Learn about . . . TEXAS INSECTS

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A Learning and Activity Book

Color your own guide to the insects that crawl, hop and wing their way across the plains, hills, forests, deserts and mountains of Texas.

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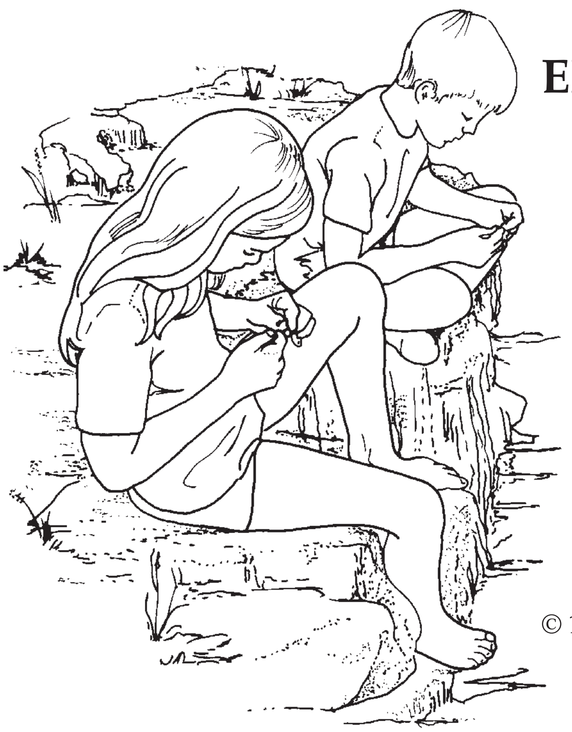

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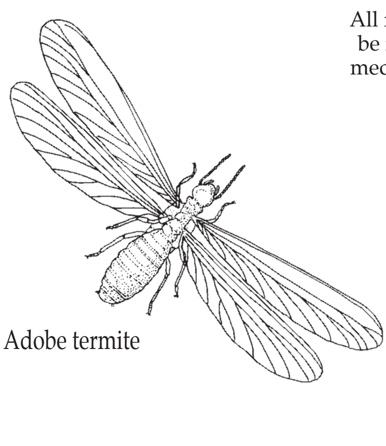


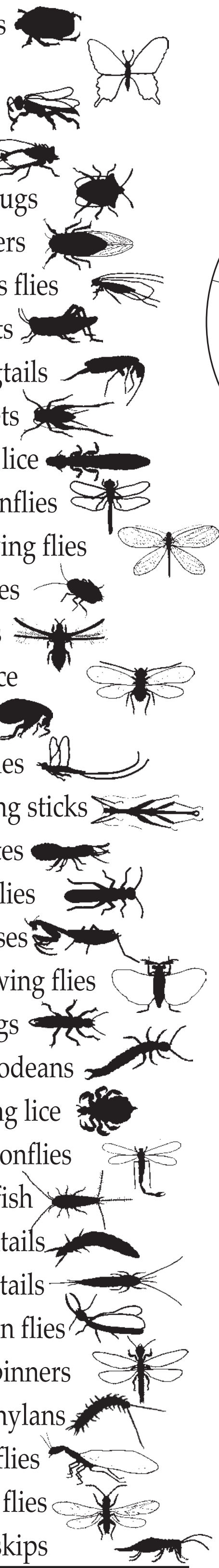
Adobe termite

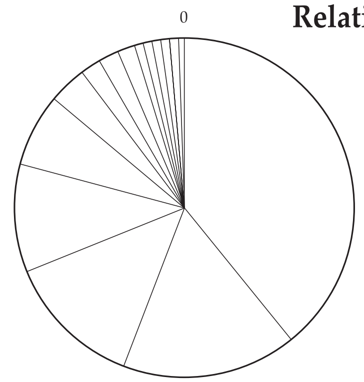
There are Lots of Insects and They are Fun to Watch

More than half of all the animals known on earth are insects. There are more than 1 million (perhaps as many as 3 million) species of insects, while there are only 1/2 million other known animal species. There are 100,000 or so species of insects native to the United States. More than 1/3 of these have been found in Texas. Texas has more different kinds of insects than any other state.

Relative Importance of the Orders Among Insects

Rank	Scientific Name of Order	Percent of World Species	Common Name of Order
1	Coleoptera	38.54	Beetles
2	Lepidoptera	14.89	Moths
3	Hymenoptera	13.69	Wasps
4	Diptera	13.09	Flies
5	Hemiptera	6.65	True bugs
6	Homoptera	4.25	Hoppers
7	Trichoptera	0.93	Caddis flies
8	Orthoptera	0.93	Locusts
9	Collembola	0.80	Springtails
10	Grylloptera	0.73	Crickets
11	Mallophaga	0.66	Biting lice
12	Odonata	0.65	Dragonflies
13	Neuroptera	0.59	Lacewing flies
14	Blattoptera	0.53	Roaches
15	Thysanoptera	0.53	Thrips
16	Psocida	0.33	Barklice
17	Siphonaptera	0.30	Fleas
18	Ephemerida	0.27	Mayflies
19	Phasmida	0.27	Walking sticks
20	Termitida	0.25	Termites
21	Plecoptera	0.21	Stoneflies
22	Manteida	0.20	Mantises
23	Strepsiptera	0.18	Twistwing flies
24	Dermaptera	0.15	Earwigs
25	Diplura	0.09	Campodeans
26	Anoplura	0.07	Sucking lice
27	Panorpida	0.06	Scorpionflies
28	Lepismida	0.04	Silverfish
29	Protura	0.03	Telsontails
30	Machilida	0.03	Bristletails
31	Megaloptera	0.03	Dobson flies
32	Embiida	0.02	Webspinners
33	Scolopendrellida	0.01	Symphylans
34	Raphidiida	0.--	Snakeflies
35	Zoraptera	0.--	Angel flies
36	Raphioptera	0.--	Snowskips
Total		100.00	

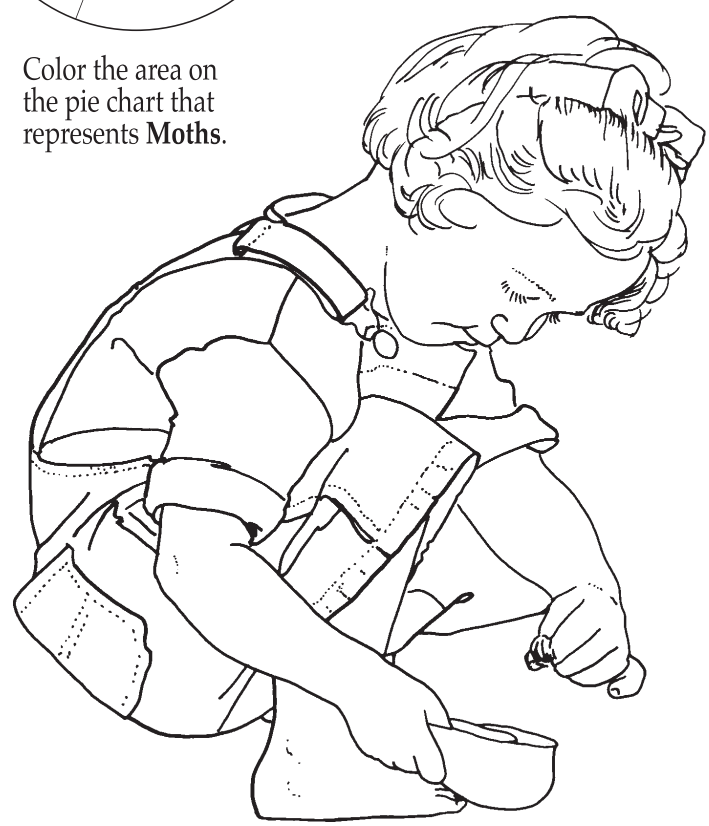




Relative Importance of Insect Species Among All Organisms

Rank	Name of Order	Percentage of Species
1	Insects	42.00
2	Other Animals	29.00
3	Bacteria	9.00
4	Fungi	8.00
5	Single-Celled Organisms	6.00
6	Plants	5.00
7	Archaebacters	1.00

Color the area on the pie chart that represents **Moths**.



Many people say they don't like "bugs", meaning insects and other "creepy crawlies", because they have not stopped to observe them and to realize how very few insects are really harmful. Insects are truly facinating and watching their activities can provide hours of fun. Insects are easy to find, since they are common in just about any kind of habitat. You can find them in your backyard and in any field or patch of woods, in lakes and rivers, in deserts and on the seashore, but almost none at sea.

Insects do a Lot of Good, but a Few are Pests

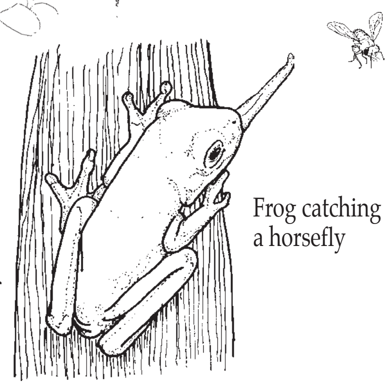
Like insects everywhere, Texas insects are important agents that, overall, make our lives better and more interesting. For better or worse, we share the planet with them. Let's try to get along.

How insects are beneficial or "good":

Without insects, we would not have pretty flowers to look at or fruits and vegetables to eat. That is because most plants need insects in order to reproduce.

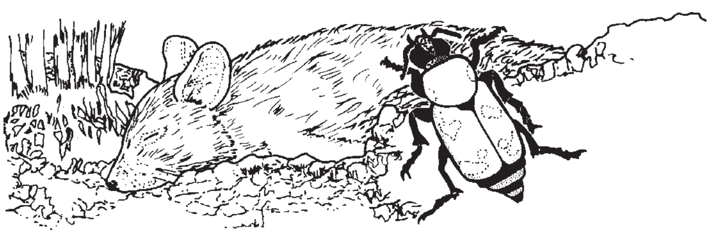
Honey bee pollinating a flower

Without insects, we would have fewer songbirds, lizards, frogs and mammals like bats, shrews and anteaters. These animals would have nothing to eat since they all feed on insects.



Frog catching a horsefly

Without insects acting as clean-up squads and garbage collectors, dead trees and animals would be piling up everywhere.



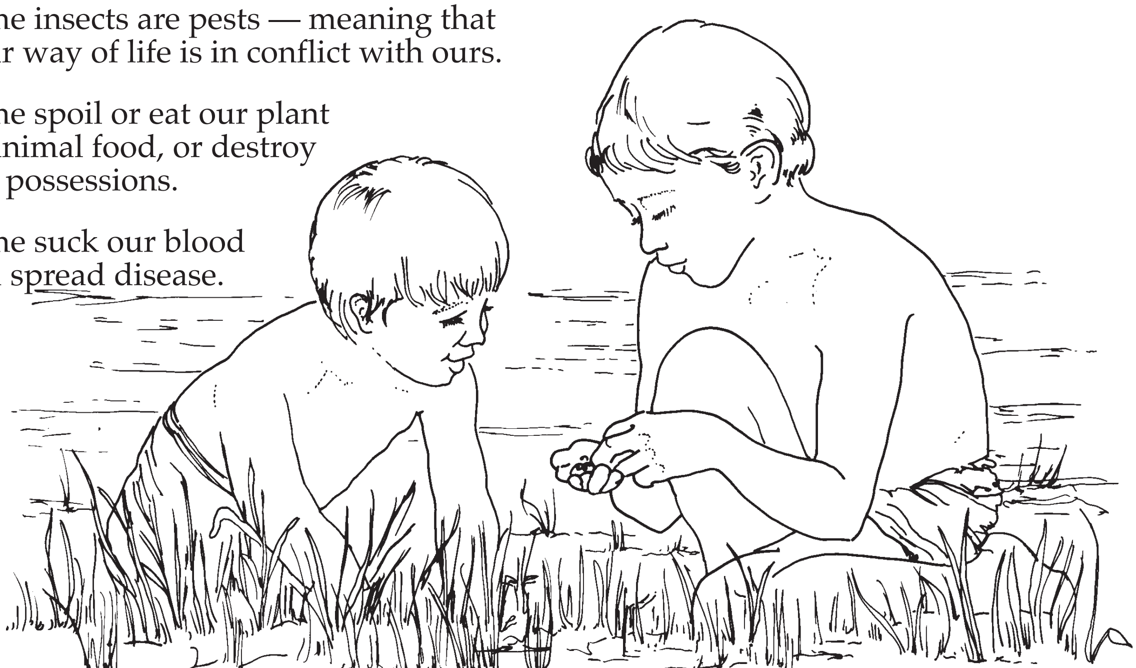
American burying beetle with a dead mouse

How insects are harmful or "bad":

Some insects are pests — meaning that their way of life is in conflict with ours.

