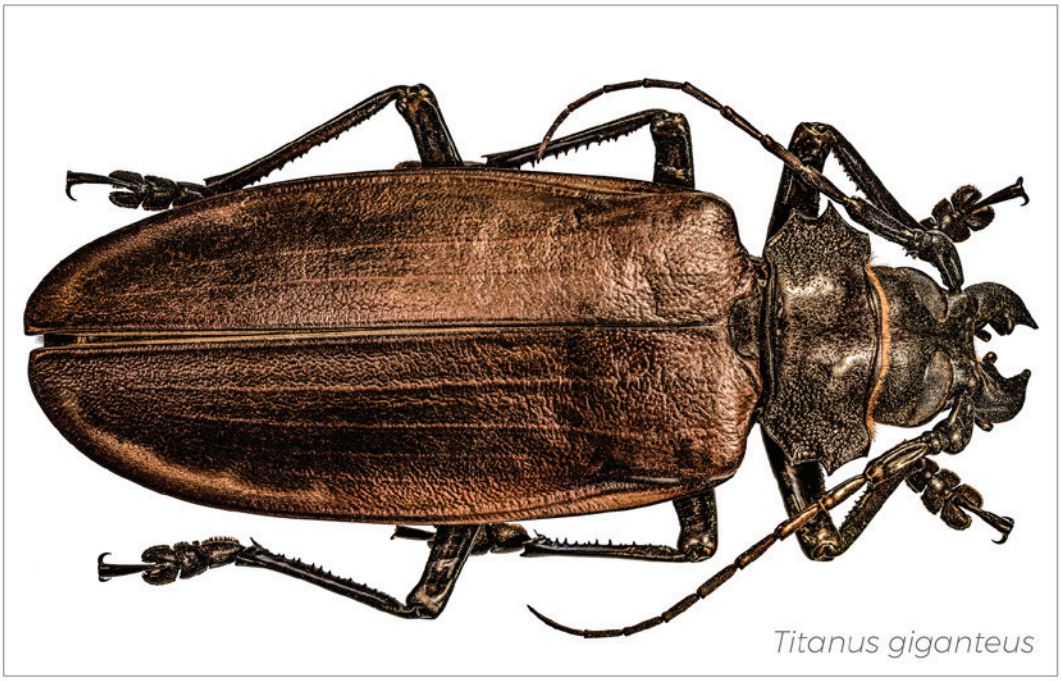
Essig Museum of Entomology

The Essig Museum of Entomology, located at the University of California at Berkeley, has an active research collection of over 5,000,000 terrestrial arthropods. From humble beginnings as a teaching collection in the early 1900s, through exponential growth as the California Insect Survey beginning in 1939, the Essig Museum holds one of the largest university-based research collections of insects in North America. Primarily a collection of specimens from the western hemisphere, regional emphasis is on the eastern Pacific Rim, in particular California, Mexico, Central America, and the islands of the central Pacific. Holdings are particularly rich in aphids and other true bugs, bees, moths, ground beetles, longhorn beetles, aquatic insects, ticks and other parasites, and spiders. The mission of the museum is to facilitate research, teaching, and outreach in arthropod biology by documenting, preserving, and sharing specimens and data for the benefit of the academic community and the general public.

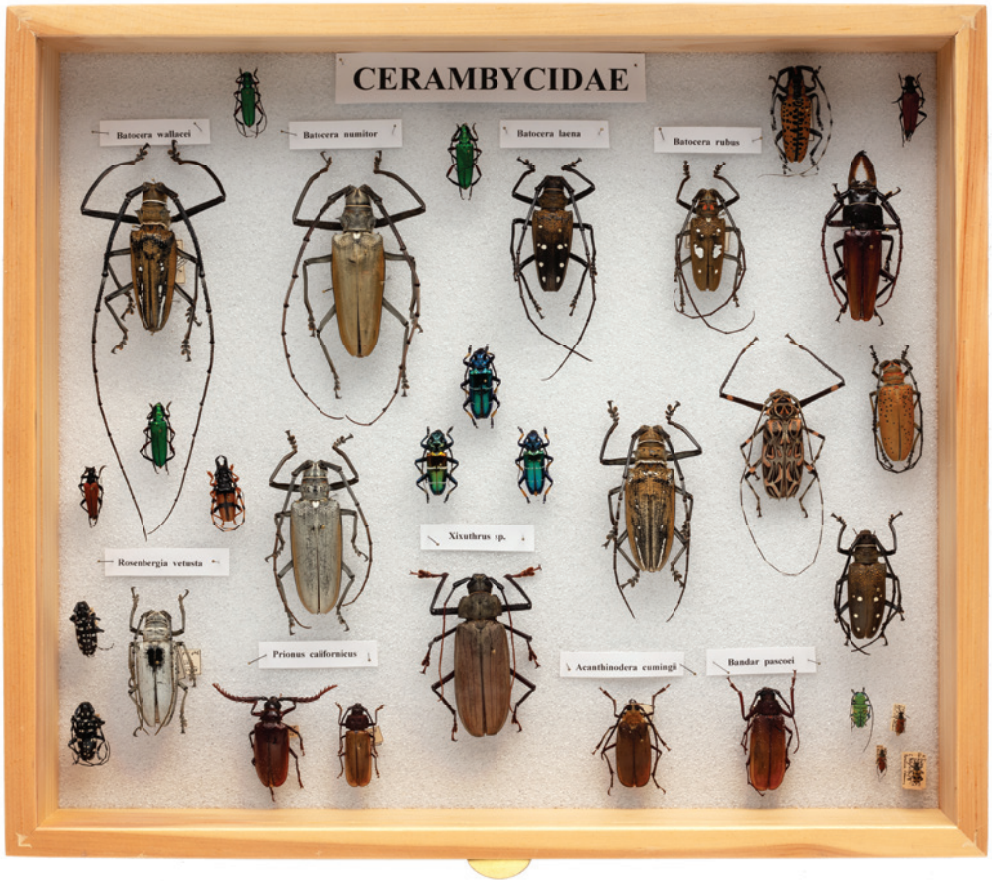
David Garnick | *Insecta*

David Garnick's Insecta series features photographs of insect specimens from the collection of the Essig Museum of Entomology at UC Berkeley. Garnick's images evoke the look of lithographic prints of illustrations found in early-twentieth-century natural history books.

