Invertebrates of Cold Canyon

The words "animals of Cold Canyon" probably bring to mind deer, newts, hummingbirds and the like. However, most animals in Cold Canyon, measured in sheer numbers or in species diversity, are invertebrates: insects, spiders, slugs, worms, and other animals lacking backbones. In fact, invertebrates comprise over 95% of the millions of species inhabiting the earth. Many of these organisms live only in the ocean; however, a huge diversity of arthropods (invertebrates like insects and spiders) live in the reserve, and other invertebrates such as worms, slugs, and snails are present but less conspicuous. To put the levels of diversity into perspective, realize that the reserve holds no more than fifty mammal species but probably thousands of insect species and hundreds of spider species, most of which have not even been identified.

Invertebrates are often ignored or dismissed by the average nature lover, who is usually only concerned with the pesky buzzing of mosquitoes or the eerie tickle of a tick. Most of the invertebrates in Stebbins Cold Canyon Reserve, however, are harmless to humans and even entertain the keen observer with a wealth of interesting natural history. While hiking the trails or enjoying lunch by the creek, take note of the invertebrate world around you. Colorful butterflies may pause to "mud-puddle" on the moist soil of the streambed, where they sip essential minerals. Water striders will entertain you with their pulsing dance on the water's surface as dragonflies hover above, their iridescent bodies glinting in the sun. Leopard slugs move imperceptibly across fallen leaves and moss, leaving behind a trail of shimmering slime.

Invertebrates like this leopard slug abound in Cold Canyon.

Habitats

Because invertebrates are so small compared to us, tiny changes in the environment that we barely notice may constitute completely different habitats for them. Our eyes readily perceive the canyon bottom as a single riparian plant community habitat. However, if we could observe the riparian community through a bug's eye, we would find a multitude of microhabitats determined by plant composition, relative moisture, soil type, sun exposure, or temperature (Table 1). Some invertebrates are generalists and range freely across all these microhabitats. Specialists, on the other hand, can be found only in one or two of these microhabitats and cannot survive elsewhere. For instance, wasps and dragonflies, which are generalist predators, can be found flying in many different communities. However, the valley elderberry longhorn beetle (*Desmocercus californicus dimorphus*), a specialist herbivore, spends the vast majority of its life inside the branches of one creekside elderberry bush (*Sambucus mexicana*). As observers of nature, we must realize that differ-

INVERTEBRATES

Table 1. Microhabitats of common invertebrates found in the plant communities of Cold Canyon.

Plant Community	Microhabitat	Common Invertebrates
Riparian	Pools	Backswimmers, waterboatmen, giant water bugs, dragonfly and damselfly nymphs
	Under stones	Stonefly and mayfly nymphs
	Rock surfaces	Black fly larvae
	Water surface	Water striders, whirligig beetles
	Emergent plants	Dragonflies and damselflies, crane flies, orb-weaving spiders
	Streamside	Toad bugs, slugs
Live oak woodland, Savanna , Chaparral, Grassland	Under ground	Ants, bees, wasps, earthworms
	Ground surface	Antlions, grasshoppers, beetles
	Leaf litter, under rocks	Earwigs, predaceous ground beetles, snails, slugs, scorpions, ground spiders, millipedes
	Rotting logs	Carpenter ants, termites, pill bugs
	Low-growing plants	Aphids, stink bugs, butterfly larvae, ticks, spiders
	In woody vegetation	Valley elderberry longhorn beetles, bark beetles
	Tree canopy	Moths, aphids, lacewings, mites
	Flowers	Butterflies, bees, bee flies, ants, beetles, crab spiders
	Galls	Wasps, moths

ent animals view the world at different spatial scales: a puddle to a coyote may be a water strider's entire universe.

In your quest to discover the invertebrates of Cold Canyon, keep in mind that they thrive in both aquatic and terrestrial habitats. As you hike up the canyon, linger by the creek and look for invertebrate life. The stream bank is itself an active invertebrate habitat. Large slugs move lazily through the leaf litter; spiders patrol the shore in search of prey; and a multitude of worms and nematodes lurk just below the surface. On, in, and under the water, riparian and aquatic invertebrates thrive. Surprisingly, the greatest diversity of aquatic insects is often hidden in the debris and rocks on the bottom of the creek. Above them on the creek's surface, some insects have the remarkable ability to walk on water. Sitting next to a pool in springtime will allow you to observe numerous insects as they glide, buzz, and whirl in an aesthetically pleasing but seemingly purposeless dance. In actuality these highly adapted insects are actively hunting or courting as they swirl across the surface. Look for other insects swimming about in calm, open water or clinging to aquatic vegetation. Spider webs, mollusk shells, and hollow insect pupal cases can often be found still attached to a bit of vegetation or a rock, evidence of the ubiquitous presence of invertebrates.

As you move away from the creek, look for invertebrates on different parts of the woodland trees and shrubs. A single oak is like a thriving arthropod metropolis; beetles,

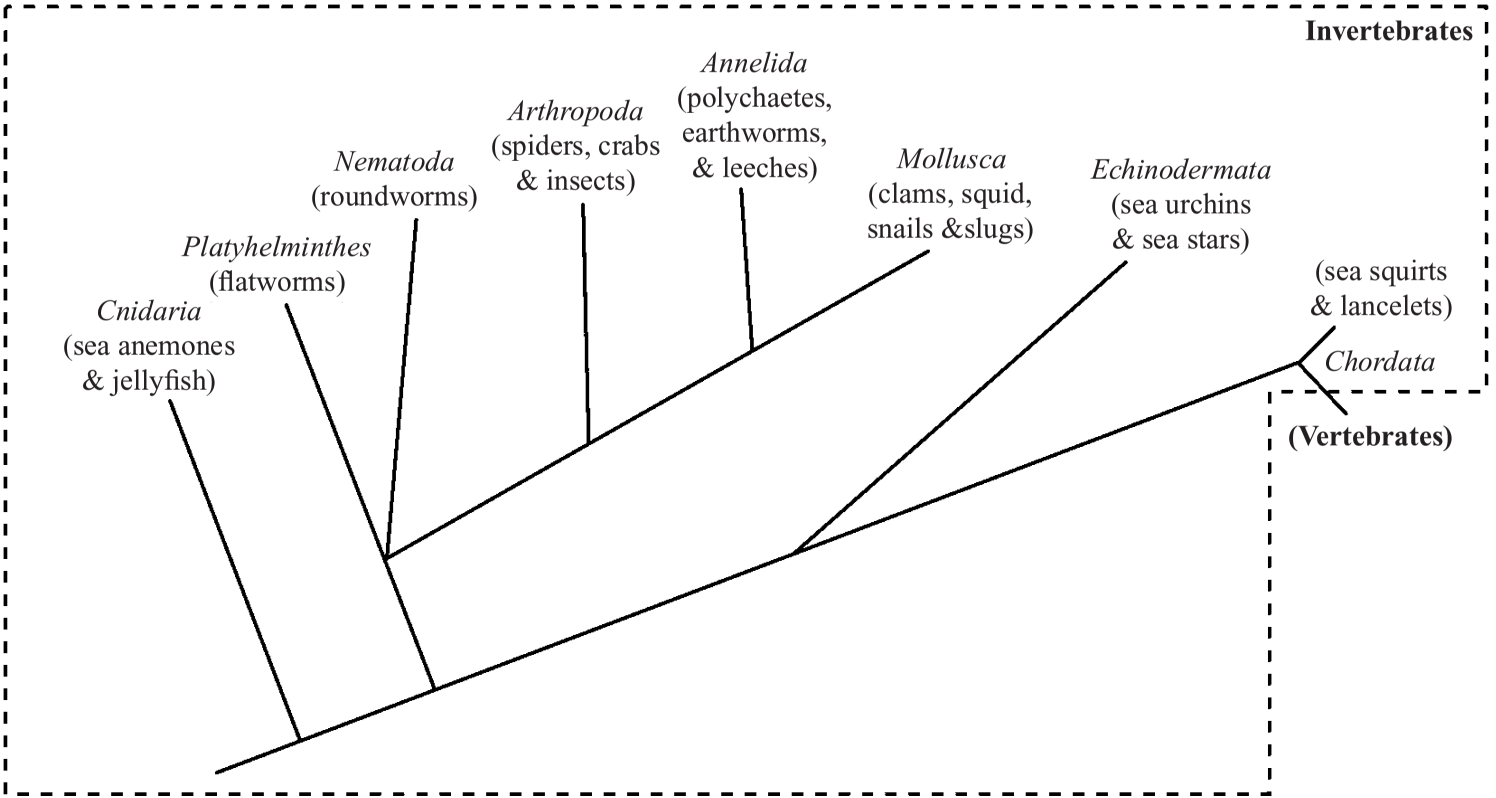
moths, and spiders hide in its bark, while other insects live off the canopy's leaves. The grasses and flowering plants will harbor yet a different set of invertebrates. As you look at a flower, notice that some insects eat the leaves or stems of the plant, other insects only sip nectar, and certain spiders have evolved to hunch motionless on the plant, waiting for these passersby. Also, do not miss the activity right beneath your feet. Cold Canyon's worms and many of its insects can be found in subterranean burrows. Ants create underground colonies, which are sometimes parasitized by other insects.