Some spoil or eat our plant or animal food, or destroy our possessions.

Some suck our blood and spread disease.



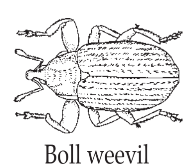
But, aside from being "good" or "bad", insects are fascinating creatures to watch and many are very beautiful.

more stuff . . .

A Kind Word About "Bug"

The word **bug** has several origins that have been punned together to form its present English meanings: a "true bug" or hemipteran, insect-like, microfossil, microorganism, disease, defect, enthusiast, obsession, fear, hidden microphone, asterisk, to sting or to molest. **Bwg** is Welsh for ghost. **Bugge** is Middle English for demon, beetle or scarecrow. **Boggle** is North English for a terrifying apparition. **Bougre** is French for a nasty fellow. **Buz** is Spanish for a hit, kiss of respect or sting. **Bogie** is a surprising event. **Bogyman** is a **bugaboo** or fearsome figure. These other meanings are probably responsible for the general dislike and fear of bugs by people who are ignorant about insects. Let's call the whole group INSECTS and save BUG just for insects of the order HEMIPTERA which can **bug** or sting you like a **bedbug** with their pointed mouthparts. This excursion into **etymology,** or the study of words, should not be confused with the subject of this book, **entomology,** or the study of insects.

Harmful insects



Boll weevil

Mosquito

more stuff . . .

An Insect Quiz

Follow this key to distinguish an insect from other living things:

Does it take on nutrients, increase in size and reproduce, using large molecules based on carbon, including DNA?
YES, it is a LIVING ORGANISM.
NO, it is a mineral.

Does it grow from one cell to many, reproduce, move, feel and react?
YES, it is an ANIMAL.
NO, it may be a plant, fungus, amoeba, alga or bacterium.

Does it have each side of the body a mirror image of the other, at least in the early stages?
YES, it is a BILATERAN.
NO, it may be a jellyfish, coral or sponge.

Does it have the nervous system under the gut?
YES, it is ARCHAEOGASTRAL.
NO, it may be a starfish or vertebrate.

Does it have a thick outside skin of chitin (which must be shed to increase body size), segmented by thin folds of skin that take up the slack in rings that bead the body into a number of segments?
YES, it is an ARTICULATE.
NO, it may be a mollusk, roundworm or flatworm.

Does it have segmented legs or other appendages attached to many of the body segments, compound eyes on the head, and powerful striated muscle?
YES, it is an ARTHROPOD.
NO, it may be an earthworm, tongueworm or tardigrade.

Does it have jaws on the second segment behind the head cap?
YES, it is a MANDIBULATE.
NO, it may be a trilobite or arachnid.

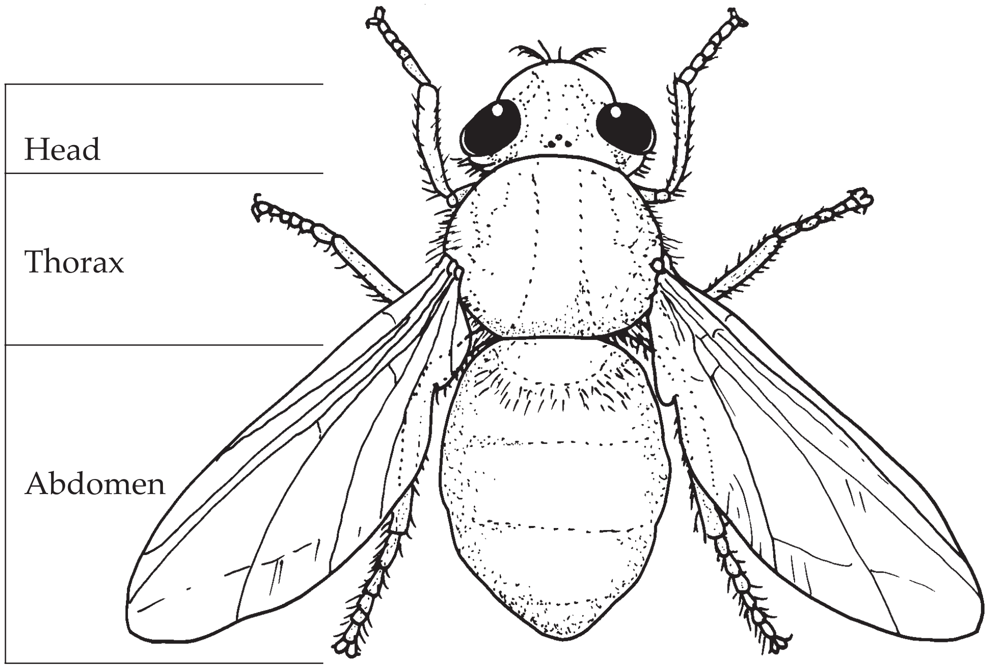
Does it have filamentous antennae on the head cap, but no second antenna by the mouth, and does it split its skin along the back to molt?
YES, it is an INSECT.
NO, it may be a pillbug, barnacle, or millipede.

• Insects are mandibulate, arthropod, articulate, archaeogastral, bilateral, animal organisms.

How To Recognize an Insect

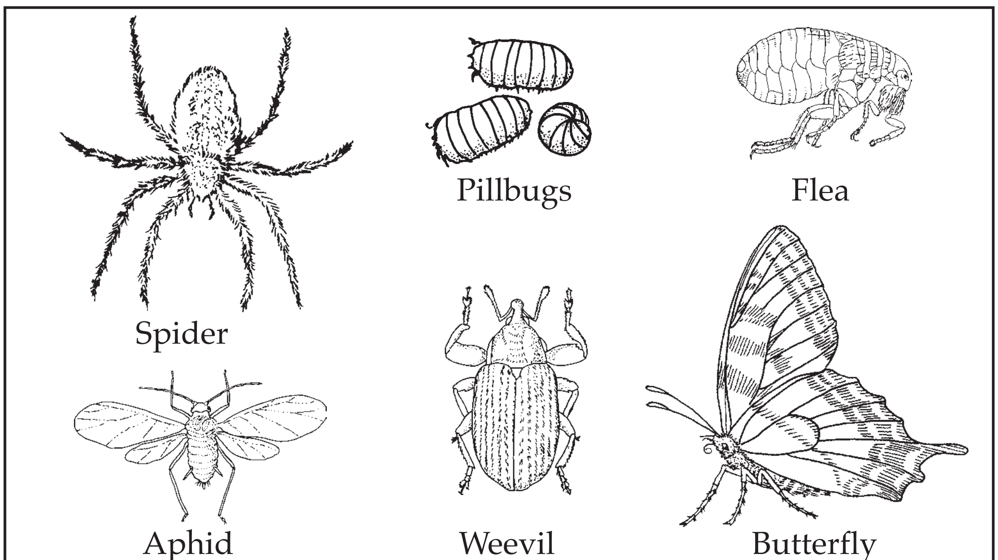
A great variety of small animals exist that you might confuse with insects. For example, spiders, ticks, scorpions, millipedes and pillbugs are **not** insects. So, how do you tell the difference between these creatures and insects? (See **An Insect Quiz** to the left.)

Only insects have their bodies pinched in to form a distinct head, mid-region (thorax) and hind region (abdomen).



All but the most primitive insects have only three pairs of segmented legs, all attached to the thorax.

Most insects also have one or two pairs of wings attached to the sides of the middle and back segments of the thorax.



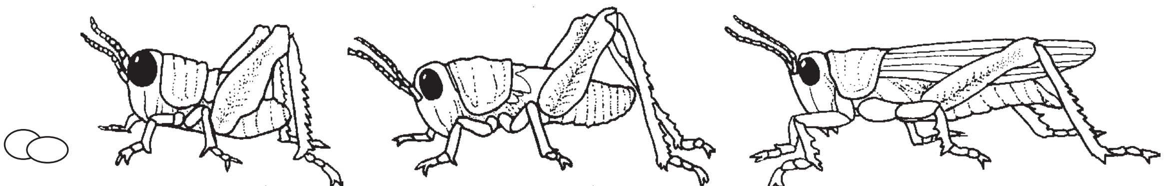
Circle the animals that you think are insects.

How Insects Grow

Insects change a great deal during their lives. These changes can be so drastic that various growth stages look entirely different. **Metamorphosis** (pronounced *metta-mor-fo-sis* and meaning change-of-shape-process) is the name given to the sequence of changes from egg to adult. The two most common forms of insect metamorphosis are called **gradual** and **complete**.

Gradual or incomplete metamorphosis

Here, the insect that emerges from the **egg** is called a **nymph**. It looks like a little **adult**, not like a worm. As the nymph grows, it sheds its skin and after several growth stages reaches adulthood. Wings develop from flaps on the thorax that enlarge sideways at each stage. The young nymphs live in the same habitat and eat the same food as the adults, thus competing with them directly.

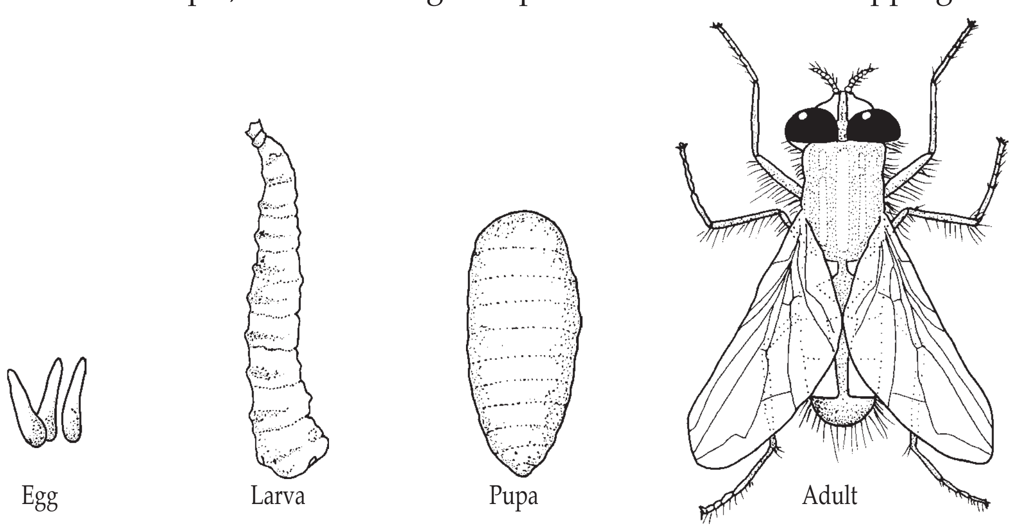


Egg Day 7-Nymph Day 23-Nymph Day 50-Adult

Life cycle of a grasshopper

Complete metamorphosis

Here, the embryo hatches from the egg without features of the adult. It usually resembles a worm and is called a **larva** (plural: **larvae**). Larvae shed their skins as they outgrow them and increase in size. After a certain number of sheddings, the outer skin hardens into a tough casing and the insect is now called a **pupa** or **chrysalis**. Some larvae which are caterpillars, like those of moths or sawflies, construct a silk covering over the pupa and this is called a **cocoon**. During its pupal stage, the insect transforms itself completely, with some cells moving into their adult position and the remainder turning to mush and being discarded. When the insect emerges from the pupal case, it is a winged **adult** and can reproduce. At first the wings are soft and shriveled. They are pumped up with blood to full size, then enzymes tan and harden the skin. Complete metamorphosis allows the young insect not to compete with the adult by living a different life from the adult in a different habitat. For example, the leaf-eating caterpillar becomes a nectar-sipping butterfly.