David Garnick is a photographer living and working in the San Francisco Bay Area. Garnick is the founder and a co-director of the San Francisco Bay Month of Photography, an annual month-long celebration of the art and craft of photography. He is the editor of Bokeh Bokeh Photo, an online magazine featuring contemporary artistic photography. Garnick's work is held in public, corporate, and private collections.



Titanus giganteus 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.015



Display drawer of longhorn beetle (Cerambycidae) specimens
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.046

Longhorn Beetles

Longhorn beetles belong to the family Cerambycidae and derive their name from their long antennae. Their larvae feed inside the wood of dead and dying trees, including roots, trunks, and branches. Many species specialize on particular species of trees or even specific parts of trees. One species only feeds in the seed cones of California's giant sequoia trees, which may hang from the trees for up to twenty years before dropping their seeds after a fire. Most longhorn beetle eggs are laid under pieces of bark. Larvae first feed on the cambium (new growth layer under the bark) before boring deeper into the wood. Beetle larvae have been found in firewood and wooden pallets used for shipping. When wood is moved great distances, the beetles emerge in new habitats where there are no natural enemies to control them. Most species only attack trees that are weakened by disease, drought, or fire. But some species, such as the Asian longhorn beetle (*Anoplophora glabripennis* Motschulsky, 1853), which has invaded northeastern North America, can attack the healthy trees of many species. The intricate patterns on the elytra (wings) of many species help them to blend in with the bark of the trees on which they feed.

Vocabulary word

larvae: a young, wingless stage before metamorphosis takes place and the insect becomes an adult

Review questions

What type of trees do most species attack?

Most species only attack trees that are weakened by disease, drought, or fire

Where do most longhorn beetles lay their eggs?

Most longhorn beetle eggs are laid under pieces of bark

Wallace's longhorn beetle (*Batocera wallacei*)
Collection of the Essig Museum of Entomology, University of California, Berkeley

Melolontha japonica 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.002

Cockchafer Beetle & House Fly Models

The cockchafer beetle *(Melolontha melolontha* Linnaeus, 1758) is a well-known plant pest in Europe, and one of the first beetle species named by Carl von Linné (a.k.a. Linnaeus), the Swedish biologist who created the binomial system for naming species. This *papier-mâché* model was made by the manufactory of French surgeon Dr. Louis Auzoux in 1881 as a teaching tool for entomology students. All of the internal and external organs are labeled with their proper names in a style he called *anatomie clastique* ("broken in pieces"). Auzoux created similar models of humans, horses, and other animals.

Cockchafer beetle *(Melolontha melolontha)* model 1881
Made by the firm of Dr. Louis Thomas Jérôme Auzoux (1797–1880)
Paris
papier mâché, paint, adhesive
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.001

Vocabulary word

binomial system: a system used to name species; each species is given a name that consists of two parts—the first is the genus to which the species belongs; the second part is the species name

Review questions

What did Carl von Linné do?

He was a biologist who created the binomial system for naming species

What is the cockchafer beetle known for?

It is a well-known plant pest in Europe

Glaucopsyche xerces 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.009

Endangered and Extinct Species

Lists of endangered and extinct insects are always dominated by butterflies. Butterflies are charismatic daytime flyers that visit flowers on sunny afternoons. So, it is easy to understand why people notice when they disappear. No doubt, countless species of insects are on the brink of extinction, or already gone, which we will never know about because they are small, dull, or hide from view. Small gossamer-wing butterflies (blues, coppers, and hairstreaks) in particular are often limited to open habitats in small geographic ranges with very specific food plant requirements. A new housing development or golf course can easily erase a population. For instance, the Xerces blue butterfly, first described in 1852, once graced the sand dunes of San Francisco's shoreline, but went extinct in the 1940s as a result of urban development. Many other San Francisco Bay Area species are clinging to small patches of habitat at dangerously low population levels. Even the once ubiquitous monarch butterfly has undergone an eighty-five percent decrease in population size in recent years due to host plant and habitat loss, diseases, and invasive species. Extinction is forever, and awareness is our best weapon to combat it.