Taxonomy

Taxonomists classify each organism by placing it into a kingdom, phylum, class, order, family, genus, and species. These groups are hierarchically organized, so related species share a common genus, related genera (plural of "genus") share a common family, related families share a common order, and so forth. The accompanying evolutionary tree on page 42 shows the relationships among the most common invertebrate groups as they are currently understood by biologists. Groups connected by a single branching point share a common ancestor, and are thus more closely related than phyla separated by several branching points. For instance, the phyla Mollusca, Annelida, and Arthropoda are each more closely related to each other than they are to the phylum Chordata (the phylum that includes mammals and other vertebrates). Likewise, the phylum most closely related to Chordata is Echinodermata.

The evolutionary tree also indicates that the term "invertebrates" is not a rigorous classification because it refers to a hodgepodge of animals whose only commonality is that they do not belong to our group, the subphylum Vertebrata. Nevertheless, we divide Cold Canyon's fauna into invertebrates and vertebrates (in the next chapter) for several reasons. First, people can usually distinguish between a vertebrate and an invertebrate animal, even if they have trouble distinguishing the different subgroups. Second, although people can usually tell the difference between two closely related vertebrate species, such as bald and golden eagles, the same is often not true for invertebrates: some related species cannot be differentiated without a microscope. Fortunately, many invertebrates share characteristics at higher taxonomic levels, such as at the level of the family or order. For example, distinguishing between Lepidoptera (the order that comprises the butterflies and moths) and Odonata (the order including dragonflies and damselflies) is relatively easy. Third, the sheer diversity of the invertebrate world defies the scope of this field guide. For example, the order Lepidoptera is represented by at least 500 species of moths and butterflies in the reserve. Thus, in Cold Canyon, that single order has ten times the diversity of the mammals, and a guide that offered descriptions of every worm, spider, insect, and mollusk that occurred in the reserve would be far too heavy to take along on a hike! Finally, the division highlights the fact that all vertebrates of Cold Canyon have been identified to species level, but many fewer invertebrates in Cold Canyon have achieved this level of identification. Hence, the distinction between vertebrates and invertebrates indicates that we simply do not know much about the species diversity of invertebrates.

Nevertheless, the information in this chapter will help you to identify many of the reserve's invertebrates. Table 2 provides a list of the main invertebrate groups covered in this field guide. We focus primarily on mollusks, spiders, and insects, and cover other groups only briefly. In most cases, we identify distinctions only among the major groups of organisms, i.e., at the phylum and order levels. However, some families, genera, and



The major phyla of the animal kingdom. As indicated by the dotted line, most phyla are invertebrates, and vertebrates are only a part of the phylum Chordata.

Table 2. The major invertebrate phyla and classes of Cold Canyon.

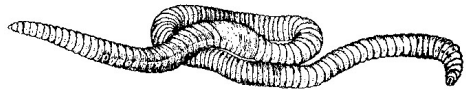
PHYLUM/Subphylum	Class
ANNELIDA	Oligochaeta (earthworms)
MOLLUSCA	Gastropoda (slugs and snails)
ARTHROPODA	
Chelicerata	Arachnida (arachnids)
Crustacea	Malacostraca (amphipods, sowbugs, and pill bugs)
Uniramia	Diplopoda (millipedes) Chilopoda (centipedes) Insecta (insects)

species can be readily identified and are covered individually in the text. For example, the black and iridescent-green wings of the pipevine swallowtail (Papilionidae: *Battus philenor*) differentiate it from all other butterfly species in the reserve. In such cases, this field guide provides information to allow observers to spot these particular species.

Annelids (Phylum Annelida)

Annelids are segmented worms and include polychaetes (class Polychaeta), leeches (class Hirudinea), and earthworms (class Oligochaeta). Polychaetes are strictly marine and free-living; leeches are aquatic and usually parasitic; and earthworms are free-living in moist detritus or soil. Cold Canyon obviously does not support polychaetes and probably does not have leeches because of a lack of their food sources.

Earthworms (Class Oligochaeta). Earthworms are tubular, segmented, soft-bodied animals that subsist on organic material in the soil they ingest. They are perhaps most associated in the human mind with aerating garden soil; however, earthworms actually perform this same service all over the globe in natural systems as well. Although they have not yet been surveyed, earthworms can undoubtedly be found in Cold Canyon. They are probably easiest to find when they emerge at the soil surface after hard rains.



Earthworm

Mollusks (Phylum Mollusca)

Mollusks are the group that includes octopuses, squid, clams, oysters, and snails. Although these animals are all quite diverse in body form and lifestyle, they have certain commonalities that betray their shared evolutionary history. For instance, they all have a radula, a tongue-like organ lined with sharp teeth-like protrusions, used for feeding. Mollusks are a successful group in evolutionary terms, which means that they have evolved into

many different species. All mollusks share a soft, unsegmented body, and their skin is not covered by a chitinous external skeleton as in insects or a cuticle like our own skin. This means that they cannot control evaporation of water from their skins, a limitation which restricts most kinds of mollusks to an aquatic existence. Because they are vulnerable in dry environments, even terrestrial mollusks inhabit only moister areas.

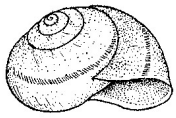
The only mollusks that occur in Cold Canyon are snails and slugs. When most people think of snails, they think of the common garden snail, which eats holes in their petunias and young tomato plants and speckle sidewalks and garden paths at night. In fact, the brown gardensnail (*Helix aspersa*) is only one of an estimated 30,000 kinds of terrestrial snails worldwide and is unusual in its habit of feeding on green, living plants. Most snails are the size of a pebble and never make themselves known to gardeners and farmers. Instead, they live in moist, shady places, quietly feeding on dead and decaying plant material, thus reducing the detritus to ever-smaller particles, which speeds up decomposition and soil formation.

Snails have shells made out of calcium carbonate, into which their internal organs are coiled, and slugs are their somewhat tubular relatives that through evolution have ceased to have a shell. A small evolutionary remnant of the ancestral shell (a "vestigial" shell) sometimes occurs buried in the tissues of the slug's back. There are several hundred kinds of slugs worldwide, but they are mostly restricted to cool, humid, and generally forested regions.

Snails and slugs are hermaphroditic, which means that each individual can produce sperm and eggs at the same time. Nevertheless, to produce offspring, they usually seek to mate with other individuals of their species. Mating is often preceded by a lengthy "courtship" of mutual circling and touching, which scientists believe sends a message to its partner that it can produce healthy offspring, much like the message male birds send with their bright plumage.

Cold Canyon Reserve has not been studied by malacologists (mollusk biologists), so we do not know exactly what kinds live here. You may actually be the first person to discover that a species occurs in the reserve, and interested malacologists are encouraged to study this area. The following information is based on the distributions of snails and slugs elsewhere in the Coast Ranges of California.

Shoulderband (*Helminthoglypta* spp.). The shoulderband, a snail with a shell about 1 inch (2 cm) in diameter, may be a reserve inhabitant. Shoulderbands look similar to brown gardensnails (*Helix aspersa*) known from human-dominated California landscapes, but their tan shells have a single narrow dark band rather than a broad zone of dark, cloudy pigment. The name shoulderband refers to that narrow band on the "shoulder" of the shell. More than 60 species of *Helminthoglypta* are native to California.



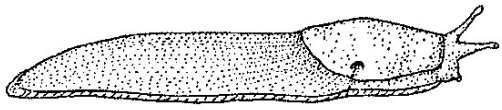
Shoulderband shell

Lancetooth snail (*Haplotrema* spp.). Lancetooth snails are flat-shelled snails without bands; the shell is greenish-yellow with a waxy luster and is about 0.5 to 0.75 inches (1-2 cm) in diameter. The head and foot of the animal are pale buff or cream-colored. *Haplotrema* is unusual among snails in that its diet also includes other snails; the

Lancetooth snail

"teeth" of its radula are sharp and elongate (leading to the common name "lancetooth"), presumably as an adaptation to this food source.