Life cycle of a two-wing fly

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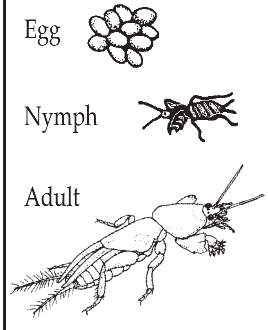
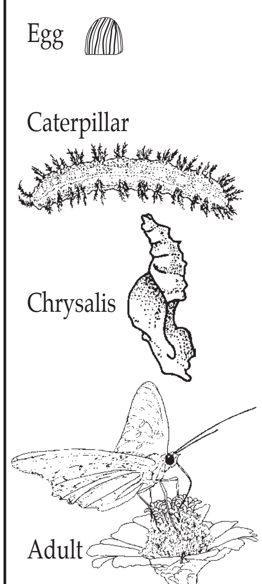


Gradual metamorphosis of a mole cricket

Where do you fit?

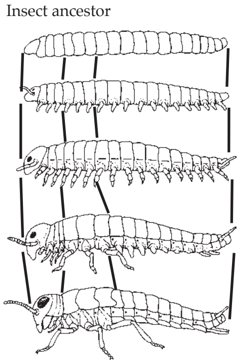


Complete metamorphosis of a Gulf fritillary

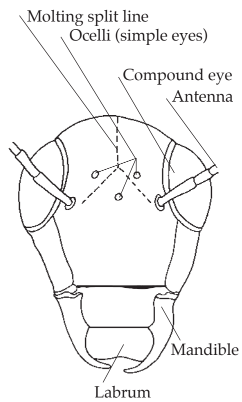
The Working Parts of an Insect: Outside

All insects have three body divisions:

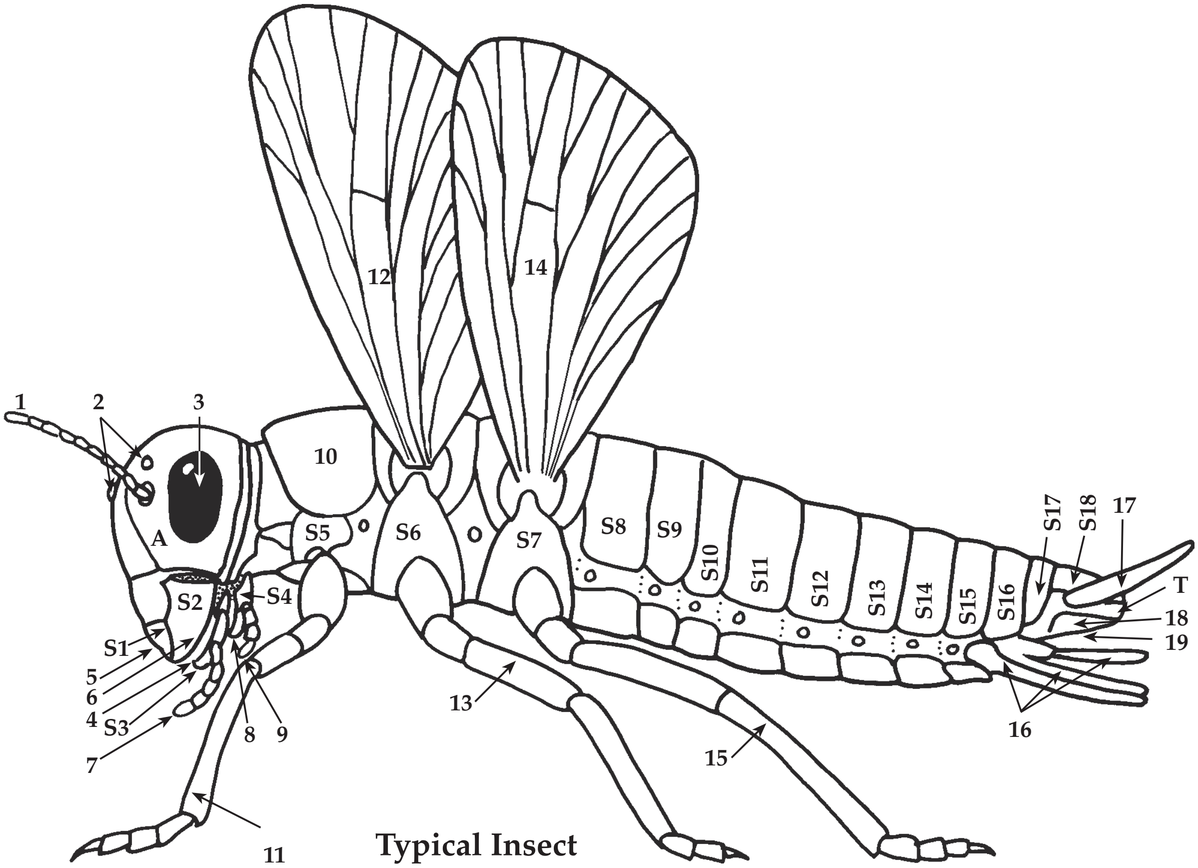
- The **head** is concerned with getting food and with sensing what goes on in the insect's surroundings. Thus, **eyes** (for seeing), **antennae** (mostly for smelling and tasting) and **mouthparts** (for feeding) are all located on the head.
- The **thorax** is the body division involved with movement. Thus, the **three pairs of jointed legs** (typical for all insects) and the **two pairs of wings** (possessed by most, but not all insects) are located on the thorax.
- The **abdomen** is the largest, fattest section and it contains the **organs** for digestion, elimination and reproduction.



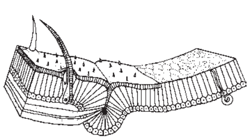
Evolution of insect anatomy



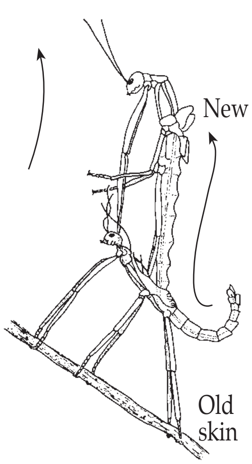
Front view of an insect head



Typical Insect



Exoskeleton



Molting of a stick insect

Head	Thorax	Abdomen
The **head** consists of: a cap or **acron** (A) in front with **antenna** (1); **ocelli** (2); **eyes** (3); **mouth** (4); segment **S1** with upper lip or **labrum** (5); segment **S2** with jaws or **mandibles** (6); segment **S3** with foodfingers or **maxillary palps** (7); segment **S4** with lower lip or **labium** (8); often with additional foodfingers or labial palps (9).	The **thorax** includes: segment **S5** or **prothorax** with **pronotal shield** (10); and **foreleg** (11); segment **S6** or **mesothorax** with **forewing** (12) and **midleg** (13); segment **S7** or **metathorax** with **hindwing** (14) and **hindleg** (15).	The **abdomen** includes: segment **S8** (often reduced or fused with the thorax in wasps); and segments **S9** through **14** (simple segments usually without appendages); segments **S15** to **S17,** carrying **gonopods** (16) or specialized appendages for mating and egg laying; the last segment **S18,** carrying hind feelers or **cerci** (17) and the **paraprocts** (18) or frass shapers for eliminating waste. The **anus** (19) opens between the last segment and the **telson** (T).

Insects do not have a skeleton made of bones inside the body the way we and other backboned animals do. Instead, the insect skeleton, called an **exoskeleton**, is a tough skin made of a horn-like material called **chitin** (pronounced *kai-tin*). The exoskeleton fits the insect's body like a suit-of-armor with flexible membrane joints that permit movement. As the insect grows, the body gets plumper, stretching the membranes until the skin must be shed to accommodate the larger body size. This shedding is called **molting**. There are several molts before an insect can mature.

The Working Parts of an Insect: Inside

Inside an insect's body are the organ systems concerned with various life functions.

The **digestive system** $\boxed{Y}$ — for extracting nutrients from swallowed food and pushing out the waste as **frass**. The system is basically a tube that starts at the **mouth** (1) with **salivary glands** (2). The tube of exoskeleton extends as **foregut** (3) to a **crop** (4) which often has teeth for grinding food. The soft **midgut** (5) is attached behind the crop where there are appendix-like sacks or **diverticulae** (6). These secrete digestive enzymes. The midgut absorbs nutrients, which are transported to the cells by the blood.

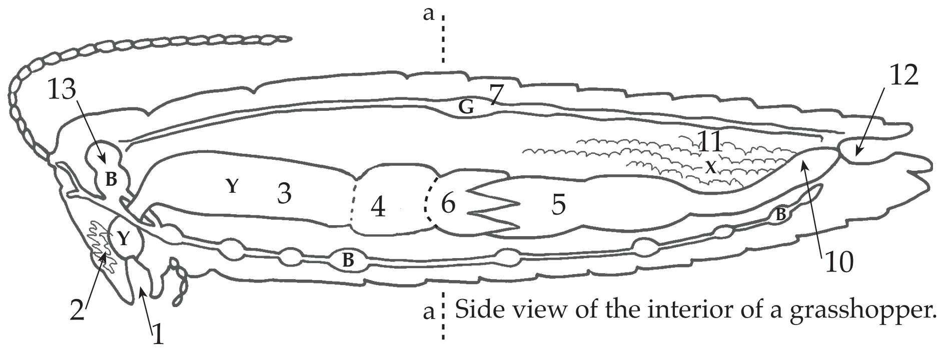
The **circulatory system** $\boxed{G}$ — for carrying nutrients to, and waste from, all the parts of the body. A tube-shaped segmentally chambered **heart** (7) pumps the greenish-colored blood to the front of the body along the back. This fluid then circulates freely throughout the body, seeping toward the back as it bathes the cells. There are no blood vessels.

The **respiratory system** $\boxed{P}$ — for obtaining oxygen from air and getting rid of carbon dioxide. Tiny tubes called **tracheae** (8) (pronounced *tray-key-ay*), carry air throughout the body from small outside openings called **spiracles** (9). Aquatic insects have gills as well to keep the tracheae from flooding. Oxygen passes across the gill membrane into the tracheae. Gases are passed directly between cells and tracheae. Some larger insects such as dragonflies and bees may be seen to breathe by muscular movement. Some insects use air to make hissing sounds.

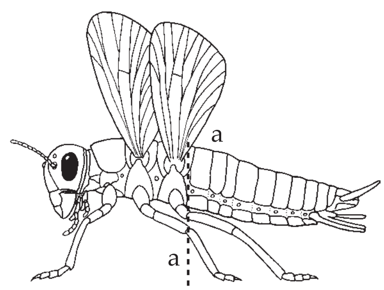
The **excretory system** $\boxed{X}$ — for getting rid of the waste left from metabolizing nutrients. The **hindgut** (10) excretes crystals of soluble waste products removed from the blood by **Malpighian** tubules (11) which function like kidneys. This soluble waste is excreted dry and combined with discarded food detritus to form the **frass** which is expelled through the **anus** (12). The dry excretion of soluble waste allows retention of water. Some wastes get stored in the hard skin of the exoskeleton where they are used to make pigments for bright colors.

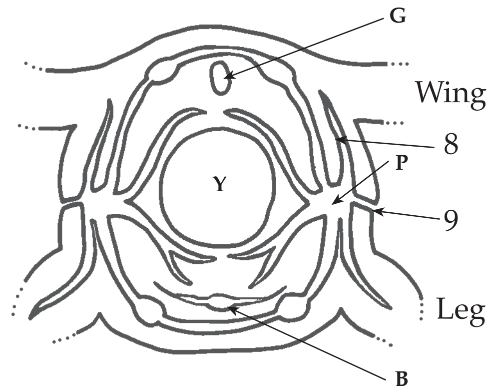
The **nervous system** $\boxed{B}$ — for picking up information from the sense organs and coordinating behavior. There is a **brain** (13) at the head end. A double nerve cord runs the length of the underside of the body. There are nerve centers or **ganglia** (14) in each segment to control various parts of the body. Because of these extra brains, an ant that has lost its head will still walk.

The **reproductive system** — for the production of future generations. Females have two ovaries with eggs, and males have two testes and an organ for mating. Females mate and save sperm to use later. In most insects, eggs are fertilized as they are laid. Some insects lay unfertilized, yet viable, eggs. This process is called **parthenogenesis**. Many insects may be parthenogenic in summer but produce males for sexual reproduction in winter.