Display drawer of endangered and extinct insect species

Collection of the Essig Museum of Entomology, University of California, Berkeley

L2019.0401.025

Vocabulary word

ubiquitous: existing everywhere at the same time

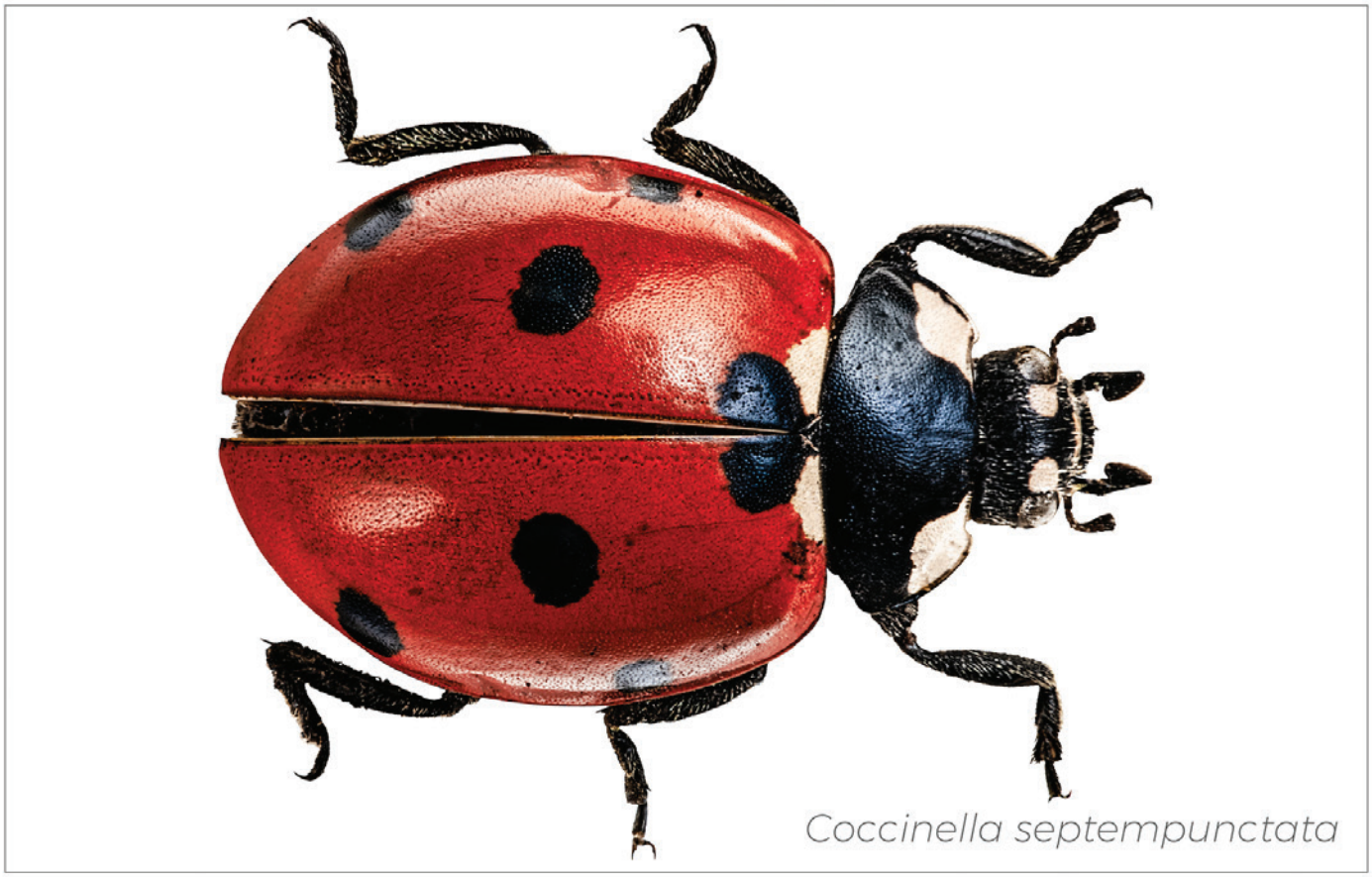
Review questions

What butterfly went extinct in San Francisco in the 1940s?

The Xerces blue butterfly

What are some of the reasons that insects go extinct?

Host plant and habitat loss, diseases, and invasive species



Coccinella septempunctata 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.020

Display drawer of ladybug (Coccinellidae) specimens

Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.053

Ladybugs

Ladybird beetles, also known as ladybugs, all belong to the beetle family Coccinellidae. Ladybugs come in a variety of colors and sizes. Brightly colored species (like orange and black) are toxic—they exude a small, yellow drop of hemolymph (insect blood) from their leg joints that tastes bad to predators, such as birds and lizards, who can see color. Ladybugs are best known as voracious predators of aphids and other garden pests. Gardeners often buy clusters of ladybugs to control such pests, as a single ladybug might eat up to five thousand aphids in its lifetime. Larvae (immature stages) of ladybugs look like tiny, fuzzy alligators and are also predators.

People have moved many species around the world to help control pest insects. This practice is called Classical Biological Control or Biocontrol. The first modern day success story of biocontrol was the introduction of the Vedalia beetle (*Rodolia cardinalis* Mulsant, 1850), a species of ladybug, from Australia into California in 1888 to control cottony cushion scale, a major insect pest of oranges and other citrus trees. Another species, the convergent ladybug (*Hippodamia convergens* Guérin-Méneville, 1842), is collected in vast quantities in California and shipped around the world for pest control.

Vocabulary word

aphids: aphids are tiny, destructive insects that feed in clusters on plant sap, causing damage to plants

Review questions

What are ladybugs best known for?

They are best known as voracious predators of aphids and other garden pests

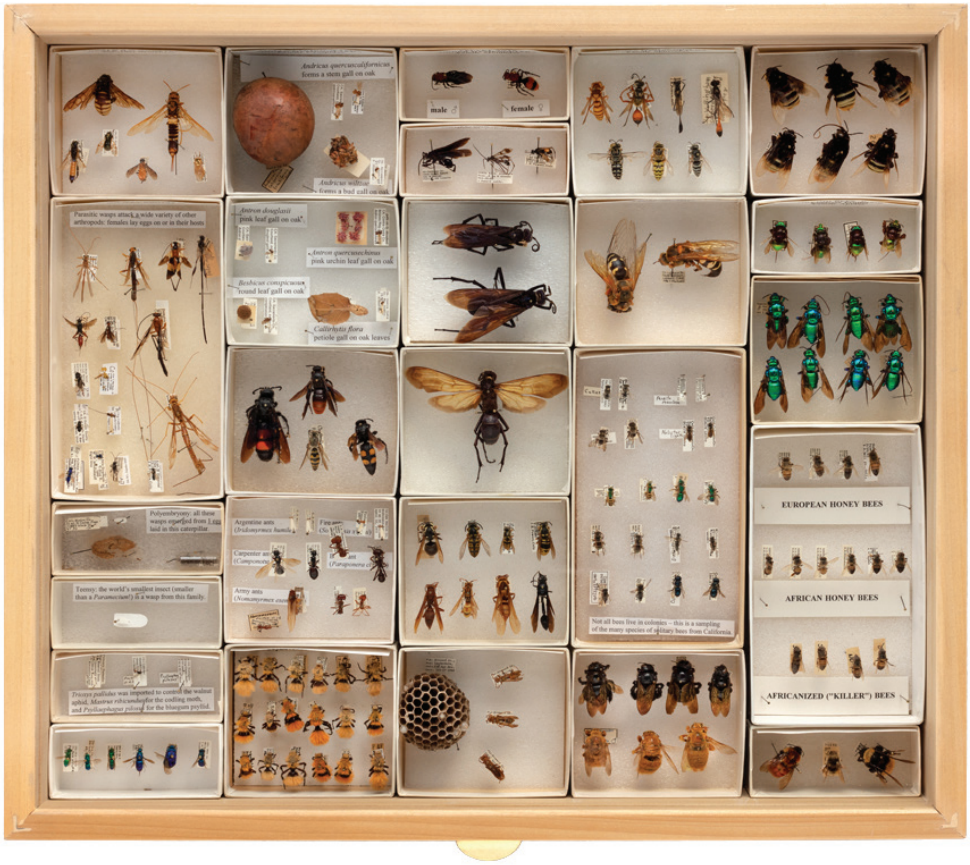
How many aphids might a ladybug eat in its lifetime?