Pacific banana slug or leopard slug (*Ariolimax columbianus*). The only species of land mollusk already observed to occur in the reserve is a large yellowish or olive-brown slug, sometimes almost covered with black patches. This peculiar appearance explains its common names. Sometimes reaching almost 10 inches (25 cm) in length, the Pacific bananaslug is one of the largest species of slugs in the world. Most individuals in Cold Canyon Reserve are somewhat smaller. It has been suggested that the metabolic cost of producing mucus (which slugs and snails need to glide on) makes slugs much larger than this species biologically improbable.



Banana (or leopard) slug

Arthropods (Phylum Arthropoda)

The diversity of arthropods worldwide can only be guessed, but it is known to be enormous. The importance of arthropods in ecosystems is, in many cases, not well understood; however, ecologists believe that they often play pivotal roles in ecosystem processes such as nutrient recycling. Although arthropods are quite diverse in appearance, ranging from lobsters to millipedes to spiders to butterflies, they all have certain characteristics in common. For example, "arthropod" means "jointed foot," which hints at their jointed appendages. Also, all arthropods have tagmata, which are specialized body segments, such as the head, thorax, and abdomen in insects.

Chelicerata: Arachnids

The class Arachnida, which includes the spiders (order Araneae), harvestmen (order Opiliones), mites and ticks (order Acari), and scorpions (order Scorpiones), has long attracted the attention of naturalists for its amazing diversity in morphology, ecology, and life history. Arachnids have conquered most of the earth's terrestrial and marine environments and play major roles as predators, herbivores, parasites, and decomposers in ecosystems worldwide. With more than 108 families and 40,000 species, spiders are the second largest order of arachnids and exhibit some of the most interesting biology known among invertebrate animals. Only in the insects can another assemblage of such diverse organisms be found.

Arachnids can be differentiated from other small, hard-bodied creatures in the reserve by their numbers of legs and antennae. Arachnids have four pairs of walking legs and no antennae, whereas insects have three pairs of walking legs and one pair of antennae. Many arachnids also have the startling characteristic of multiple pairs of eyes, which may be one reason for their success as predators.

Because of its numerous microhabitat types, Cold Canyon provides an excellent representation of Californian arachnid diversity. Most of the major orders occur in the reserve, including spiders, scorpions, mites and ticks, harvestmen, pseudoscorpions, and windscorpions. A current list of recorded families and habitats can be found in appendices (p. 108). To date only the spiders have been surveyed, leaving significant gaps in the understanding of what should prove to be a remarkable fauna. Arachnid researchers are encouraged to expand on this work through additional surveys or taxonomic work.

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Mites and ticks (Order Acari)

Mites and ticks are both small, flattened, hard-bodied animals that occur in multiple habitats on the reserve. Mites are minute, almost microscopic creatures that may either feed on plants, other insects, mammals, or birds, depending on the species. They are ubiquitous and abundant, and can often be spotted by looking for red dots on plants in the reserve. Ticks, on the other hand, are not as common as mites, but because they have the unpopular habit of feeding on blood, they attract more attention. After the adult tick has fed on enough blood to nourish her eggs, she drops off her host and lays her eggs in the ground litter. After hatching from the eggs, her offspring work their way up a leaf of grass and wait to hitch a ride on the next passerby. Because the bite of a tick is not detectable, it is important to carefully examine your skin for ticks after hiking anywhere in California.

Scorpions (Order Scorpiones)

Scorpions occur throughout the Coast Range and are an exciting if somewhat startling sight. They have stout bodies, large pincers, and a tail that curves over its body to deliver a poisonous sting to its prey. Their stings, though painful, are not toxic enough to be life-threatening to human beings. Scorpions usually lurk in dark places, so they should be sought under logs or rocks.

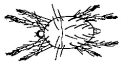
Spiders (Order Araneae)

California is a center of spider diversity and endemism with 55 families and over 1,500 species represented. Despite its small area, Cold Canyon is home to an exciting amount of this diversity (20 recorded spider families, see Appendix 3, p. 107). This diversity is partly due to the wide array of available microhabitats in Cold Canyon. The following groups of spiders are some of the more common families found in the reserve. Where possible, the descriptions that follow emphasize web construction because webs are often the most straightforward means of identifying spiders.

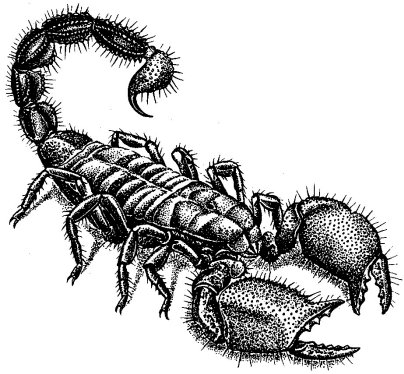
Funnel-web spiders (Family Agelenidae). These spiders construct funnel-shaped webs leading into a shallow retreat near the ground or into dense vegetation. The funnels of grass spiders (*Agelenopsis* spp.) are found along the trail during spring, especially in tall, grassy vegetation. Grass spiders tend to be yellowish to brownish in color and have eight eyes. *Hololena* is among the most common spiders in the reserve and occurs in virtually every habitat although it is less abundant in riparian areas. In addition to the typical funnel, *Hololena* constructs an adjoining sheet that serves to signal the spider of approaching prey.

Orb-weaving spiders (Family Araneidae). Anyone who remembers Charlotte from childhood will instantly know the classic shape of an orb-weaver's web. The two genera with the largest body sizes in this family (0.8-1.2 in., or 2-3 cm, body length) in the reserve are *Araneus* and *Argiope*. Both genera consist of species that tend to be yellow to brown, but members of the genus *Argiope* are covered with silvery hairs. These spiders are abundant in the riparian areas of the reserve and are generally observed in their webs at dawn or dusk. In late summer their young are responsible for gossamer – the tangled strings of web often seen floating through the air. Gossamer results from ballooning juvenile spiders that abandon their mode of transport upon finding suitable new habitat to colonize.

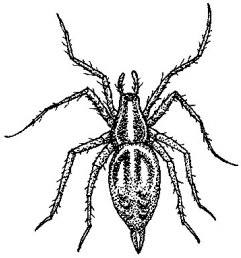
Tick



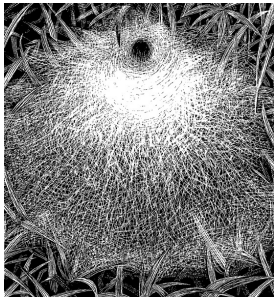
Red spider mite

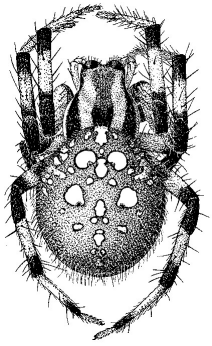


Scorpion

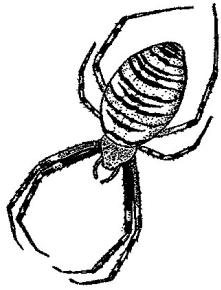


Funnel-web spider and web

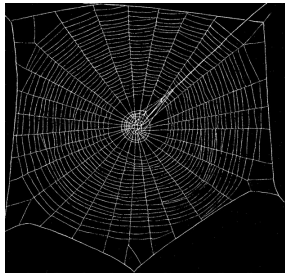


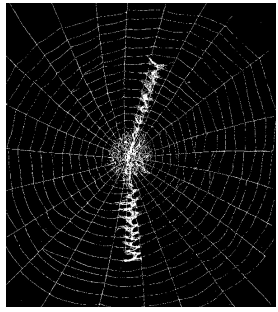


Orb-weaving spider (*Araneus*) and web

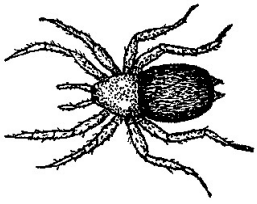


Orb-weaving spider (*Argiope*) and web

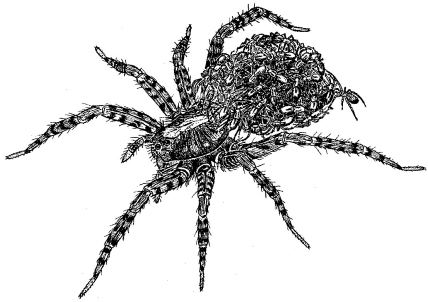




Ground spider (*Micaria*)



Ground spider (*Sergiolus*)



Wolf spider (*Pardosa*), carrying offspring

Funnel web spider web, social spider, black widow, and all webs on page 49 are reproduced with permission from McGraw-Hill Companies from Kaston and Kaston (1953).