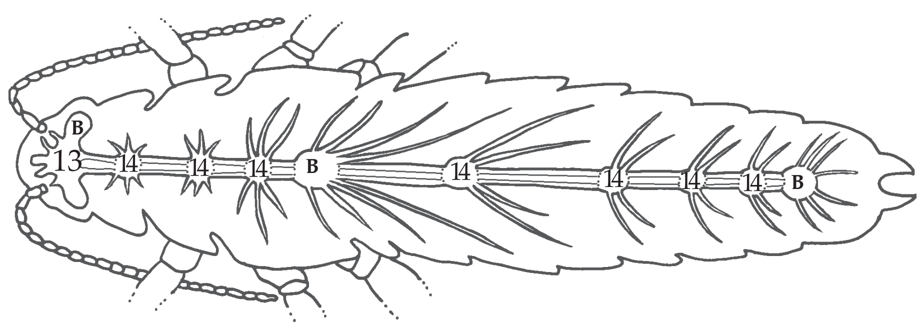


Side view of the interior of a grasshopper.





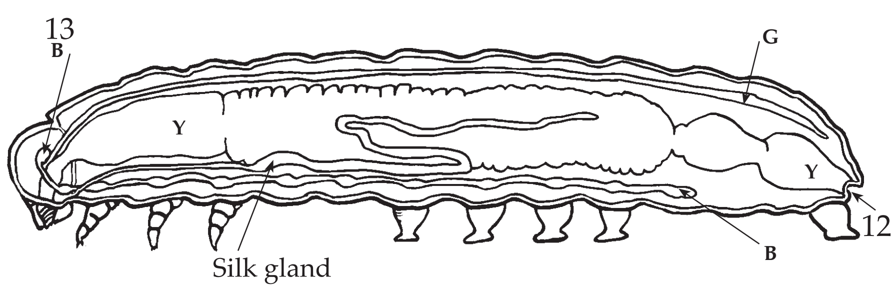
Cross-section (a-a) of the interior of a grasshopper.



Bottom-up view of the interior of a grasshopper.

Color Guide

G - Color the blood vessel green.
Y - Color the digestive system yellow.
X - Color the excretory system (Malpighian tubes) red
B - Color the nervous system blue.
P - Color the air tubes of the respiratory system pink.



The alimentary canal (Y), silk gland, dorsal blood vessel (G) and ventral nerve cord (B) of a caterpillar.

How Insects Smell, Taste, See and Hear

Smelling and tasting are most important to insects. They are chemical senses that use nerve sensors to recognize molecules. Insects use smell and taste to recognize others of the same species, distinguish males from females, locate suitable foods and follow trails back to the nest.

Molecules carried by breezes land on nerve sensors on the antennae where they are identified as **smells**. Male silk moths smell **pheromone** (pronounced *fer-oh-moan*) molecules released by a female miles away and fly to her. Sexton beetles can smell a dead mouse many yards away and fly to it to lay their eggs on this food and bury it.

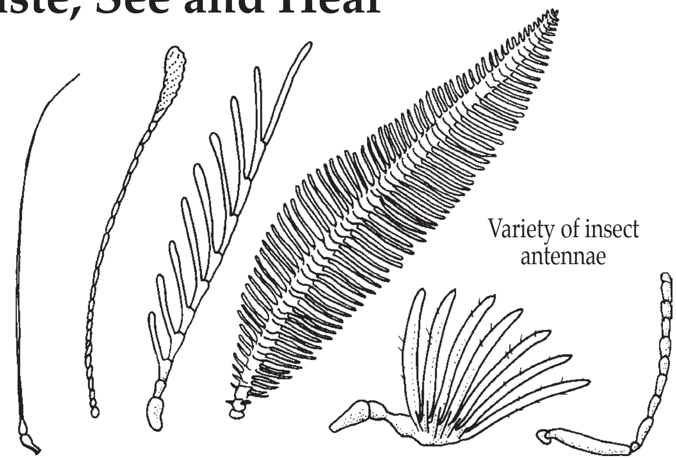
Other insects **taste** flavors by touching membranes to foods. Beetles and cockroaches taste with their mouth palps. Butterflies taste leaves with organs on their feet to identify suitable caterpillar food on which to lay eggs. Ants use their antennae to taste the chemical trails marked for them by fellow workers.

Seeing is also very important to insects. This physical sense is based on the intensity, color wavelength and polarization of light.

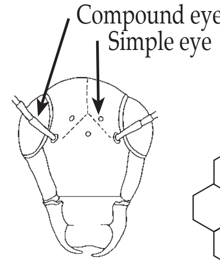
Simple eyes, or **ocelli**, are present in most larval insects and many adults where there may be up to three. They are used to distinguish day from night, and determine the polarization of light which is used to tell time or direction.

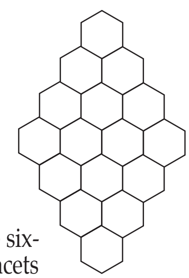
Compound eyes are found in the adults of insects and other arthropods. The individual eyelets are close-packed honeycomb-like to form a compound eye with six-sided lens facets of clear thick cuticle. Under each facet, an eyelet has its own receptor and optic nerve. We do not know how an insect puts these individual pictures together in its brain. We do not know what a bee actually sees. Compound eyes are good for detecting minute movement. They also sense colors but in different parts of the spectrum than we do. Thus bees and butterflies see the hidden ultraviolet patterns in flowers.

Hearing is another important sense for many different insects. Most insects hear by sensing the vibration of small hairs or membranes on the skin. Grasshoppers, crickets and cicadas signal their presence by making noise with **ratchets** or vibrating membranes. They make noise to communicate their presence or attract mates. Crickets and mantises have membrane organs on the front legs that function as ears. Grasshoppers and cicadas have ears on the abdomen. Many moths have ears on either the thorax or abdomen, tuned to the frequencies of bats, their most serious predators.

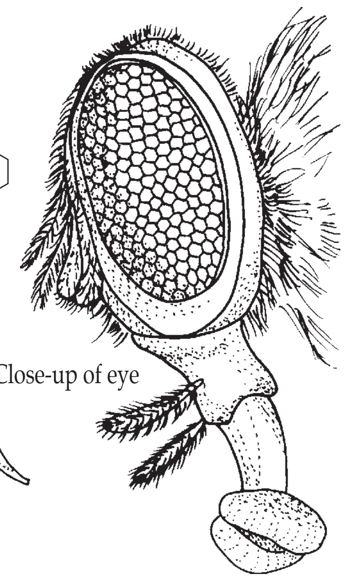


Variety of insect antennae

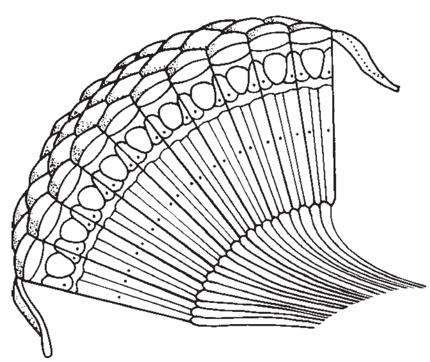




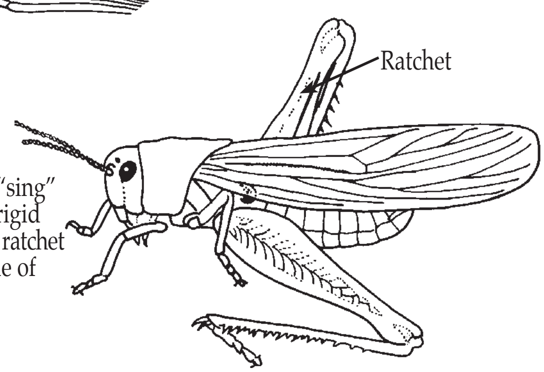
Honeycomb six-sided lens facets



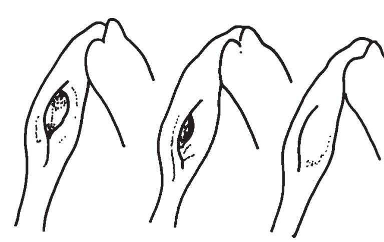
Close-up of eye



Under each facet each eyelet has its own receptor and optic nerve.



Grasshoppers "sing" by bowing the rigid forewing with a ratchet on the inner side of their hindleg.



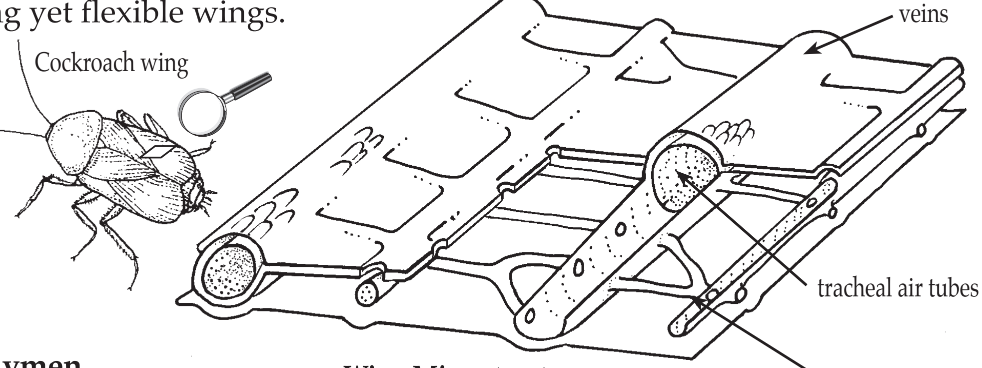
Crickets and mantises have membrane organs on the front legs that function as ears.

How Insects Fly

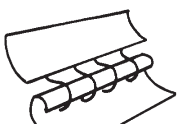
Most insects have wings and can fly. Insects were the first organisms to evolve wings 325 million years ago in the middle of the Carboniferous Period. Wings helped their owners escape from the predatory arachnids (spiders and their relatives) and vertebrates that proliferated at that time. Wings may have first served as a shield for the soft abdomen, then as a parachute. They also serve as a radiator-receptor to warm the blood in sunlight on a cold day.

The wing is a "cell sandwich" with tracheal air tubes and blood pathways between upper and lower cuticle. The cuticle is thickened, usually over blood vessels and tracheae to form **veins**. These veins are struts that permit long and strong yet flexible wings.

Insects that have power flight use hooks or other methods to lock their wing pairs together in flight.

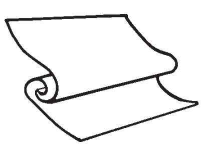


Wing Microstructure



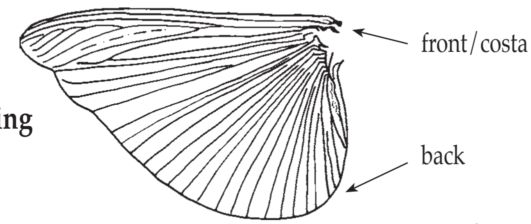
Wasps use a **hymen** or row-of-hooks.

Moths use a **frenulum** or spike-in-bracket.

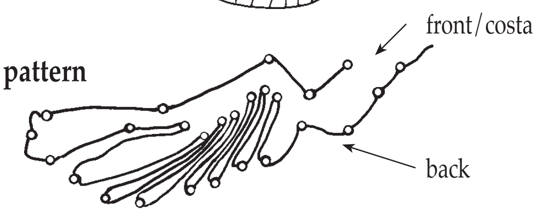


Bugs use a **sulcus** or folded margin.