Up to five thousand

People have moved many species around the world to help control pest insects. What is this practice called?

Classical Biological Control or Biocontrol

Sphex ichneumonius 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.017



Bees, Wasps, and Ants

Bees, wasps, and ants all belong to the order Hymenoptera, meaning membranous wings. Most conspicuous and well-known are social species, including honey bees, yellowjacket wasps, and ants. These insects live in societies with overlapping generations and complex visual and chemical communication systems. For example, honey bees do a "waggle dance" to communicate the distance, direction, and quality of nectar and pollen resources. Most bees, however, are solitary. They provision each egg with just enough pollen and nectar to grow to adulthood, and then fly away forever. When foraging among flowers, bees accidentally drop pollen, which pollinates the plant. Nearly 4,400 different species of bees inhabit North America, and more than 20,000 species of bees exist worldwide.

Many wasp species are parasitoids. Whereas predators kill and eat their prey and parasites feed without killing their hosts, parasitoid larvae feed on or inside their insect host for days or weeks while it is alive, eventually killing it before emerging as adults. Because many parasitoids prefer very specific prey species, they are often used to control pests. Other wasps are herbivores, such as sawflies that feed on leaves, needles, and wood. Gall wasps cause plants to grow tumors where the wasps' larva develops protected from the outside world.

Display drawer of bee, wasp, and ant specimens (Hymenoptera)
L2019.0401.048

Vocabulary words

membranous: animal-like tissue that lines an organ or connects a body part

conspicuous: standing out, attracting attention

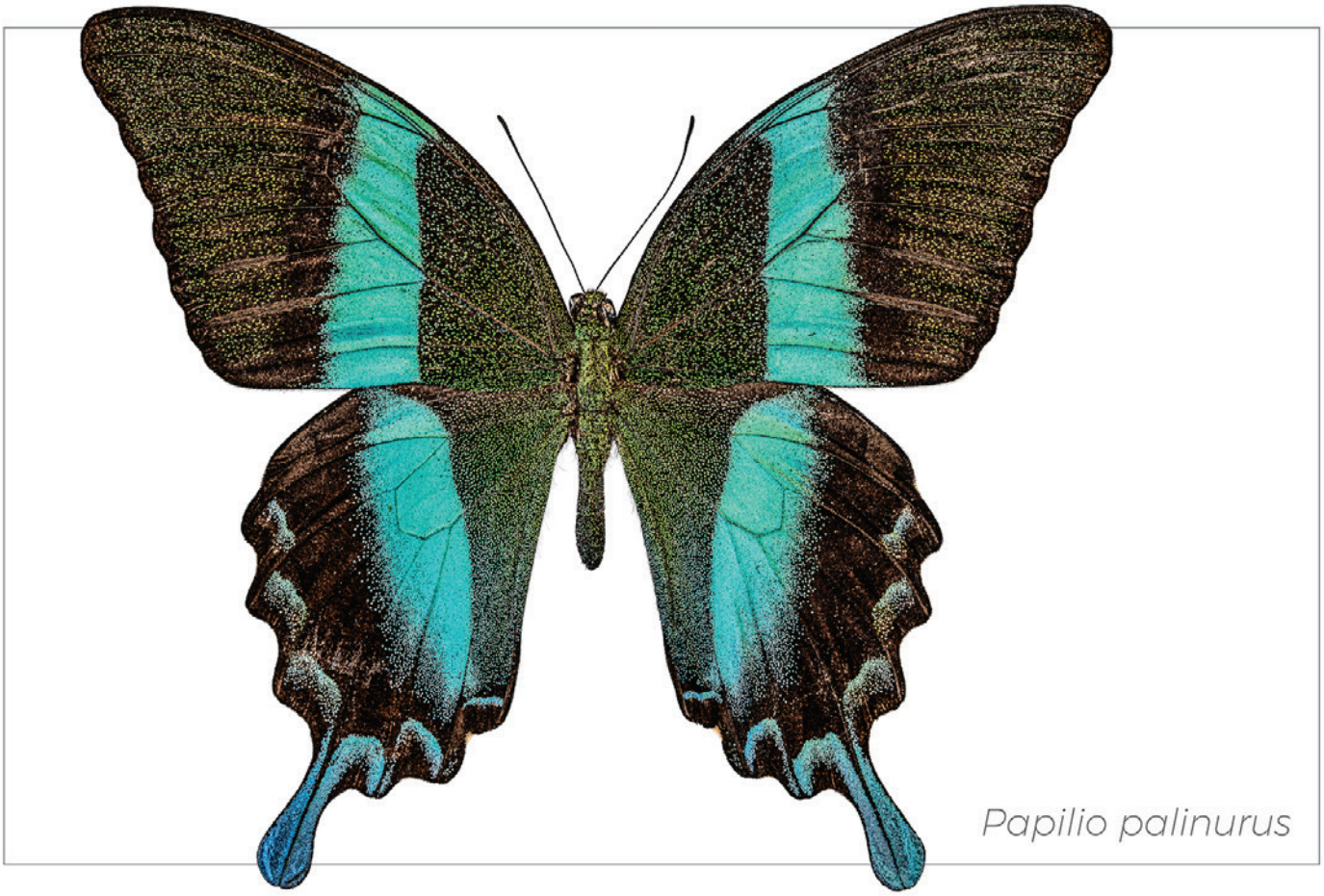
Review questions

Why do honey bees do a waggle dance?

To communicate the distance, direction, and quality of nectar and pollen resources

How many species of bees exist worldwide?