INVERTEBRATES

Ground spiders (Family Gnaphosidae). Ground spiders are among the most diverse spider families in California. They can be found in most microhabitats on the ground – under rotting logs, stones, or leaf litter. Most members of this family are dark and uniformly colored (not mottled like many other spiders). *Sergiolus montanus* is found under stones in the reserve, especially in cool areas. It has a black and white pattern on its abdomen and a distinctive "jerky" motion when disturbed. *Micaria* is found in the drier areas of the reserve and a constriction in its abdomen makes it an exceptional ant mimic.

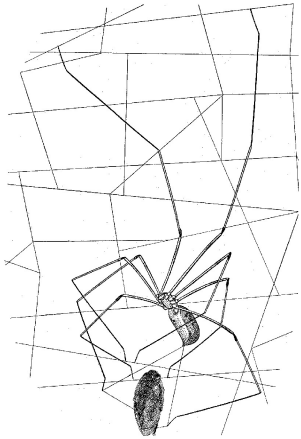
Wolf spiders (Family Lycosidae). Wolf spiders are nocturnal predators and are notable for their pairs of eyes of unequal sizes. They are best observed at night (not on the reserve!) with a headlamp because their eyes reflect light and produce a distinctive iridescence. In most genera, the female carries the egg sac, and when the young emerge, they hitchhike on her abdomen for a considerable length of time. Two genera of wolf spiders occur in the reserve and are identified by size differences. The smaller (0.4-0.8 in., or 1-2 cm, body length) and very abundant thin-legged wolf spiders (*Pardosa* spp.) are common in riparian areas where they can be seen running along rock surfaces searching for prey. They acquired their name because of their relatively long, thin legs. The much larger and generally uncommon *Schizocosa* is most likely to be found among leaf litter in moist areas, though it may be difficult to spot due to its excellent mottled camouflage.

Social spiders (Family Pholcidae). Social spiders are one of the most common spiders at home – there are probably several living in the corners of your bedroom. Because they have small bodies and long legs, social spiders are often mistaken for "daddy longlegs" (also called harvestmen, Order Opiliones), which are not actually true spiders. Like many other spiders but unlike harvestmen, social spiders build large webs to trap prey. However, social spiders sometimes share webs with their neighbors. If you watch them closely, you can often see them communicating with each other by tapping on the lines of web.

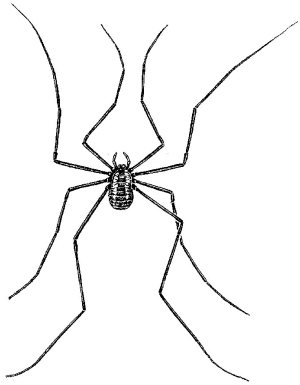
Jumping spiders (Family Salticidae). Jumping spiders have the best vision of all spiders and can be observed in the open, slowly stalking their prey and suddenly pouncing. Their brightly colored appearance and complex behavior have captured the hearts of many would-be arachnophobes. *Habronattus americanus* is arguably the most beautiful of California's spiders and can be found in exposed sunny areas. Only the males of this species exhibit the wonderful contrast of red, white, and iridescent blue colors which have made this species famous. The larger *Phidippus audax* is the most abundant jumping spider in the reserve and is easily recognized by the white spots on its abdomen, its iridescent blue-green chelicerae, or biting mouthparts, and its extreme hairiness.

Long-jawed orb weavers (Family Tetragnathidae). Tetragnathid spiders are easily located by the small, horizontal (not vertical as in Araneidae) orb webs that are constructed over shallow streams or pools. These spiders have long abdomens, and bizarre, protracted jaws. When disturbed, these spiders align their legs vertically in the center of their webs, effectively mimicking twigs or other vegetation.

Comb-footed spiders and widow spiders (Family Theridiidae). Theridiid spiders are a large and disparate family of spiders much maligned due to the poisonous widow spiders

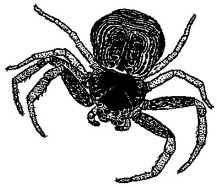


Social spider with prey

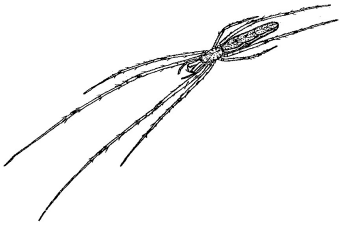


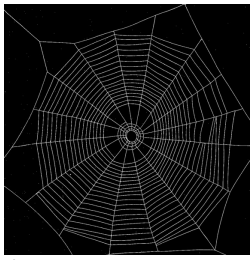
Harvestman (daddy longlegs)

Jumping spider

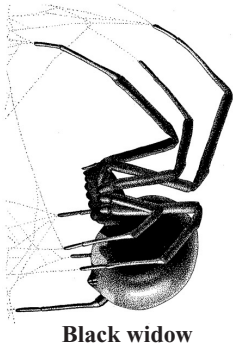


Crab spider

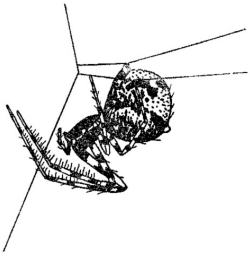


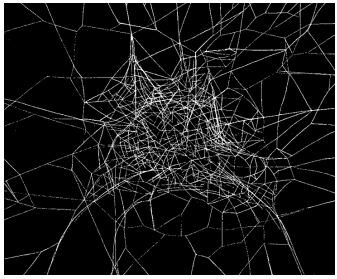


Long-jawed orb-weaving spider and web

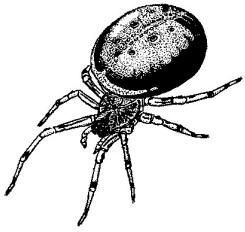


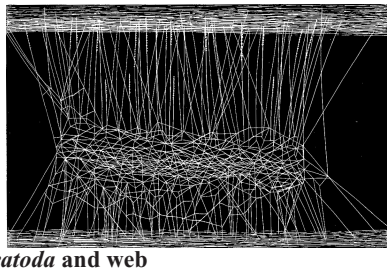
Black widow





Comb-footed spider (*Theridion*) and web





Steatoda and web

Pill bug

(*Latrodectus mactans* in California). While *L. mactans* does occur in the reserve, *Theridion* and *Steatoda* are more commonly encountered. *Theridion* is a very small spider (less than 0.2 in., or 5 mm, body length) of variable coloration, which builds irregular webs on vegetation and in crevices. *Steatoda* very closely resembles the black widow in size and shape, although it has no ventral hourglass marking and instead has a diagnostic white U on the back of the abdomen. Both *Steatoda* and black widows spin irregular webs and live in dark crevices, so it is critical to pay attention to detail when trying to distinguish between these two genera!

Crab spiders (Family Thomisidae). Crab spiders, which do indeed look like miniature crabs, are common throughout the reserve but are most abundant among trailside vegetation and riparian areas. They are sit-and-wait predators that build no webs. *Coriarachne* sports amazing bark-like camouflage that is so effective that the inexperienced or impatient eye will often not see this spider. *Coriarachne* is common on the bark of oak trees, especially at the edges of riparian areas.

Crustaceans

Crustaceans, including pill bugs, sowbugs, crayfish, and crabs, have two pairs of antennae and variable numbers of legs. Most crustaceans are aquatic, and therefore cannot live in Cold Canyon when the creek dries up. The only crustaceans likely to be found are therefore pill bugs and sowbugs, and these are still restricted to moist microhabitats.

Pill bugs and sowbugs (Class Isopoda). Also called "rolly-pollies," pill bugs have the distinctive ability to roll up into a perfect ball when disturbed, and can be found under most rocks or logs where there is abundant detritus, their primary food source. Sowbugs look quite similar to pill bugs, but are flatter and cannot roll into a tight ball.

Millipedes, Centipedes, and Insects

Millipedes and centipedes (Class Diplopoda and Chilopoda)

When presented with a millipede, a centipede, and an insect, most people would be able to identify the insect right away, but they might stumble over the other two. However, a few simple points clearly distinguish them. First, millipedes are rounded like a finger, and centipedes are flattened. Second, millipedes have two pairs of legs per segment, while centipedes have only one pair per segment. It is important to make these distinctions before deciding to pick one up – millipedes eat detritus and are harmless to humans, but centipedes are predators and can deliver a nasty bite.