Open wing

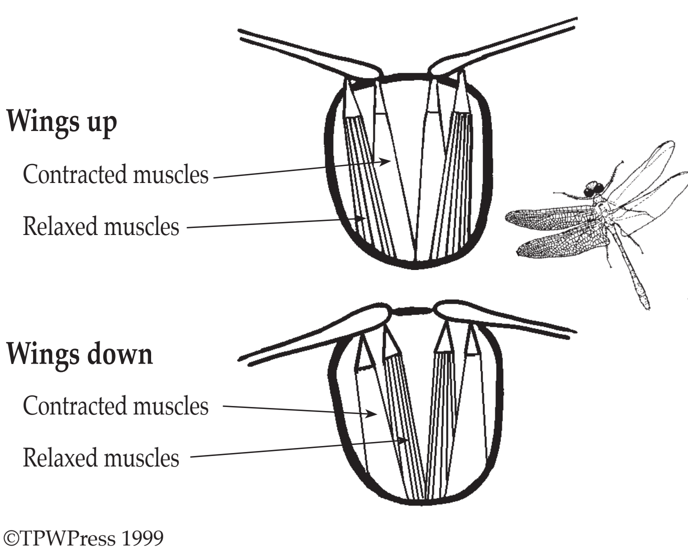


Folding pattern



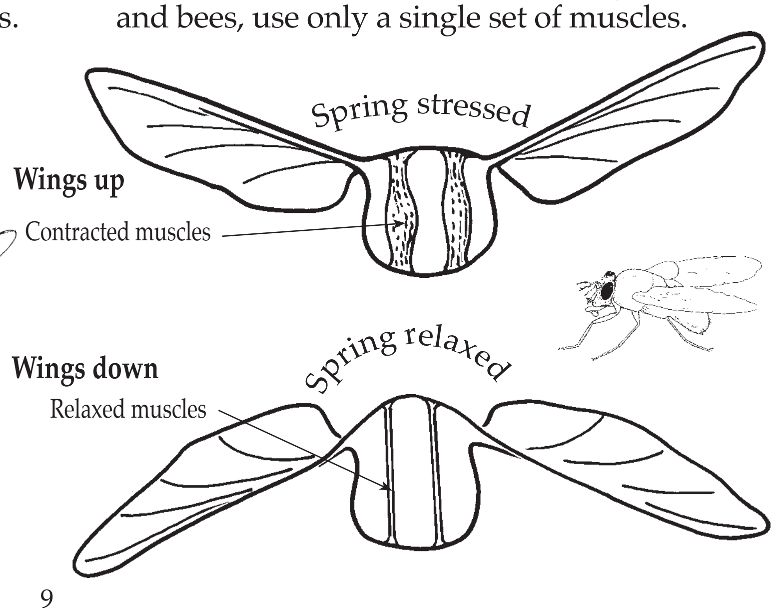
Primitive Wing Structure

In order to move the wings, primitive insects like mayflies and dragonflies use two sets of muscles.



Advanced Wing Structure

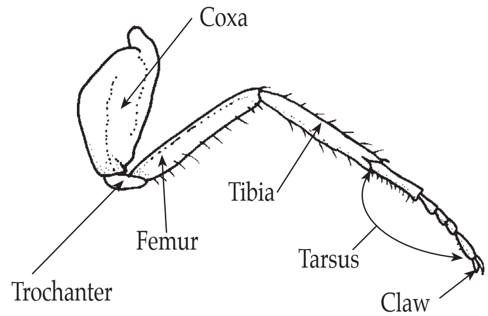
More advanced fliers, like butterflies, flies and bees, use only a single set of muscles.

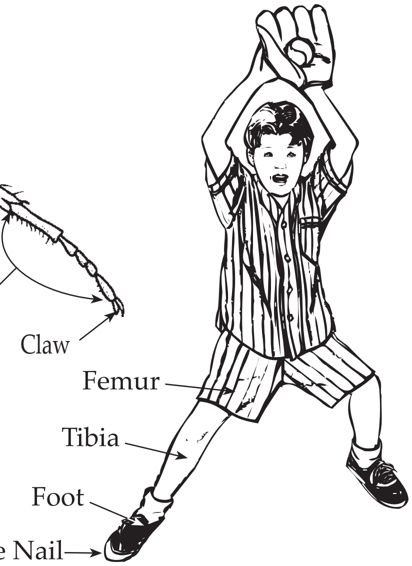


How Insects Move

Most adult insects, nymphs and many larvae have three pairs of legs, one for each segment of the middle section of the body called the **thorax**.

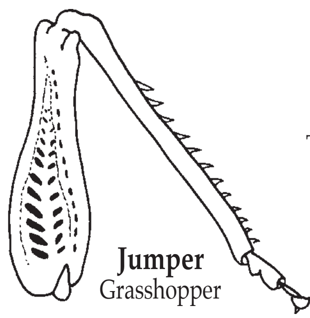
The usual insect leg consists of five parts:
The **coxa** joins the leg to the body and is often fused with the body.
The **trochanter** is a small joint permitting the leg to rotate foreward and back.
The **femur** looks like a thigh and is usually large.
The **tibia** looks like a shin.
The **tarsus** looks like a foot with up to 5 segments. It ends in a claw or pair of claws. Many insects have hairy or sticky pads on the tarsal segments for traction and tasting. All segments of the leg may have articulated spines or rigid teeth for traction or protection.



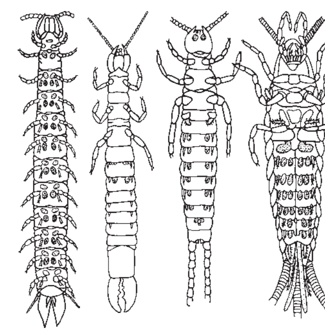


Names of the parts of your leg

The shapes and proportions of the various parts that go to make up an insect's leg vary, depending on its way of life:



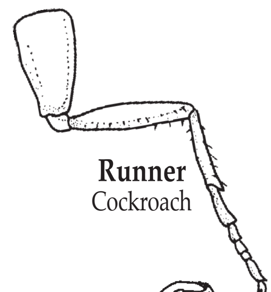
Jumper
Grasshopper



The many legs of primitive insects (view of abdominal leglets and tubercle organs)

Grasshoppers, crickets, fleas, leafhoppers, leaf beetles and other **jumpers** have muscular femurs and long propelling tibias.

Tiger beetles, ants, cockroaches and other **runners** have long legs in strong sockets.



Runner
Cockroach

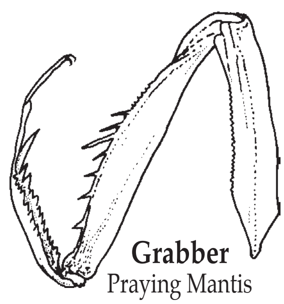
Chafers and other **tree-climbing** beetles have strong turned-back claws for grasping twigs and leaves.

Hanging flies have similar recurved claws for capturing and **holding** prey.

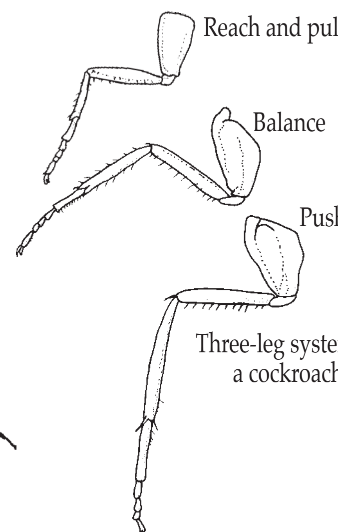
Water beetles and water bugs have paddles or hair-fringed flippers for **swimming**.

Pond striders, caddis flies and other **pontoon walkers** have fringed feet that hold air-bubble floats permitting walking on water.

Flies and other **crawlers** on smooth leaves or skin have dry adhesive pads that cling to glass with a molecular bond the same way that plastic wrap does.



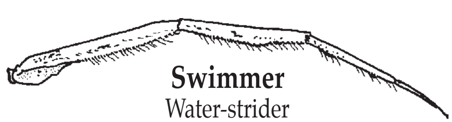
Grabber
Praying Mantis



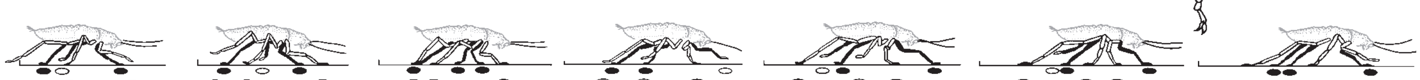
Three-leg system of a cockroach

Mantises, mantis flies, assassin bugs and other **hunting** insects have a forelimb with a spined and muscular femur and opposing tibia for **grabbing** prey.

The usual insect walk is accomplished with reaching forelegs, stabilizing midlegs and pushing hindlegs. The majority of insects have other specialized functions for one or more pairs of legs. In addition to those already mentioned these include **digging**, **clasping**, **signaling** and **disguise**.



Swimmer
Water-strider



When an insect walks it never lifts more than one or two legs at a time. This gives the insect walk a wavelike motion. Each pair of legs performs a specific function. The forelegs reach ahead, the hindlegs push, while the midlegs act as stabilizers.

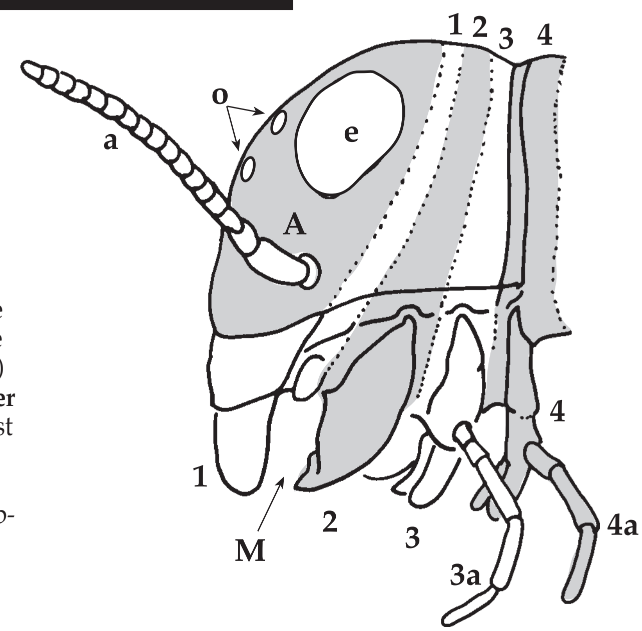
How Insects Feed

Insects feed on all sorts of organic materials. Some bite and chew plant materials, others are hunters or scavengers that eat meat (usually other insects), still others suck plant juices or blood. There are even midge larvae that feed on crude oil in tar seeps, digesting it with bacteria in the gut.

Biting and chewing mouthparts consisting of several pairs of jaws and jaw-like structures moving from side to side are the basic kind found in insects. These mouthparts evolved from the jointed legs of the front segments of the early ancestor of insects. Biting and chewing mouthparts are common to beetles, grasshoppers, cockroaches, termites and most wingless primitive insects.

Basic Kind of Insect Head and Mouth Structure

A - The **acron** is the front-end head cap. It is divided on top by a Y-shaped epicranial suture, found only in insects.
o - The three **ocelli** or little eyes.
a - The **antennae** or feelers.
e - The **compound eyes** or big eyes.
M - The **mouth** opens between acron and segment 1 underneath.
1 - The **labrum** is the movable upper lip on segment 1 that is joined to the acron behind and around the mouth.
2 - The **mandible** is the limb of segment 2 which also bears the tongue.
3 - The **maxilla** is the limb of segment 3. It has a **coxa** of two segments. The mandible-like **lacinia** is attached to the inside of the coxa. The palp-like **galea** is attached to the end of the coxa. The leg-like **maxillary palp** (3a) is attached to the outer side of the coxa. This jointed palp has its **trochanter** attached to the coxa, followed by **femur**, **tibia**, **tarsus** and **pretarsus**, just like a leg.
4 - The **labium** is the limb of segment 4. It has a **coxa** of two segments. The lip-like **glossa** is attached to the outer segment on its inner edge. The palp-like **paraglossa** is attached to the end of the same segment. The leg-like **labial palp** (4a) is attached to the outer edge of the same segment. This jointed palp has a **trochanter**, followed by a **femur** and **tibiotarsus**.



This basic kind of chewing structure is modified in other groups of insects. Usually the modified mouthparts take on a thin, long, piercing and/or sucking shape.

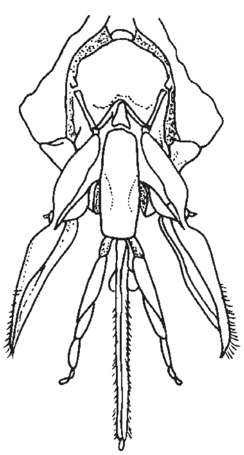
Modified Mouthparts

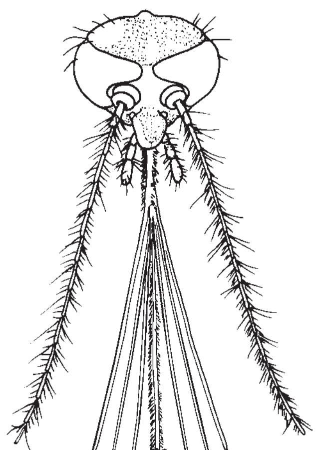
Chewing / Lapping: bees and some wasps

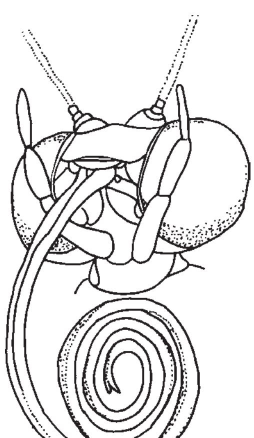
Piercing / Sucking: most true bugs, leafhoppers, treehoppers, mosquitoes, fleas and horseflies

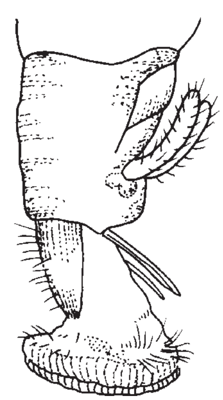
Siphoning: butterflies and moths

Sponging: houseflies and stableflies


Bee


Mosquito


Butterfly


Fly

Major Features of the Evolution of Insects

In Cambrian times, 570 million years ago, a kind of marine crustacean adapted to life in beach pools, caves and freshwater ponds. This may have been an **agnostid** or an **ostracod**.