20,000



Papilio palinurus 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.014

Display drawer of blue and green butterflies (Rhopalocera) and colorful beetles (Coleoptera)
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.045

Structural Color

Some insects are brightly colored while others appear dull or drab. Either way, just like melanin in people, insects have pigments that give them their colors (black, brown, red, orange, yellow, etc.)—with the exception of blue and some shades of green. Blue pigments are incredibly rare in nature. Just as a prism breaks light into the colors of the rainbow, so too do nano-structures on the surface of insects. In some cases, these nano-structures resemble spruce trees. The different wavelengths (colors) of light bounce around within these nano-structures and interfere with each other, allowing only the blue wavelengths to escape. In other cases, light refracts within very thin layers on the surface of the insect allowing only blue to escape. For butterflies, these structures are part of the microscopic scales that cover their wings and bodies. For instance, the iridescent green of the emerald swallowtail (*Papilio palinurus*) displayed in the photograph on the previous page, is a result of blue and yellow visible reflections producing the perception of green when mixed together. For beetles and many other insects, these nano-structures are layered upon their exoskeleton. These nano-structures are also responsible for the blue feathers on birds and the blue irises of blue-eyed humans.

Vocabulary word

melanin: pigments found in living organisms that account for the color of their hair, skin, feathers, fur, etc.

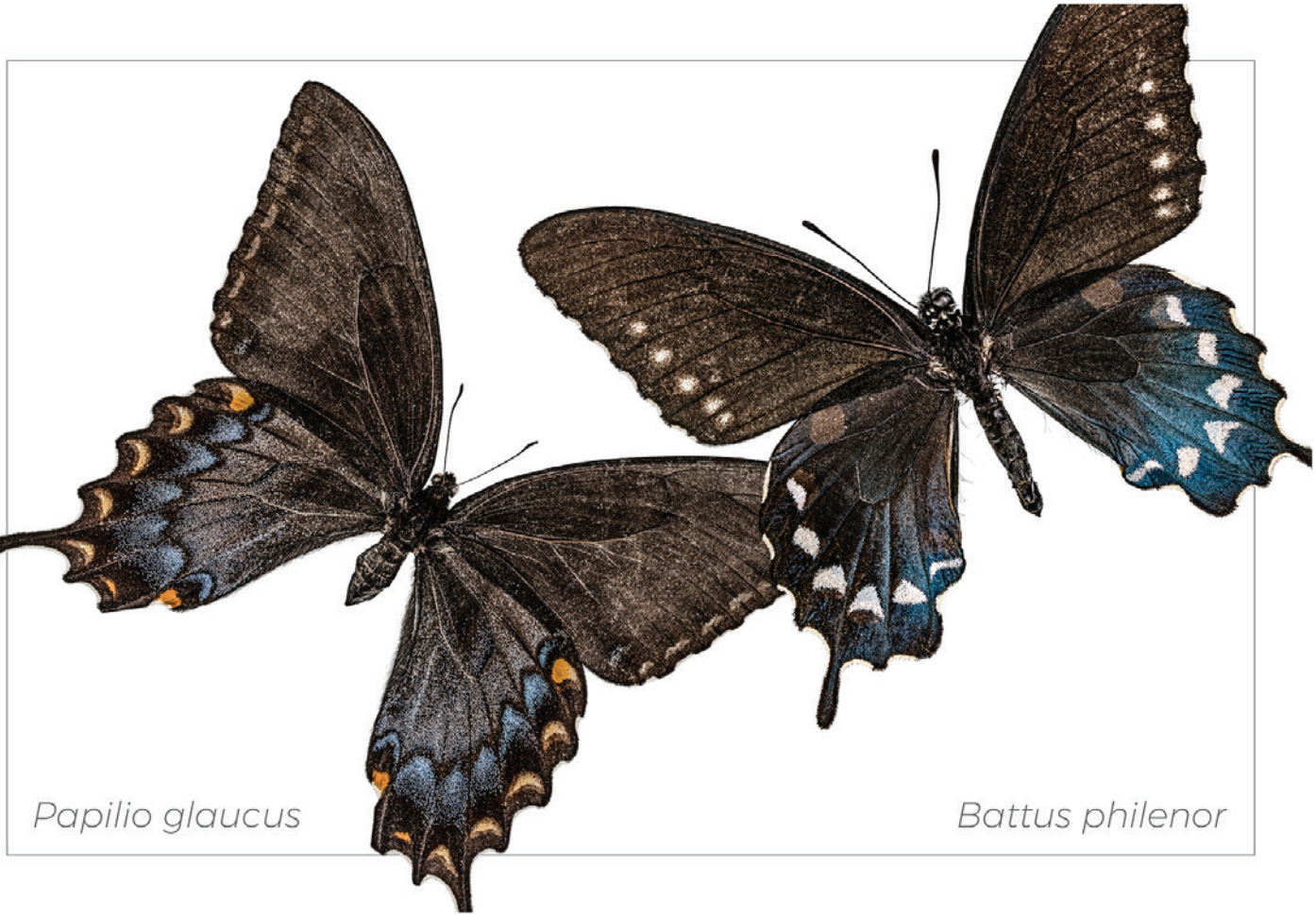
Review questions

Insects have pigments that give them their colors, with the exception of which two colors?

Blue and some shades of green

Nano-structures are responsible for reflecting many shades of blue on insects. What else are they responsible for?

The blue feathers on birds and the blue irises of blue-eyed humans



Papilio glaucus* and *Battus philenor 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.013

Display drawer of insect specimens
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.044

Mimicry

Some insects are difficult to see because they blend in with their environment, while others seem to advertise themselves with bright colors. Insects with bright, high-contrast colors—black and orange or black and yellow—are often noxious and do not taste good, or may bite, or sting. They evolved these repellant color patterns as a result of predators more easily recognizing the brightly colored individuals in the population. In some places, several different kinds of noxious insects have evolved similar repellant color patterns. Referred to as Müllerian mimicry, this allows predators to learn to quickly identify these patterns.

Some insects that are palatable have evolved color patterns similar to the noxious species. Called Batesian mimicry, these imposters trick visual predators into thinking they will taste bad. Visual predators are not born knowing that aposematically colored insects taste bad; it is something they learn from experience. If there were more mimics (palatable insects) than models (noxious insects), predators would have a hard time learning this lesson. For Batesian mimicry to work, there needs to be more models than mimics in the area.