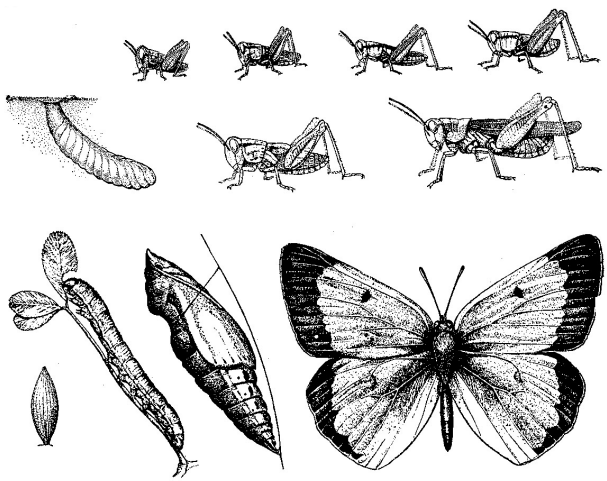
Insects (Class Insecta)

At first glance, insects may appear to be a uniform group of small, drab creatures. Fortunately, a closer look reveals much more exciting news. They are an extraordinarily diverse group, and their role in ecosystems is fascinating. Because insects are critical players in a number of ecological processes, E. O. Wilson, one of the most famous ecologists of our time, calls insects "the little things that run the world." For example, many terrestrial insects are responsible for breaking down fallen leaves and dead wood into fertile soil, and aquatic insects provide food for multitudes of other insects, spiders, and birds.

Insects are well-known for their diversity of form at different life stages, and their ability to undergo metamorphosis. Metamorphosis can be incomplete or complete. In incomplete metamorphosis, young insects (often called nymphs) transform into similar-looking adults except that they acquire wings and sexual organs. Insects exhibiting incomplete metamorphosis include dragonflies, grasshoppers, and termites. In complete metamorphosis, the larvae of insects transform into very different-looking adults. Butterflies, beetles, ants, and bees fall into this category. Many larvae of thse insects are roughly the shape of stuffed sausages and no more attractive, but others have an appeal similar to caterpillars.

Because it takes a great deal of metabolic energy to undergo metamorphosis, inquisitive natural historians have long wondered why insects would bother. Unlike humans and other vertebrates, whose skeleton is on the inside, insects wear their skeleton on the outside. They molt, or shed their skeleton, to grow larger. This process allows them the flexibility to change form completely in a way the vertebrate internal skeleton does not (except in the case of amphibians). In addition, metamorphosis – especially complete metamorphosis – allows insects to avoid competition with their offspring for food. For instance, caterpillars eat foliage, but adult butterflies sip nectar.

Taxonomic experts at the University of California, Davis, have as yet cataloged only the insect orders and families of the reserve (see appendix on page 108 for a complete list of families). The following descriptions are grouped by insect orders (with the most ancestral orders appearing first), and some descriptions of particular families, genera, or species are also included. The taxonomy used in this guide comes primarily from *An Introduction to the Study of Insects* (Borror et al. 1989). The evolutionary relationships of many insects are still under debate, so be aware that the taxonomy in your insect field guide may vary somewhat from that used below. An indispensable resource for the interested entomologist is *California Insects* (Powell and Hogue 1979), which provides descriptions, interesting anecdotes, and illustrations of most of the insect species mentioned as well as additional ones not covered in this guide.



Incomplete metamorphosis

Complete metamorphosis

The two main types of metamorphosis. Incomplete metamorphosis occurs in species like grasshoppers, and complete metamorphosis occurs in species like butterflies.

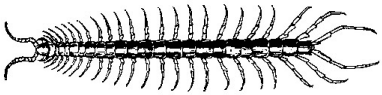
INVERTEBRATES

Mayflies (Order Ephemeroptera). The juveniles of this order are exceedingly diverse in form, but they are all aquatic and have a series of flap-like gills along each side of their abdomen. The adults have delicate bodies, translucent wings, and three long tails. Mayfly nymphs live on the stream bottom under rocks, sand, and submerged leaves (especially in riffles), but despite their inconspicuousness they are one of Cold Canyon's most abundant invertebrates. In their hidden world, insect nymphs feed and grow. Some filter feed, others wait surreptitiously for prey. Mayflies (Baetidae: *Baetis* spp. and Siphlonuridae: *Ameletus* spp.) are abundant, and, as herbivores, serve as an important source of food for both vertebrate and invertebrate aquatic predators. Although the juveniles spend months under the debris of the creek, the winged adult forms, which have no mouthparts and consequently cannot feed, spend only hours flying around in a mating dance above the creek.

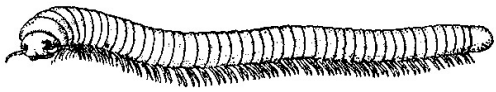
Dragonflies and damselflies (Order Odonata). These familiar insects have long, thin bodies and two sets of elongated wings. Dragonflies can usually be found hovering in midair or at rest with their wings stiffly outstretched, whereas damselflies are most often seen perching, with wings folded above. These conspicuous and often beautiful insects congregate in clearings adjacent to the creek and the main trail, where swarms of gnats, other small flies, and mosquitoes provide the dragonflies and damselflies with ample food. The nymphs are also predatory, feeding on aquatic insects and, in some cases, even tadpoles or small fish. They are difficult to spot because of camouflage. They may either be a dull color or be covered with hairs that catch mud and help them to blend with the background. However, the adults are easy to spot. The common green darner (Aeshnidae: *Anax junius*) is a large bright green dragonfly with yellowish, transparent wings which buzzes around the ponds that form in the upper creek. A related dragonfly (Aeshnidae: *Aeshna multicolor*) sports two yellow diagonal markings on its dark thorax. Both are spectacular to watch as they perform their courtship and territorial acrobatics. Another common odonate in Cold Canyon is the blue damselfly (Coenagrionidae), which looks like a small, delicate dragonfly.

Grasshoppers, crickets, and katydids (Order Orthoptera). Members of this group are often recognized by their heavy bodies, mouthparts adapted for chewing plants, and the ability to jump. Despite this habit, many also have large wings. Jerusalem crickets (Stenopelmatidae: *Stenopelmatus fuscus*), which despite their name are native to this area, lurk in dark, moist places, such as under rocks and fallen logs. They may be up to 3 inches (8 cm) long, almost cartoon-like in their bumbling largeness. Recently, entomologists have discovered that these fascinating creatures exhibit species-specific ground-drumming patterns. The male plays a rhythmic serenade for the female, who responds only to the song of her own species. Some orthopterans communicate visually. As the summer approaches, sometimes the only activity visible to the hiker is that of grasshoppers (Acrididae: *Trimerotropis* spp. and *Arphia* spp.), which flash their yellow or orange hind wings as they fly about, seemingly oblivious to the hot, dry conditions around them. Other common grasshoppers on the reserve (Acrididae: *Melanoplus* spp.) have colorless hind wings.

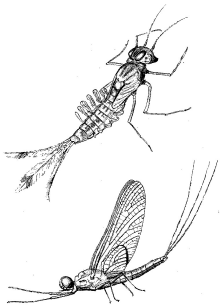
Earwigs (Order Dermaptera). Every gardener is familiar with the earwig's general appearance – a dark elongated body with rear pincers. There is only one native species of earwig in California and its range does not extend to northern California. Nonetheless, a represen-



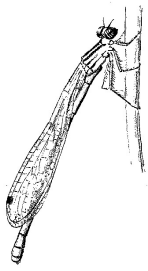
Centipede



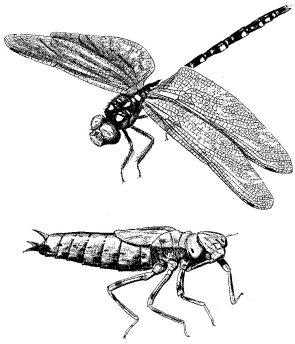
Millipede



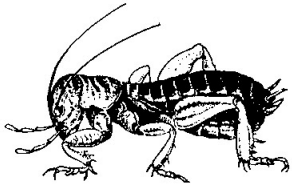
Mayfly with nymph



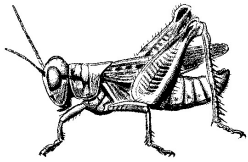
Damselfly



Dragonfly and nymph

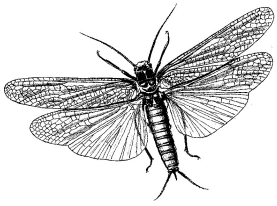


Jerusalem cricket

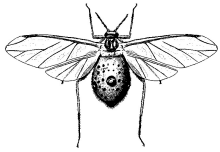


Grasshopper

Earwig

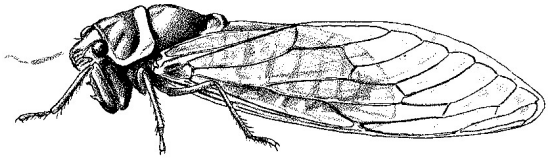


Stonefly and nymph



Aphid

Spittlebug



Cicada

tative of this order in the form of the ubiquitous introduced European earwig (Forficulidae: *Forficula auricularia*) occurs in the reserve. It can often be found inside the empty seed capsules of spice bush (*Calycanthus occidentalis*) and other moist dark places.