The first insects were **entomostracans** or tiny shrimp-like animals that lived in caves or in damp earth between the rocks sometime between the late Cambrian and the Silurian, from about 535 to 440 million years ago. They stopped being crustaceans when the organization of the head, with one pair of antennae, reached that of insects and when the molt line was restricted to the back and neck. At first they had to be small, as oxygen reached the body cells only by diffusion through the skin.

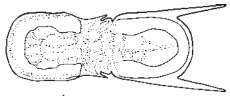
They evolved inpocketing of the skin which formed tubes that brought fresh air through a branching network of tracheal tubes to serve cells deep within the body. This allowed an increase of body size that brought insects out from under rocks and exposed them to the predators of the time. These predators were only arachnids and centipedes until the end of the Devonian, about 350 million years ago, when vertebrates came out on the land. To evade predators, the early insects evolved different body styles and ways of life. They fed on fungus, lichen, algae, decaying plant matter, worms and small arachnids. From this early radiation, symphylans, diplurans, proturans, bristletails and springtails have survived.

By the early Devonian, 390 million years ago, some insects evolved a stronger jaw. The two sockets on which the jaw now moved allowed strong muscles and precise biting. Woody plants, armored arthropods, shelled snails and active amphibians became potential food. From this stage, silverfish have survived.

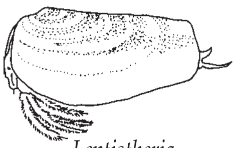
By mid-Carboniferous time, 325 million years ago, some insects specialized for amphibious or aquatic life, becoming predators of ponds, especially ephemeral pools which had no predatory fish. To breathe in water, flaps at the edge of the body developed rich tracheae in order to absorb oxygen from the water. These flaps became gills. Some of these gills were used as fins for swimming. As the body grew larger after each molt, the fin-gills enlarged; those of the muscular thorax, especially on the second and third segment, were largest. Amphibious adults could crawl out on vegetation and fall on prey, using the expanded gills as parachutes.

Precision of movement increased with the development of a muscular articulation and the parachute gill-flaps became wings. Dragonflies and mayflies have survived since the middle of the Carboniferous Period from this stage.

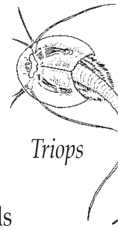
The early members of this group all had **nygma**, or clear disc-shaped wing organs of unknown function that today are found only in the wings of panorpoid (see page 37) and neuropteroid (see page 49) superorders. Most of the early nygma-bearing insects, other than dragonflies, evolved sucking mouthparts, at least in the adult stage. They certainly fed on the protein-rich developing cones of higher plants and may also have fed mosquito-like on the blood of the large basking labyrinthodont amphibians of the middle Carboniferous Period.



Agnostus

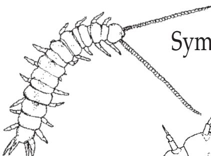


Leptistheria



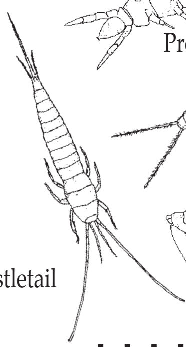
Triops

Tiny shrimp-like animals

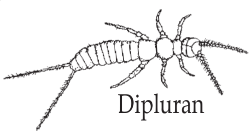


Symphylan

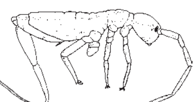
Proturan



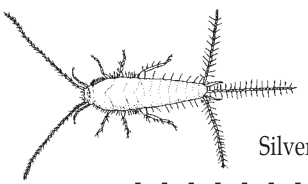
Bristletail



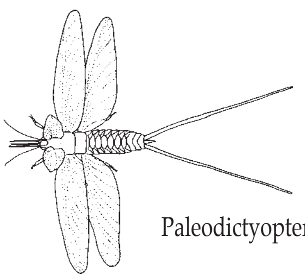
Dipluran



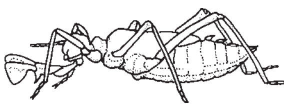
Springtail



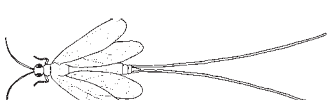
Silverfish



Paleodictyopteran



Dragonfly nymph



Megasecopteran

Meanwhile, also in the mid-Carboniferous, 325 million years ago, other insects specialized for terrestrial life under and on vegetation. The flanges of the thoracic segments enlarged to form shields, especially backwards, to protect the soft upper surface of the flexible abdomen. In order to mate, these shield flaps had to be articulated. They were probably used in courtship rituals as signaling devices and as parachutes during falls out of bushes. Webspinners and angel flies have survived from this stage. None of these insects or their derivatives had nygma.

About 315 million years ago in the late Carboniferous, formidable new predators appeared in the form of small reptiles. Insects with sluggish or uncontrolled flight were ready prey. A lot of large insects went extinct when the first reptiles appeared.

Forewings became modified as aerodynamic surfaces and hindwings became large undulating pulsed sails, by enlargement of the rear edge. This happened independently in several different orders. Some cockroaches have simple wings as do their termite and beetle derivatives. Others cockroaches have folded vannal fans on the hindwing as do their mantis and cricket derivatives. Grasshoppers and stick insects have folded vannal fans of the hindwing composed of a combination of veins different than those in cockroaches. Stoneflies and earwigs have yet another configuration of the hindwing fan.

By 302 million years ago, during the late Carboniferous, some nygma-bearing insects evolved a pupal stage and proliferated in the Permian to become the panorpoid complex including snowskips, scorpionflies, fleas, caddis flies, moths, flies and twistwing flies. A second branch proliferated in the late Carboniferous to become neuropteroids including snakeflies, dobson flies and lacewing flies.

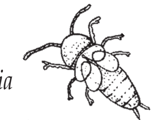
Also by 270 million years ago, in early Permian time, some of the relatives of angel flies developed piercing, then sucking mouthparts and survive today as bark lice, biting lice, sucking lice, true bugs, leafhoppers and thrips. A few leaf hopper scale insects have achieved a pupa-like stage.

Also by Early Permian time, about 270 million years ago, some of the simple-winged cockroaches evolved a pupal stage, hard forewing cases and a pattern of folding that permitted an extra long hindwing. These survive as beetles, the order of animals that today is richest in species.

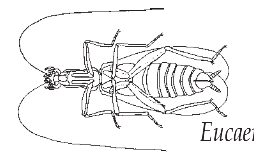
By 225 million years ago, during Triassic time, a group of parasitic neuropteroid insects evolved a hooked wing-lock mechanism and became parasitic wasps. Some larvae switched from parasitism to eating leaves and became sawflies. Others developed a pronounced waist, setting the stage for the evolution of bees and ants when the flowering plants evolved in the mid-Cretaceous Period about 100 million years ago.

Almost all the insect forms we know today had evolved by the time the dinosaurs appeared 220 million years ago. Beetles proliferated first, feeding on the high-protein pollen of conifers and later flowering plants. Flies, moths and bees took advantage of the high-energy nectar produced by flowering plants that diversified in the mid-Cretaceous. The general diversity of insects survived the asteroid impact event at the end of the Cretaceous which is thought to have wiped out the dinosaurs. Indeed a species of carpenter ant and the smoky brown cockroach survived this crisis, and are still with us today.

Herdinia

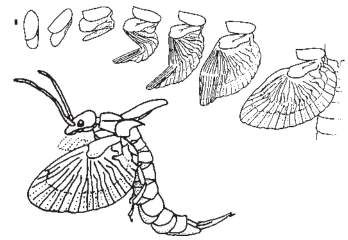


Early winged insect

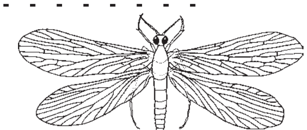


Eucaenus

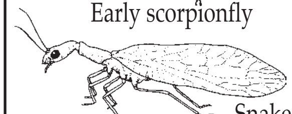
Roach relative



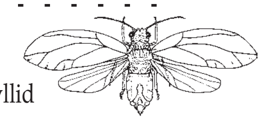
Unfolding of earwig hindwing



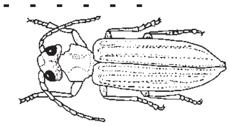
Early scorpionfly



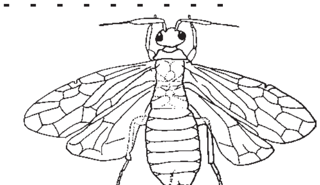
Snakefly



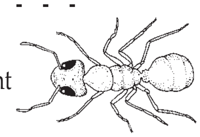
Psyllid



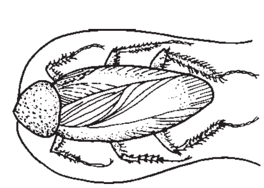
Cupedid beetle



Early wasp



Carpenter ant

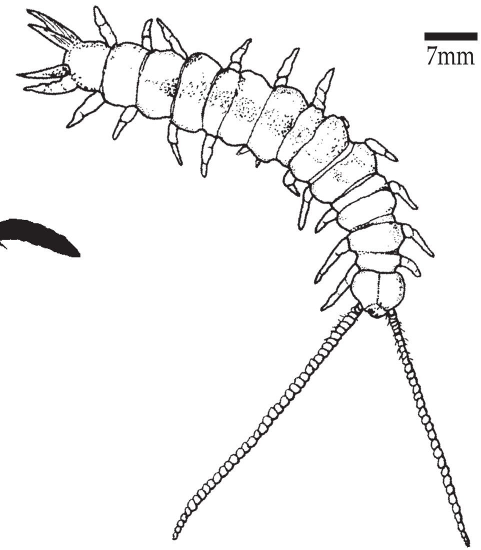


Smoky brown cockroach

Included here are survivors of the first kinds of insects that crawled onto land at least 400 million years ago. Three classes include three living orders.

SYMPHYLANS Order Scolopendrellida — 33rd in diversity — 6+ species in Texas.
Although they look like little centipedes, these animals have the same kind of head as other insects. They have the same kind of abdominal leglets and tubercle organs on their underside (see page 10) as other wingless insects, and they spin silk.