Viceroy butterflies mimic monarch butterflies who consume toxic milkweed plants as caterpillars, making them unpalatable. Entomologists originally thought viceroys exhibited Batesian mimicry. They recently discovered viceroys are actually unpalatable to birds and indeed demonstrate Müllerian mimicry.

Vocabulary

palatable/unpalatable: pleasant to taste/unpleasant, awful tasting

aposematic: having bright colors or patterns that predators learn to identify and avoid

noxious: harmful or poisonous

Review questions

Why have some noxious insects developed bright, high contrast colors?

They evolved these repellant color patterns as a result of predators more easily recognizing the brightly colored individuals in the population

Why is it that other imposters also display these same colors?

Some insects that are palatable have evolved color patterns similar to the noxious species. Called Batesian mimicry, these imposters trick visual predators into thinking they will taste bad

Chrysiridia rhipheus 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.016

Display drawer of butterfly and moth (Lepidoptera) specimens

Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.047

Butterflies and Moths

Butterflies are a type of moth. They evolved from moth ancestors around 70 million years ago. Butterflies and moths are covered in microscopic scales, like the overlapping scales on fish. Each of these scales can be differently colored—together forming the mosaic patterns we see on their wings and bodies. We most often think of butterflies as brightly-colored day flyers, visiting flowers in the sunshine, and moths as dull-colored, nocturnal creatures. But there are many brightly colored moths that fly during the day, some mimicking bees and wasps. Likewise, there are dull-colored butterflies that prefer the shade of the forest. The Madagascan sunset moth (*Chrysiridia rhipheus*) illustrated in the photograph above is arguably the most striking of the daytime-flying moths.

One way to tell butterflies and moths apart is by the antennae. Butterflies have an inflated segment at the end of their thread-like antennae. Moths have a great diversity of antennae—hairy, feathery, thick, or thread-like, but no inflated segment at the end. Like all insects, the antennae are lined with chemical sensors to help them find food and mates. The large, feathery antennae of male giant silk moths allow them to detect the pheromones (scent) of females from miles away.

Vocabulary questions

nocturnal: primarily active at night
inflated: puffed up, expanded

Review questions

What is one way to tell butterflies and moths apart?

By the antennae, butterflies have an inflated segment at the end of their thread-like antennae. Moths have a great diversity of antennae—hairy, feathery, thick, or thread-like, but no inflated segment at the end

When did butterflies evolve?

They evolved from moth ancestors around 70 million years ago

Phyllium pulchrifolium 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.039

Display drawer of camouflage insect specimens
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.042

Camouflage

Insects are a favorite food of birds, lizards, rats, mice, and even other insects. Because of this, insects have evolved many strategies to avoid getting eaten. One strategy, called crypsis or camouflage, is to hide in plain sight by blending in with the background. Insects do not have the ability to change their colors to blend in with their surroundings like a squid or an octopus. Instead, they evolved to have color patterns that are similar to the surfaces they inhabit, such as leaves and tree bark. A common theme in camouflage is broken lines or color mosaics. Visual predators, including birds, can learn to spot large areas of the same color, but have a harder time when these areas are interrupted by dashes and splashes of other colors. In addition, very few surfaces in nature have large areas of one color. In a white box, these insects seem very colorful and easy to spot. But on their natural substrates in the wild they virtually disappear.

Stick insects, as their name implies, resemble sticks, twigs, or branches, while leaf insects look surprisingly like leaves. Together, these herbivores belong to the order Phasmatodea, mimicking vegetation to disappear from view. Even the eggs they deposit come in disguise, typically resembling the seeds of certain plants.

Vocabulary words

substrate: the surface or material on or from which an organism lives, grows, or obtains its nourishment

mosaic: composed of a combination of different elements

Review question

What are some of the things that insects oftentimes resemble to hide from predators?

Sticks, twigs, branches, leaves, and bark

Katydid resembling a fresh leaf c. 1970s–90s
Photograph by Edward S. Ross (1915–2016)
Collection of the Essig Museum of Entomology, University of California, Berkeley
R2019.0411.002

Stick insect on a leaf c. 1970s–90s
Photograph by Edward S. Ross (1915–2016)
Collection of the Essig Museum of Entomology, University of California, Berkeley
R2019.0411.004

Libellula forensis 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.035

Display drawer of dragonflies (Anisoptera) and damselflies (Zygoptera)
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.017

Dragonflies and Damselflies

Dragonflies, and their more slender cousins, the damselflies, were among the first insects to evolve wings around 325 million years ago—long before dinosaurs roamed the earth. Shaped much like a helicopter, they use direct flight muscles—attached directly to the wings—to pull their wings up and down. However, because of how these muscles are attached, the wings cannot fold flat over their backs. Most other insects have indirect flight muscles, which change the shape of the thorax to which the wings are attached, causing the wings to flap up and down. This means they can fold their wings flat over their backs, making it easier to crawl around on plants, wood, and soil.

Adult dragonflies are aerial acrobats with large round eyes, able to hover or fly in any direction and even mate on-the-wing. They can fly at speeds up to thirty-five miles per hour. Their legs are lined with spikes, allowing them to capture and eat their prey while flying. Young dragonflies and damselflies, called nymphs or naiads, are aquatic predators, living in ponds, lakes, streams, and rivers.

Vocabulary word

aerial: occurring in the air

Review question

How fast can dragonflies fly?

They can fly at speeds up to thirty-five miles per hour

Dactylotum bicolor 2018
Photograph by David Garnick (b. 1955)
archival pigment print
Courtesy of the artist
R2019.0409.018

Display drawer of Orthopteroid specimens
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.051

Grasshoppers, Crickets, and their Relatives

Roaches, crickets, grasshoppers, and mantids all belong to the superorder Orthopteroidea and share something in common—they do not have a pupal stage like butterflies and beetles. Instead, young grasshoppers and roaches, called nymphs, look like adult grasshoppers and roaches, but without wings. The wings begin to develop on the outside of the body in older nymphs, rather than inside a pupa.