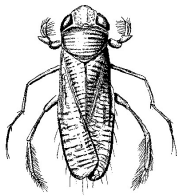
Stoneflies (Order Plecoptera). Stonefly nymphs (Perlodidae: *Kogotus alameda*) can be found in the bottom of the creek alongside mayfly nymphs. Although both groups look quite similar, they can be differentiated on the basis of tail number: while mayfly nymphs almost always have three, stonefly nymphs have two. The medium- to large-sized adults have two prominent sets of wings that fold like a tent above their abdomen, but retain their characteristic tails. Both nymphs and adult forms display a long, segmented abdomen.

Aphids, leafhoppers, and cicadas (Order Homoptera). The members of this group are incredibly diverse in form, from the soft-bodied, teardrop-shaped aphids with membranous wings to the slender, jumping leafhoppers to the froth-producing (juvenile) spittlebugs. Seek these small, delicate insects in trailside shrubs and other types of vegetation, and bring a hand lens for better viewing. Another member of this group is more often heard than seen. The electric buzz heard on hot summer afternoons is emitted by male cicadas (Cicadidae: *Platypedia* spp.), swift and elusive creatures that generally evade observation. There are several species on the reserve, the most colorful of which are black with red wing veins.

True bugs (Order Hemiptera). This group of insects is easy to recognize. The thickened, brightly colored forewings and membranous hindwings often result in a decorative X across the back of the bug. All true bugs have sucking mouthparts, and not surprisingly, many are predators. Many species are also aquatic. The most obvious riparian insect of the reserve is the water strider (Gerridae: *Gerris remigis*), which preys on unfortunate terrestrial insects that fall into the water. Water striders keep their stride on the water surface with their long middle and hind legs; however, look closely and you will also notice their short front legs, used to capture prey. Water boatmen, backswimmers, and giant water bugs spend most of their lives swimming in open water or clinging to submerged vegetation. Water boatmen (Corixidae: *Graptocorixa californica* and *Sigara mckinstryi*) have elongated oval bodies and oar-like hind legs. Backswimmers (Notonectidae: *Notonecta undulata*) look quite similar, but, as the name implies, they swim on their backs. Also, water boatmen eat algae and do not bite humans, whereas backswimmers are predatory and will give you a bite like a bee sting if you give them the opportunity. The giant water bugs of Cold Creek, amusingly named toe biters (Belostomatidae: *Abedus indentatus*), are indeed capable of inflicting a long-lasting bite. They look like large, broad water boatmen but do not have oar-like hind legs. Female toe biters lay their eggs on the backs of the males, so if you see an egg-clad bug by the creek, it is probably a giant water bug.

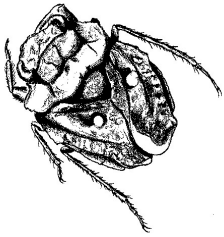
Terrestrial species have a variety of habits. Toad bugs (Gelastocoridae: *Gelastocoris* spp.) hop along the shore in search of insect prey. Stink bugs (Pentatomidae) also occur in the reserve, and, as their name suggests, they secrete a noxious odor if disturbed. Green stink bugs (*Chlorochroa* spp.) are herbivorous and cryptically colored to match the plants they feed on. The spotted assassin bug (Reduviidae: *Rhynocoris ventralis*), a medium-sized, eye-catching black and red or tan bug, is a sit-and-wait predator. It waits patiently for their prey to come to them, and then pounces on them.

Waterstrider

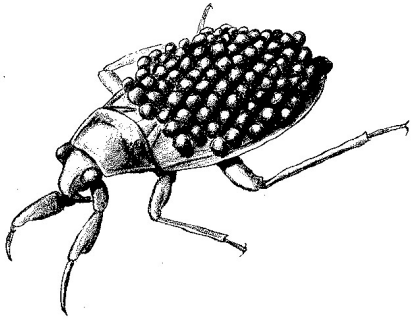


Water boatman

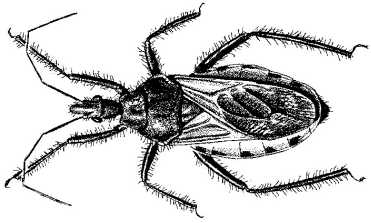
Backswimmers



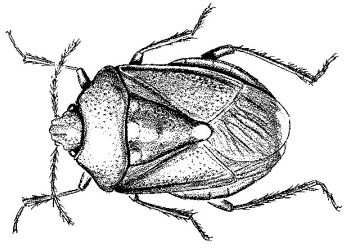
Toad bug



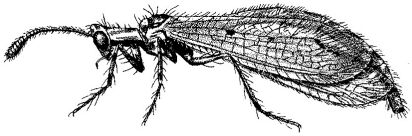
Giant water bug with eggs

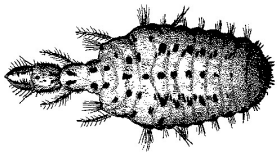


Spotted assassin bug



Stink bug





Antlion and larva

Lacewing

INVERTEBRATES

Lacewings and antlions (Order Neuroptera). Adults of this group have two pairs of long, thin wings whose veins criss-cross in a quasi-checkerboard pattern not unlike a map of suburbia. The wings fold over their backs and often extend the length of their bodies. Green lacewings (Chrysopidae: *Chrysopa* spp.) are among the most common insects in the reserve. The golden-eyed adults flutter about on intricate, gossamer wings that belie their predaceous nature. Other related predators lurk at your feet. When walking on sandy or loose, dry soil, keep an eye out for conical pits. Larval ant lions (Myrmeliontidae) dig these pits and wait at the bottom for unfortunate insects to tumble in. Adult ant lions look superficially like gray damselflies with clubbed antennae.

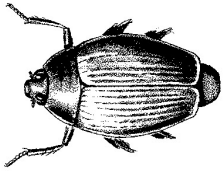
Beetles (Order Coleoptera). The most diverse group of animals on the planet, the beetles can be found in almost every conceivable microhabitat in Cold Canyon, from aquatic to terrestrial. Look for their characteristic oval body shape and non-overlapping hard wing covers armoring their backs. In flight, beetles spread their wing covers, revealing clear, membranous wings underneath.

Several species of beetles are aquatic. Swarms of whirligig beetles (Gyrinidae: *Gyrinus plicifer*) can be found either on or below the surface of the quiet areas of the creek, usually twirling madly about en masse. The beetles have two pairs of compound eyes that enable them to watch for prey above and below the water simultaneously. To avoid collisions, the beetles rest their antennae on the water and can sense the presence of another object by the tilt on the water's surface.

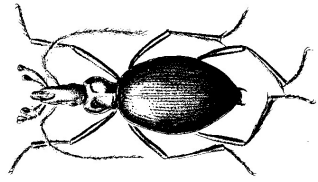
Most terrestrial beetles spend their days hiding in the leaf litter or under rocks and come out only at night. One interesting ground beetle, the snaileater (Carabidae: *Scaphinotus s*pp.), flaunts a long head and mouthparts used to eat its prey of snails and worms. Large, shiny black stink beetles (Tenebrionidae: *Eleodes* spp.) spend much of the day hiding under rocks and duff and have the amusing habit of walking about with their back ends raised much higher off the ground than their heads. Under harassment, stink beetles emit noxious fumes to deter predators.

Other beetles are diurnal and sport bright coloration. In autumn, spectacular swarms of ladybugs (Coccinellidae: *Hippodamia convergens*) converge in tree hollows and other protected sites. The only known endangered species inhabiting Stebbins Cold Canyon is the valley elderberry longhorn beetle (Cerambycidae: *Desmocercus californicus dimorphus*). The larvae of this species live in the core of elderberry trunks during their growth and maturation. Adult beetles emerge in the spring leaving a distinctive oval exit hole in the trunk that is about 1/4" in (1/2 cm) diameter. The adults live for only several weeks, are 1/2" to 1" in length, and have long antennae ('horns') that are as long as their bodies. The adult males and females look different; the males are mostly red with black spots, while females are mostly black with red around the edges.