Garden symphylan (*sym-fie-lan*)



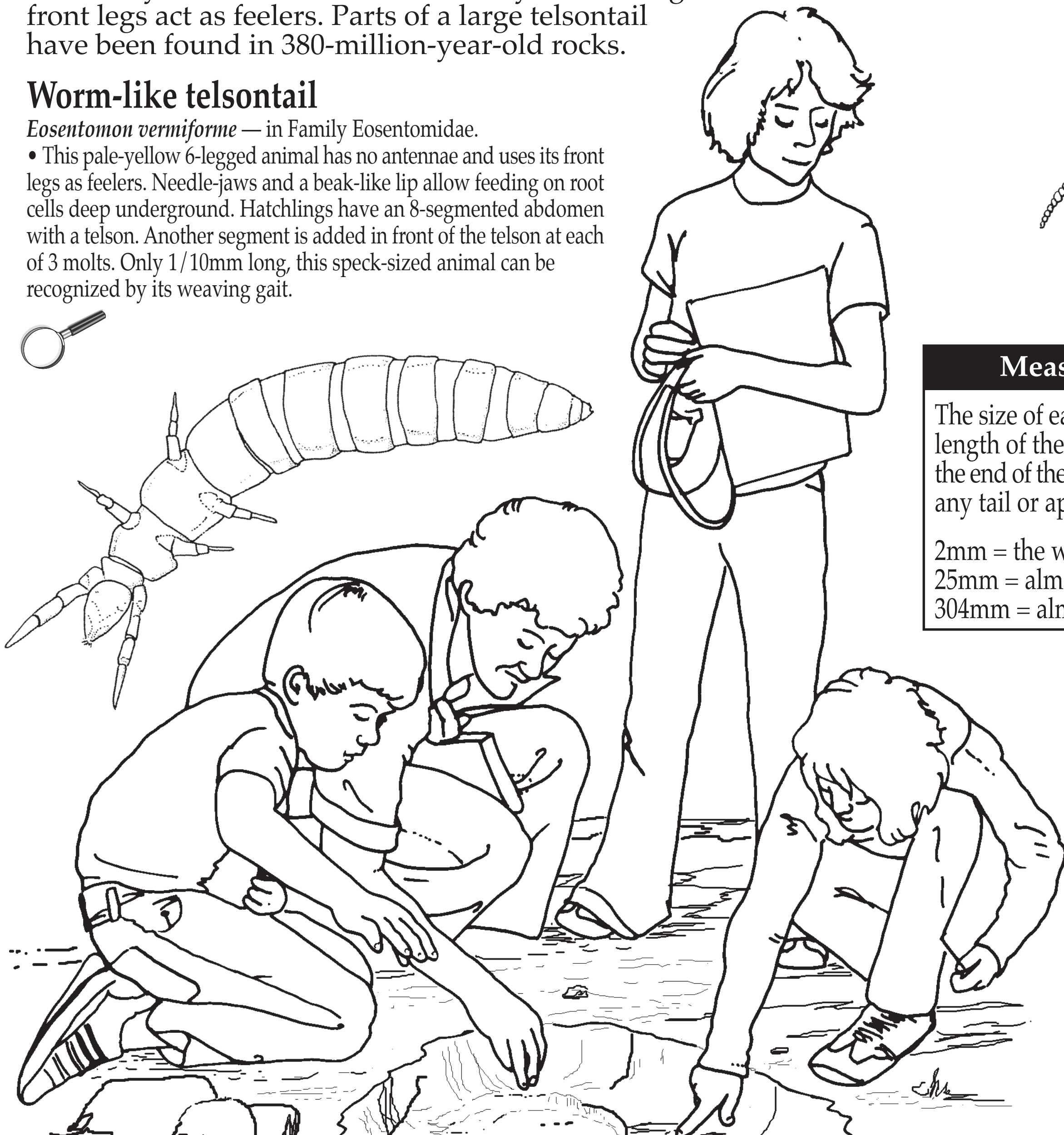
Symphylella texana — in Family Scolopendrellidae.
• This white 24-legged centipede-like animal has a true insect head but no differentiated thorax. The 7mm adult spins silk around the eggs and guards them. Hatchlings have 12 legs and add a pair at the back at each molt. Young and adults eat root hairs in rich organic earth.

TELSONTAILS Order Protura — 29th in diversity — 8+ species in Texas

These tiny insects lack antennae and eyes. The long front legs act as feelers. Parts of a large telsontail have been found in 380-million-year-old rocks.

Worm-like telsontail

Eosentomon vermiforme — in Family Eosentomidae.
• This pale-yellow 6-legged animal has no antennae and uses its front legs as feelers. Needle-jaws and a beak-like lip allow feeding on root cells deep underground. Hatchlings have an 8-segmented abdomen with a telson. Another segment is added in front of the telson at each of 3 molts. Only 1/10mm long, this speck-sized animal can be recognized by its weaving gait.



Measurement Key

The size of each insect is given as the length of the adult from the head to the end of the abdomen (not including any tail or appendages).

2mm = the width of a nickel coin
25mm = almost an inch
304mm = almost a foot

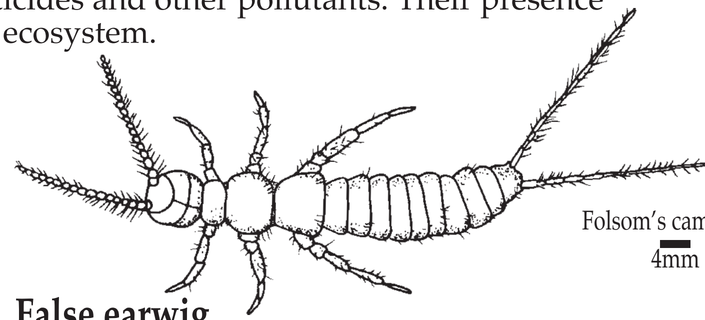
CAMPODEANS Order Diplura — 25th in diversity — about 27+ species in Texas

These small white insects are sensitive to pesticides and other pollutants. Their presence in the soil is an indication of the health of the ecosystem.

Folsom's campodean (*camp-oh-dee-an*)

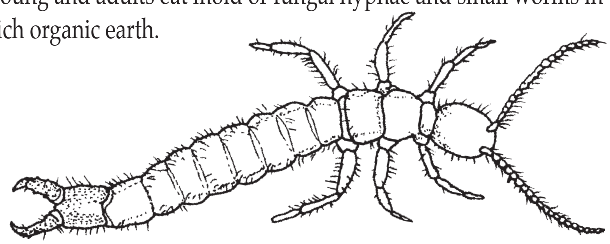
Campodea folsomi — in Family Campodeidae.

• This white 6-legged 2-tailed animal has a body like a string of beads. The 4mm adult spins silk. The young are born with 6 legs. Young and adults eat mold or fungal hyphae and small worms in rich organic earth.



Folsom's campodean

4mm



False earwig

Japyx diversiunguis — in Family Japygidae.

• This pale-yellow 6-legged animal has a pair of pincers on the abdomen. It looks like a small wingless earwig. The 8mm adult places eggs on a silk stalk in an earth cavity it guards. Hatchlings lack pincers and are guarded by the mother. Young and adults eat other soil arthropods.

HEXAPOD INSECTS — Class Hexapoda — (Includes all the remaining insects)

The earliest hexapod insects were small six-legged **wingless** forms that adapted to life under rocks at least 400-million years ago. Two subclasses include three living wingless orders. In two orders, the springtails and bristletails, leverage of the jaws is weak because there is only one articulation of the mandible with the head.

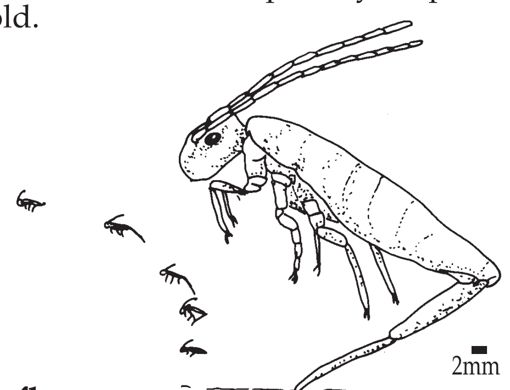
SPRINGTAILS Order Collembola — 9th in diversity — 295+ species in Texas

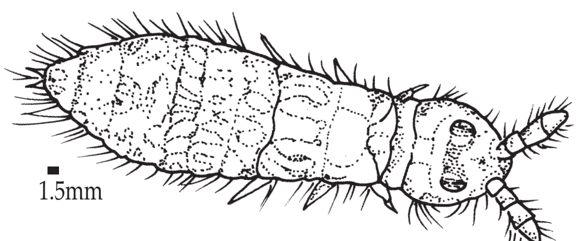
The body is compact by fusion of segments in the abdomen. This provides stability during the huge leaps performed using the spring apparatus. (See Pearly springtail below). Some springtails, like butterflies, have ribbed scales that refract bright metallic colors, especially in species that live in flowers and feed on pollen. Springtails recycle leafmold.

Pearly springtail

Pseudosinella violenta — in Family Entomobryidae.

• This white insect has iridescent pearly-bluish scales. The 2mm adult has an abdomen of 6 compacted segments. The last pair of leglets on the abdomen are lengthened to form a jacknife-spring, latched by a clasper under the body. Release of the clasper flings the insect high into the air where it may be blown away from predators. The adult places eggs in a varnish capsule. Juveniles molt 6 times. Young and adults feed on fungal hyphae, spores and bacteria.





Fungus flea

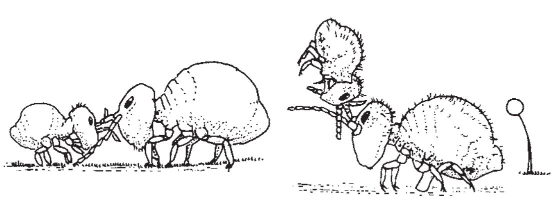
Hypogastrura boletivora — in Family Hypogastruridae.

• This blue-gray-violet insect is pale yellow underneath and covered with waterproof wax. The 1.5mm adult has an abdomen of 6 compacted segments. The furcula spring is very short. Young and adults feed on fungal spores and hyphae and may be found on mushrooms and moldy leaves by the billions in winter.

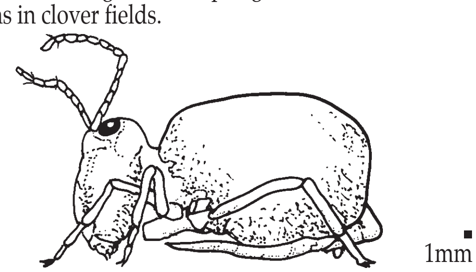
Forage flea

Sminthurides violaceus — in Family Sminthuridae.

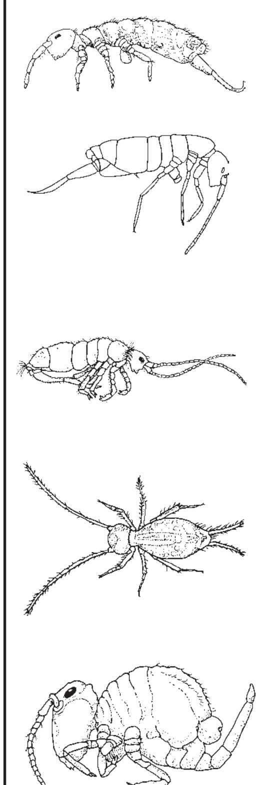
• This is a violet-brown speckle-patterned globular insect. With a tiny head and a large furcula spring, it looks like minute jumping pea. The 1mm adults and young sometimes swarm by the billions in clover fields.



The female captures the male springtail to fertilize her egg.



more stuff . . .



Other springtails

more stuff . . .

Insect designing and story telling

You've learned about the parts that make up an insect. Now, take your ideas and develop a new species of insect.

On a sheet of paper or in your journal, draw and tell the story of the discovery of your insect.

Write about how you discovered it.

What were you doing at the time of your discovery?

Does your insect fly, walk or swim?

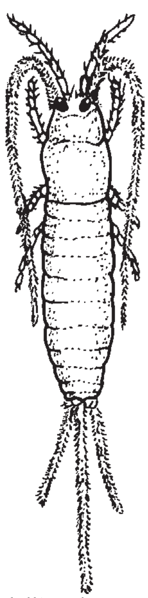
How does it develop?

What kind of food does it eat?

Where does it live?

Does it travel great distances or stay in your backyard?

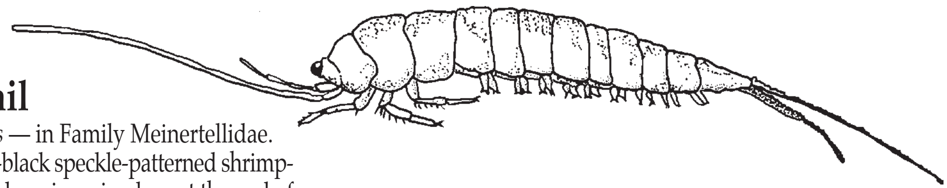
Draw an image that your insect might see from its habitat.



Reddell's subterranean silverfish

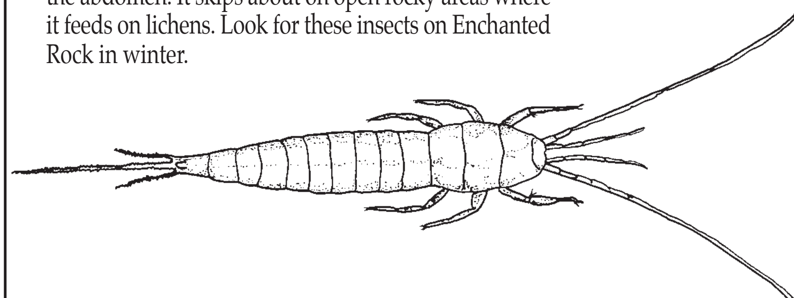
BRISTLETAILS Order Machilida — 30th in diversity — 8+ species in Texas

Bristletails have a body round in cross section or flattened sideways like a shrimp. Fossil bristletails have been found in 390-million-year-old rocks.