Crickets and katydids are well-known for the "songs" or chirps they produce by stridulation—that is, rubbing the "scraper" found at the base of one wing across a series of ridges or "file" on the other wing. These vibrations carry through the wings which amplify the sound. The frequency of the chirps fluctuates with temperature—warmer crickets chirp faster. To approximate the temperature in Fahrenheit, count the number of chirps in fourteen seconds and add forty. Some grasshoppers sing by rubbing a file on their hind leg against a thickened ridge on their front wing. Jerusalem crickets, by contrast, make sounds by drumming their abdomen on the ground. Males of these various species use these "songs" to attract females or ward off other males from their territory. Crickets have "ears" on their front legs, while grasshoppers have them on their abdomen, and mantids have one on the middle of their chest between their hind legs.

Vocabulary words

nymph: a juvenile stage of an insect before it develops wings

mantids: a group of approximately 1800 predatory insects with long front legs

Review questions

What do roaches, crickets, grasshoppers, and mantids have in common?
They do not have a pupal stage like butterflies and beetles. Instead, young grasshoppers and roaches, called nymphs, look like adult grasshoppers and roaches, but without wings

Where are crickets' "ears"; where do grasshoppers have "ears"?
Crickets have "ears" on their front legs, while grasshoppers have them on their abdomen

Chrysochroa castelnaudi 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.003

Various wood with insect damage
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.005–.007

Termites & Other Wood Feeders

Most animals do not eat wood because of tough lignin fibers and cellulose sugars that are difficult to digest. Some insects, however, such as termites, bark beetles, and sawfly wasps, have evolved the ability to feed on dead and dying trees. Termites are able to digest wood thanks to symbiotic microbes (bacteria and protozoa) in their hindgut or "stomach" that break down cellulose into short-chain fatty acids, which the termites use as nutrition. Other insects, including some ants and bees, cannot digest wood as food, but rather carve it out to create nesting cavities for their young. Openings caused by insects allow fungi and bacteria to penetrate wood and help recycle the nutrients. This is beneficial in forests, but a detriment to homeowners. Most wood used in construction is now pressure-treated or kiln-dried to kill any existing insects. But this does not stop insects from infesting wood years after treatment, or when it becomes wet from leaks, contact with soil, or exposure to the elements. Healthy trees defend themselves by pushing out attacking insects with their resinous sap. Sometimes insects get trapped by these resins, which can harden over millions of years and become amber.

Vocabulary words

lignin: a substance in plants that makes them woody

cellulose: the most abundant substance in plants, non-digestible to humans, but consumed by many animals; it is processed to make paper

protozoa: single-celled organisms

Review questions

Why don't most animals eat wood?
Most animals do not eat wood because of tough lignin fibers and cellulose sugars that are difficult to digest

What are some insects that have evolved the ability to digest wood?
Termites, bark beetles, and sawfly wasps

Scarabaeus sacer 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.008

Display drawer of scarab beetle (Scarabaeidae) specimens
Collection of the Essig Museum of Entomology, University of California, Berkeley
L2019.0401.024

Scarab Beetles

Dung beetles, June bugs, chafers, and scarabs all belong to the beetle family Scarabaeidae. They all have lamellate antennae, which means the ends of their antennae can spread like fingers. Goliath beetles are the largest insects on Earth in terms of body mass. Some species, such as rose beetles and chafers, can be abundant pests in gardens, feeding on roots as larvae and on leaves and flowers as adults. Dung beetles and other detritivores are responsible for recycling nutrients and preventing animal waste from building up and breeding pest flies. In places where cows and other large mammals are not native, dung beetles have been purposely introduced to help control their waste.

Egyptians were fascinated by adult scarabs (Scarabaeus sacer Linnaeus, 1758) rolling balls of dung and burying them in the ground, just as the sun rolls across the sky and then disappears beneath the horizon until the next day. Ancient Egyptians also observed how scarabs suddenly realize that they have wings that allow them to fly off and explore. In ancient Egypt, the scarab beetle was a symbol of rebirth and transformation used on seals, amulets, and jewelry, and also appeared on their god Kheper, who has a scarab head. Another genus is named Sisyphus for the mythological Greek king whose punishment for thinking he was more clever than Zeus was to forever roll a rock up a hill.

Vocabulary word

detritivore: an animal that feeds on dead plant and animal material

Review questions

What do all scarabs have in common?

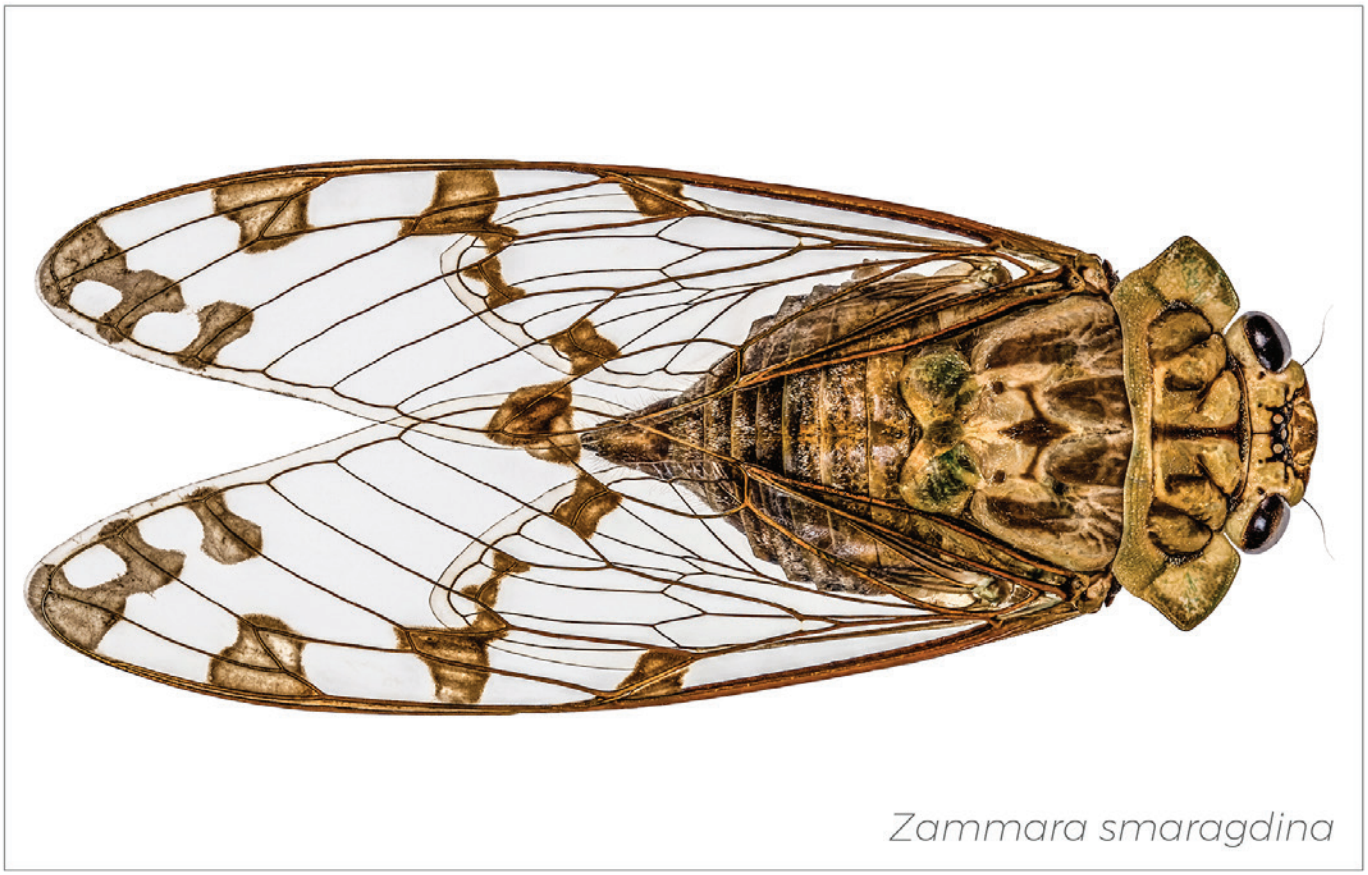
They all have lamellate antennae, which means the ends of their antennae can spread like fingers