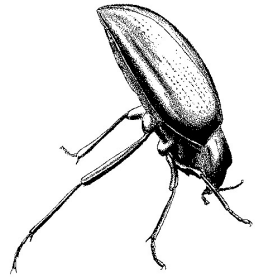
Butterflies and moths (Order Lepidoptera). Butterflies and moths are among the most recognizable and beloved of all insects. They sport large, often showy wings, which are covered with tiny scales arranged like shingles on a roof. Most Lepidoptera sightings during the day at Cold Canyon are butterflies, though several intriguing day-flying moths occur on the reserve as well. In general, butterflies rest with their wings folded above their backs and have clubbed antennae, while moths fold their wings down along their bodies like lacewings and have feathery antennae; however, the exceptions are numerous! A spec-



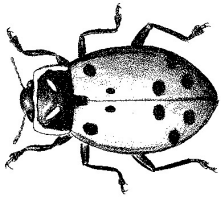
Whirligig beetle



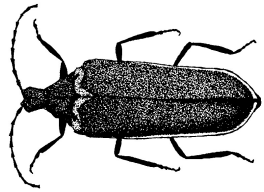
Snaileater



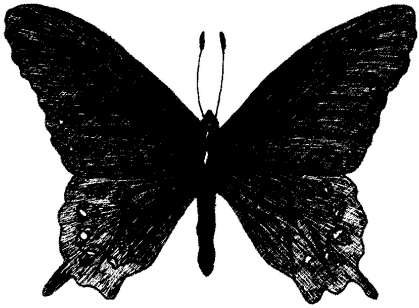
Armored stink beetle



Ladybird beetle

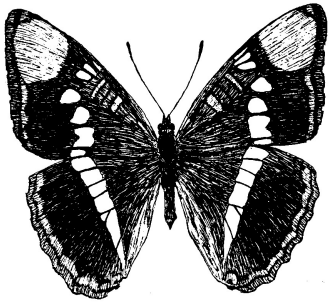


Valley elderberry longhorn beetle

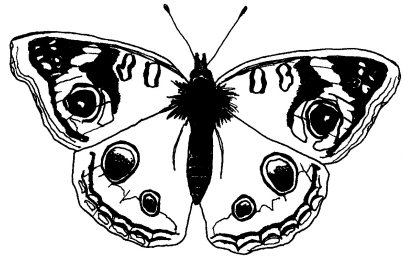


Pipevine swallowtail

Western tiger swallowtail



California sister



Buckeye

tacular diversity of butterflies of all different shapes, colors, and sizes occurs in the reserve. Many are showy and can be spotted flying along the path, sipping nectar at flowers, or mudpuddling near the stream crossing.

Pipevine swallowtail (Papilionidae: *Battus philenor*). The pipevine swallowtail, a spectacular large, black butterfly with an iridescent green shimmer, courses up and down the canyon walls, especially in the spring. Its large black caterpillar, covered with red fleshy spines and spots, can be found eating California pipevine (*Aristolochia californica*) in the canyon bottom.

Western tiger swallowtail (Papilionidae: *Papilio rutulus*). The bold markings of the large and showy, yellow and black Western tiger swallowtail will catch even the disinterested eye. The larvae feed on willow, so the adults can often be found in the creek bottom.

California sister (Nymphalidae: *Adelpha bredowii*). Another large and conspicuous species, the California sister is brown with a diagonal white stripe and a large orange eye-catching blotch near the tip of each forewing. It can be spotted soaring lazily among the oaks.

Buckeye (Nymphalidae: *Junonia coenia*). In autumn, the buckeye, a medium-sized brownish butterfly with intricate, multicolored "eyespots," may be extremely numerous on blossoms of coyote brush.

Chalcedon checkerspot (Nymphalidae: *Euphydryas chalcedona*). Look for the medium-sized, strikingly patterned, black, white, and red chalcedon checkerspot basking in the spring sun.

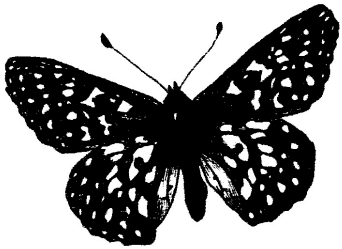
Common duskywing (Hesperiidae: *Erynnis propertius)*. The common duskywing, a medium-sized, dark, common butterfly, is often initially mistaken for a moth because of its heavy body and habit of holding its front wings up like a butterfly's but its back wings down like a moth's.

Sara orange-tip (Pieridae: *Anthocharis sara*). Another lovely sight in early spring is the flash of color from the Sara orange-tip, a white butterfly whose wings are, as the name states, tipped with orange.

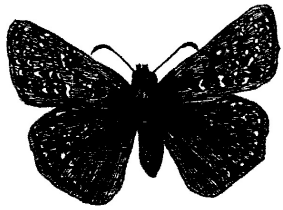
Acmon blue (Lycaenidae: *Plebejus acmon*). The acmon blue, a beautiful delicate blue butterfly the size of a child's thumbprint, often can be found in a virtual cloud around coyote brush in the same season as the buckeye.

Echo blue (Lycaenidae: *Celastrina echo*). A smaller but equally easy-to-spot butterfly is the echo blue, a shimmering blue butterfly that flits madly about in the spring and early summer.

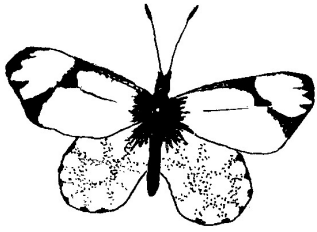
Moths are also abundant in Cold Canyon; however, most of them are only flying about at night. One distinctive day-flying moth species, common in the reserve in the spring, is



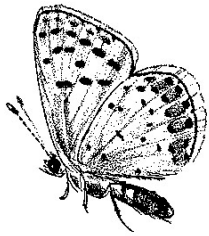
Chalcedon checkerspot



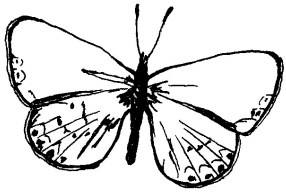
Common duskywing



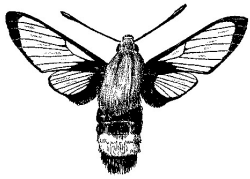
Sara orange-tip



Acmon blue



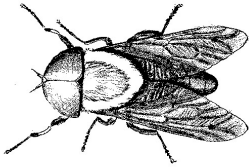
Echo blue



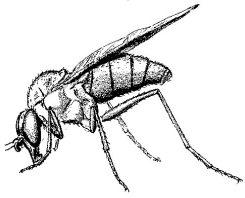
Bumblebee hawkmoth

Mosquito

Black fly



Horse fly



Snipe fly

the green bumblebee hawkmoth (Sphingidae: *Euproserpinus phaeton*), a convincing mimic of its namesake. In the late spring, grassy sunlit spots flicker with the presence of the three-striped longhorn (Incurvariidae: *Adela trigrapha*). The hair-like antennae of this tiny, silver-striped moth are several times its body length, giving it a distinctive appearance.

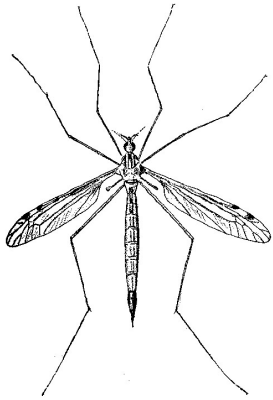
Flies, gnats, and midges (Order Diptera). If you cannot tell whether the insect buzzing across the path is a fly or a bee, carefully count its wings. If it has two sets of wings, you are probably looking at a bee or wasp; if it has only one set, it is a fly. Members of this order tend to be small, and their wings are semi-transparent.

Many flies are maligned because they bite unwary hikers. The most infamous blood-suckers are mosquitos (Culicidae: *Culex pipiens* and *Anopheles freeborni*), which develop as aquatic larvae in Cold Creek's pools and metamorphose into adults in late spring. Black fly larvae (Simuliidae: *Prosimulium* spp. and *Simulium* spp.) can also be found in abundance in Cold Creek. Club-shaped black fly larvae form dense black mats on many rocks in the creek. Although you will have to seek out the larvae in order to see them, the adults will be glad to come to you. Adult females must feed on blood to produce eggs, and they give a nasty bite. Adult female deer and horse flies (Tabanidae: *Tabanus* spp. and *Chrysops* spp.) do the same but can be differentiated from black flies because the Tabanid flies are brown and much larger. Many have brilliantly colored compound eyes and are known as "green-eyed monsters." Deer flies have black or brown patterns on the wings, while horse flies do not. Also among the biting flies of the reserve are the snipe flies (Rhagionidae). Common snipe flies (*Rhagio costatus*) attack exposed human limbs and inflict a painful wound. Adults are just under 1 inch (2 cm) in length, relatively hairless, and dull orange in color. Their natural hosts are probably the many non-human mammals of the reserve.