What are the largest insects on Earth in terms of body mass?

Goliath beetles

Bilderbuch fur Kinder Vol. VII 1810
Carl Bertuch (1777–1815)
Leipzig, Germany
Courtesy of Cavallini & Co., South San Francisco
L2019.0410.004

This illustration depicts beetles that belong to the family Scarabaeidae.



Zammara smaragdina 2018
Photograph by David Garnick (b. 1955)
Courtesy of the artist
R2019.0409.019

Display drawer of Hemiptera specimens
Collection of the Essig Museum of Entomology,
University of California, Berkeley
L2019.0401.052

True Bugs

When you say "bug" to entomologists, they assume you mean a true bug—an insect in the order Hemiptera. This group includes stink bugs, kissing bugs, water striders, cicadas, aphids, and many more. They all have stiff, beak-like mouthparts, like a hypodermic needle, that can pierce through plant tissue or other insects' exoskeletons. By injecting saliva with digestive enzymes into their food, they are able to suck the fluids out with their straw-like mouthparts.

One group, cicadas, live underground as nymphs (immature stages) and emerge during the warm days of summer, filling the air with their buzzing. Some produce sounds of over one hundred decibels. Most cicadas have a one-year life cycle, with adults emerging each summer. But some species live underground for seven, eleven, or seventeen years (all prime numbers!) before emerging for only a few weeks as adults—all at the same time. Many cultures have captured cicadas in works of art, particularly in China where they symbolize rebirth and immortality.

Some bugs, such as lygus bugs and brown marmorated stink bugs, are serious agricultural pests, attacking fruits, vegetables, and other crops. Others, like big-eyed bugs, are important predators of these pests. Many true bugs are aquatic as both nymphs and adults.

Vocabulary

immortality: the ability to live forever

rebirth: to be born again

entomologist: a scientist who studies insects

Review questions

What do all true bugs have in common?

They all have stiff, beak-like mouthparts, like a hypodermic needle, that can pierce through plant tissue or other insects' exoskeletons

Wasp (*Vespula vulgaris*) sculpture 2008
Gar Waterman (b. 1955)
New Haven, Connecticut
steel, copper, nickel plate
Courtesy of the artist
L2019.0402.001

Insects in Art

From humble ants to dragonflies and zebra swallowtails, insects have captured the imagination of artists and poets alike. Whether buzzing through the air, clinging to rocks in a stream, or rustling through the undergrowth, insects abound. However, apart from the quintessential butterfly, the intricate beauty and delicate features of most insects are overlooked due to their small size. Artist Gar Waterman brings this magnificence to life with this wasp sculpture. Its long legs and steel construction illustrates the insect's agility and strength.

Unlike humans, birds, and other vertebrate animals that contain an internal skeleton, insects have an exoskeleton that is finely textured with embedded color pigments and internal ridges for muscle attachments. Rather than lungs, insects have tiny holes (spiracles) in their sides and tubes (trachea) through which oxygen passively diffuses. For its size, the insect exoskeleton is incredibly strong, yet lightweight. However, insects could never grow to the size of this sculpture. They would suffocate for lack of oxygen and probably collapse under the weight of their own exoskeletons, which would have to be much thicker and heavier to maintain their shape.

Your visit to SFO Museum

SFO is a great destination for your class

- Museum and library admission, educational programs, and tours are all free.
- Educational programs and tours can be customized for higher grades, mixed ages, and special needs students.

You can extend your visit

- Bring your lunch and sit in the public dining areas adjacent to the aviation museum, or select from the many restaurants at SFO.
- Take a tour of the airport and ride the AirTrain (by prior arrangement and availability).
- Meet the trained service dogs of the SFPD Airport K-9 Unit and see them in action (by prior arrangement and availability).
- Visit other museum exhibitions at SFO. (Schedules are subject to change, please check www.flysfo.com/museum/exhibitions for updated information).

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Take SamTrans Routes KX and 292 directly to SFO.

Take Caltrain to BART for service to SFO.

- By School Bus/Charter Bus:
Parking for buses is available at no charge by prior arrangement only.

- By Car:
Groups booked for educational programs can park in Airport garages and Airport parking tickets can be validated at the aviation museum at no charge.

For more information on transportation to SFO go to: www.flysfo.com