Fortunately, most species of flies are harmless to humans. Among the most primitive and unusual of the flies are the crane flies (Tipulidae), which are sometimes referred to as mosquito hawks even though they are not related to mosquitos and do not suck blood. However, like mosquitoes, they are nearly ubiquitous in cool, moist microhabitats. Common dance flies (Empididae: *Rhamphomyla* spp.), which have small heads and usually have smoky wings, can be found in the springtime. If you look at the males closely, you may discover the small, frothy prey balls they carry, which they present to the females as part of a courtship ritual. This dipteran equivalent of an engagement ring may contain a variety of smaller insects captured by the males.

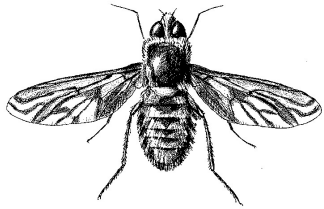
Other flies are important pollinators. Many flower visitors that appear on first glance to be bees are in fact bee flies (Bombyliidae), which have evolved to look like bees, presumably to avoid hungry predators. These fascinating flies, delicate and fuzzy as adults, take flower nectar and pollen as nourishment. One of the most common species in the reserve is the greater bee fly (*Bombylius major*). They are bulbous, dark, fuzzy flies, and are often seen hovering over flowers or basking in moist, open areas near the trail. The front of each wing has a sharply margined dark brown blotch, and the rear of each wing is transparent.

Sawflies, wasps, bees, and ants (Order Hymenoptera). This order contains an exciting diversity of insects with a huge range of appearances and behaviors. Most hymenopterans have two pairs of wings, and a constricted abdomen at its attachment point with the thorax. Many species also have nasty stings. However, the most primitive groups are harmless.

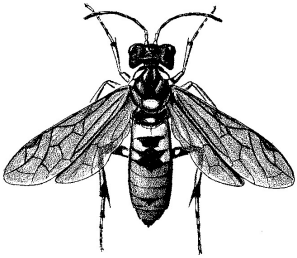


Crane fly

Dance fly

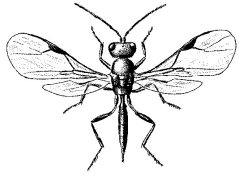


Bee fly



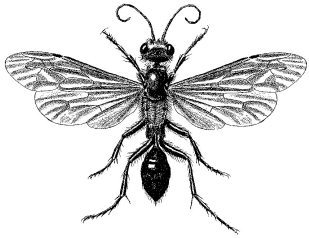
Sawfly

Oak gall wasp

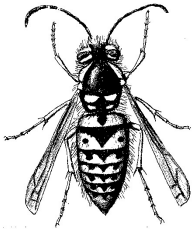


Aphid parasitoid wasp

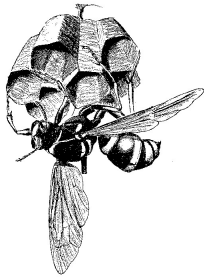
Velvet ant



Green cricket hunter



Yellowjacket



Paper wasp

INVERTEBRATES

Sawflies (Tenthredinidae: *Tenthredo* spp.), medium-sized, stout-bodied insects that attack plants, are present but not common in the reserve. Many species in this group exhibit parthenogenesis, wherein the females produce eggs without mating. All of the offspring are consequently female, and therefore many of these species have no males. The adults are rust-red to black with a large, rectangular head. The juveniles look caterpillar-like and feed on leaves, often gregariously. Another important group of hymenopterans in Cold Canyon and throughout California is the gall wasps (Cynipidae). The most reliable place to find gall wasps is on oak trees, where they occur in bewildering diversity. Most species lay their eggs in oaks, and chemicals released by the eggs or larvae induce the formation of tumor-like galls, whose shape is usually species specific. Depending on the wasp species creating the gall, it may protrude from the branches or the leaves of the oak. Remember that oaks reproduce by acorns, so any non-acorn protrusion you see on an oak, no matter how much it may look like an apple or some other fruit, is a gall.

The parasitoids, a diverse group of hymenopterans, feed on other insects without initially killing them outright. Parasitoids (Braconidae and Ichneumonidae) have interesting life histories, wherein the adult female deposits her eggs in the egg, juvenile, or adult form of another insect. The eggs hatch and the larvae then feed on the other insect, eventually killing it, but often leaving its skin intact. The carefully observant naturalist may see an adult parasitic wasp then emerge from a beetle larva, an adult aphid, or some other insect. Another common sign of parasitoid activity is rows of white parasitic wasp cocoons lining a caterpillar's back.

Many hymenopterans are wasps, predatory insects with a noticably pinched abdomen and a nasty stinger. One of the more visually appealing wasps is the velvet ant (Mutillidae), which looks like a furry ant. The females are wingless and scuttle along the ground; males look similar to the females but have wings. The "fur" on their backs is often brightly colored red, orange, or yellow. Velvet ants are solitary and parasitize other insects, especially ground-nesting wasps and bees. Another solitary group of wasps, the thread-waisted or digger wasps (Sphecidae), are primarily ground-nesting predators. The green cricket hunter (*Chlorion aerarium*), a metallic-green monster up to 1.5 inches (4 cm) long, can occasionally be seen dragging paralyzed crickets along the ground to its cloistered young.

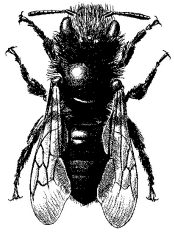
Other groups of wasps are social, and form colonies or hives. Keep a lookout for the distinctive gray spherical nests of paper nest wasps (Vespidae). Paper nest wasps, the only paper-makers on the planet besides humans, mix wood pulp with saliva to create their nests. Two different black-and-yellow genera are common in the reserve. Yellowjackets (*Vespula* spp.) are aggressive, attacking nearly everything (including the meat in your sandwich), and deliver extremely painful stings. Paper wasps (*Polistes* spp.) are also predatory, but they are less aggressive and have slightly less troublesome stings. Yellowjackets often nest in abandoned rodent burrows and in hollow trees, while paper wasps hang their nests off of exposed tree limbs.

Like wasps, bees are often social and also have stingers, but bees are much less aggressive and are primarily pollinators. Two bumblebee species (Apidae: *Bombus edwardsii* and *B. vosnesenskii*), which are densely hairy yellow and black social bees, are extremely important members of the community because they are the sole pollinators for many native flowers. Without them, Cold Canyon's vivid spring wildflower display would be much less spectacular, and the food sources of certain insects and vertebrates would disappear. Another interesting and common group of bees are the metallic leafcutter bees (Mega-

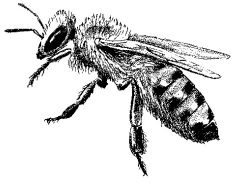
chilidae: *Osmia lingnaria*), which are bright metallic blue and live solitarily. Sociality is carried to an extreme in the introduced European honeybee (Apidae: *Apis mellifera*). Members of this species live as different castes: queens produce eggs, while sterile workers search for flowers, tend and defend the hive, and produce honey.

The most social of all hymenopterans are the ants (Formicidae). Ants can be pivotal members of natural communities, and the huge colonies of this group scavenge large quantities of organic matter including plant seeds and dead and living insects. One of the more common ants in Cold Canyon is *Messor andrei*, a seed-harvesting species with no common name, whose workers are black and medium sized. In the summertime these ants consume prodigious numbers of plant seeds and leave large accumulations of seed chaff around their nest entrances. Several species of carpenter ants (*Camponotus* spp.) also abound in the reserve. One common ground-dwelling species (*Camponotus semitestaceus*) nests both in rotten logs and directly in the soil. The workers of this species are orange-brown in color, with a contrasting darker head, and vary in size from medium to quite large (0.25-0.75 in. or 2-8 mm). The reserve is also notable for its lack of non-native ant species, such as the pestiferous Argentine ant (*Linepithema humile*), which is a serious threat to the continued diversity of native ants.

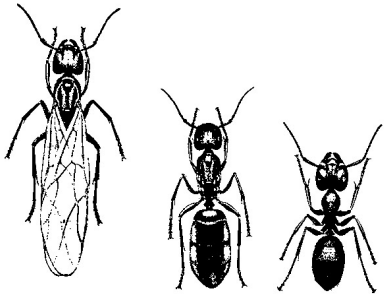
Bumblebee



Leafcutter bee



Honeybee



Winged adult, wingless adult, and worker forms of the carpenter ant