Rock bristletail

Hypomachilodes texanus — in Family Meinertellidae.
• This 18mm gray-and-black speckle-patterned shrimp-shaped insect has very long jumping legs at the end of the abdomen. It skips about on open rocky areas where it feeds on lichens. Look for these insects on Enchanted Rock in winter.



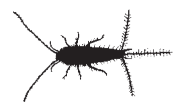
Prairie bristletail

Machilis variabilis — in Family Machilidae.
• This 9mm silvery and brown speckle-patterned shrimp-shaped insect also skips among the pebbles of gravelly prairie. It feeds on devil's dishrag algae and lichens. These insects may swarm by the millions in winter.

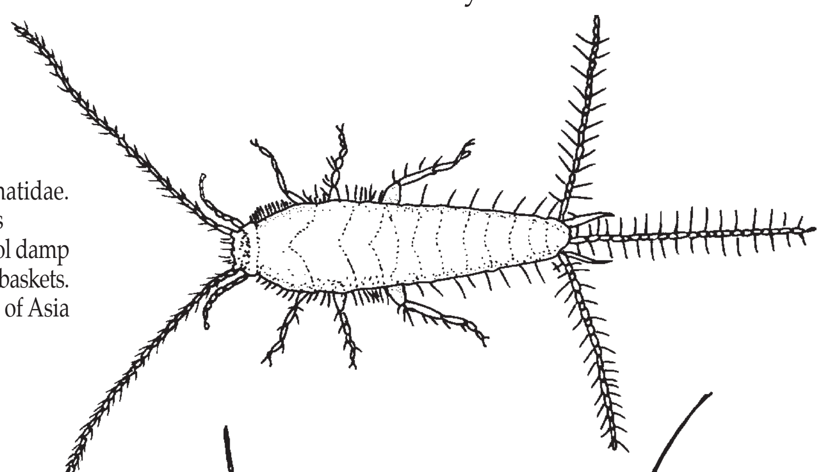
STRONG-JAWED INSECTS — Subclass Dicondylata — (Includes all the remaining insects.)

At least 392 million years ago insects made their first great leap forward. The jaw developed a second articulation socket with the head. This allowed strong muscles to power a mandible with optimum leverage.

SILVERFISH Order Lepismida — 28th in diversity — 8+ species in Texas

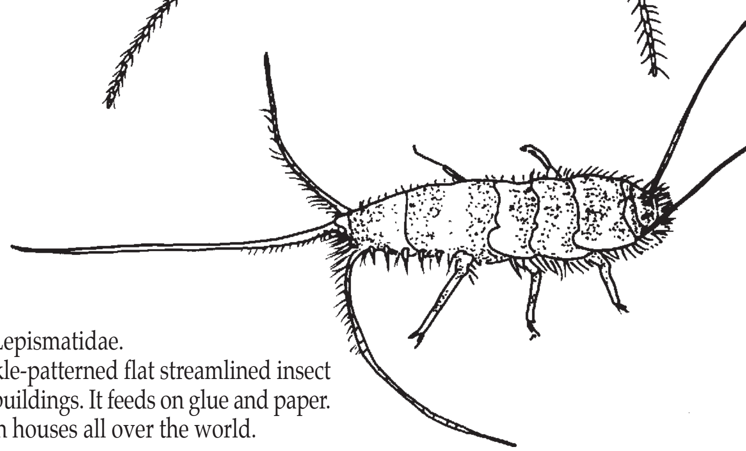


Silverfish are primitive wingless insects, flattened top to bottom, like cockroaches. They are covered with hairs, some of which are enlarged to form scales that have a pearly or iridescent sheen. They occur in houses, rock shelters and under rocks in dry habitat. A fossil silverfish was found in 389 million-year-old rocks.



Silverfish

Lepisma saccharina — in Family Lepismatidae.
• This 19mm silver-scaled flat sinuous streamlined insect runs from light in cool damp storage buildings. It feeds on books and baskets. It has followed people out of the caves of Asia into our houses all over the world.

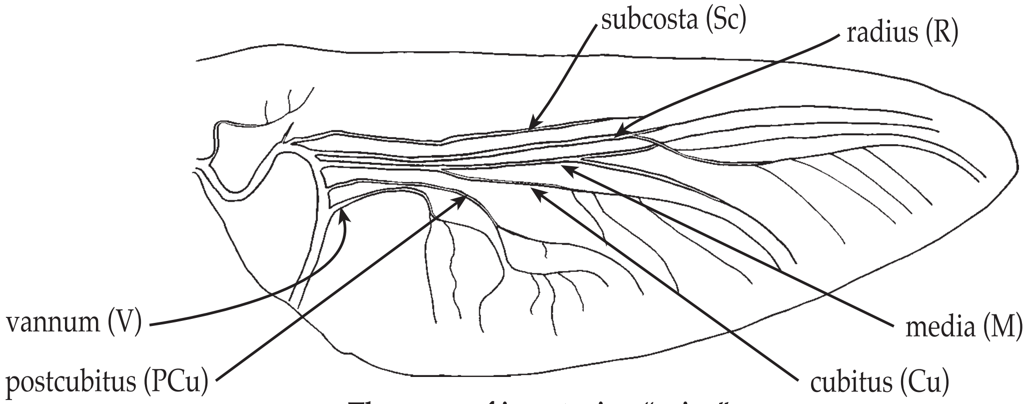


Firebrat

Thermobia domestica — in Family Lepismatidae.
• This 15mm gray or brown speckle-patterned flat streamlined insect runs from light in hot dry storage buildings. It feeds on glue and paper. Originating in Asia, it now lives in houses all over the world.

WINGED INSECTS — Infraclass Alata — (Includes all the remaining insects)

At least 325 million years ago, strong-jawed insects evolved wing flaps on the second and third segment of the thorax. This was the second great leap forward for insects. There are 6 strong tracheal tubes in a simple insect wing. These tracheal tubes are located in blood passages, the finest of which form a delicate network between the upper and lower skin of the wing. The wing membrane is thickened over the tracheal tubes to form the “wing veins”. The branched veins act as struts supporting the floppy wing membranes.



The name of insect wing “veins”.

PRIMITIVE WINGED INSECTS — Supraorder Polyneoptera

These insects have mouthparts adapted to solid food handling and chewing. Except in beetles, the young are little versions without or with incompletely developed wings. The major metamorphosis or structural change between embryo and insect occurs just before hatching of the egg and the young live with and compete with the adults for food. Fossils have been found in 325-million-year-old rocks.

HOMONEUROUS PROTORTHOPTERANS — Superorder Embioidea

These primitive winged insects have the forewing and hindwing nearly the same shape. The oldest fossils have been found in 325-million-year-old rocks.

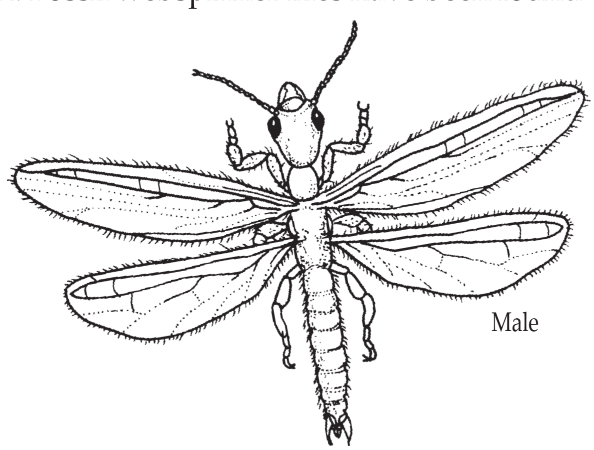
WEBSPINNER FLIES Order Embiida — 32nd in diversity — 4+ species in Texas

These curious insects spin silk from glands on their forelegs. They live communally under bark or in leaf thatch of palms and yuccas. In some species, wingless females feed on plants and winged males are predators. The wings develop gradually over several nymph stages, as backward extensions of the corners of the top shields of the middle and back segment of the thorax. Fossil webspinner flies have been found in 260-million-year-old rocks.

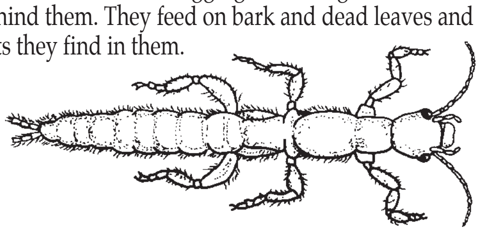
Black webspinner fly

Oligotoma nigra — in Family Oligotomidae.

• This 14mm brown-to-black beaded-bodied insect is found under the bark of dead postoak trees. Winged males retreat into the tubes backwards, dragging their wings over their heads behind them. They feed on bark and dead leaves and the insects they find in them.

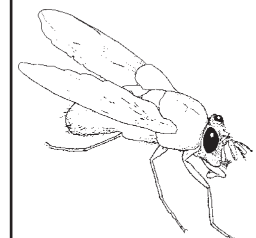


Male

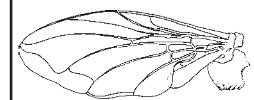


Female

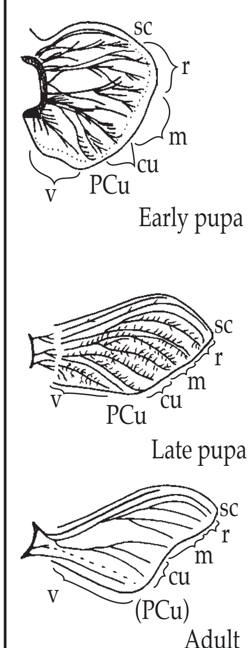
more stuff . . .



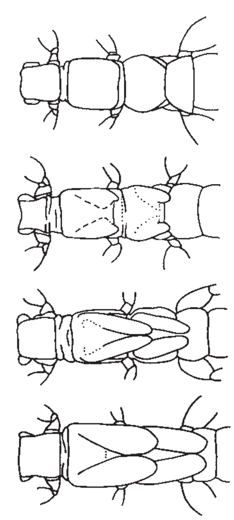
Bluebottle fly



Bluebottle fly wing

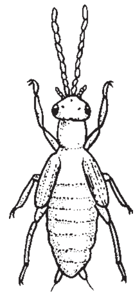


Development of tracheae in a silkmoth wing



Webspinner nymph wing development

more stuff . . .



Angel fly nymph

Finding words you've learned

N	I	G	N	U	F	C
Y	E	M	O	L	D	S
W	N	L	T	H	T	S
O	S	I	L	N	A	P
O	A	R	A	O	K	O
D	P	L	I	N	P	R
C	P	H	A	R	D	C
S	E	B	D	O	O	F

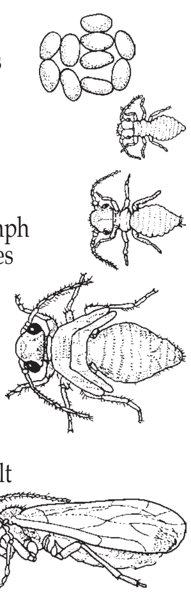
Find the words below. They can be up, down, forward, backward or diagonal within the puzzle.

CROPS
FOOD
FUNGI
MOLD
PLANTS
POLLEN
SAP
WOOD

Eggs

Nymph stages

Adult



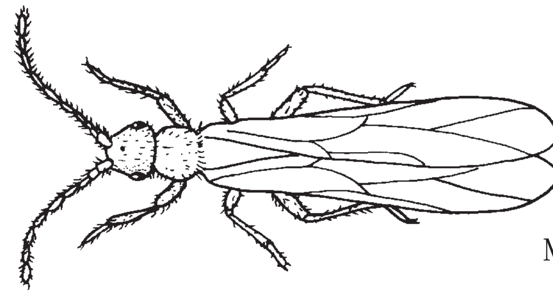
Developmental stages of a barklouse

ANGEL FLIES Order Zoraptera — 35th in diversity — 1 species known in Texas

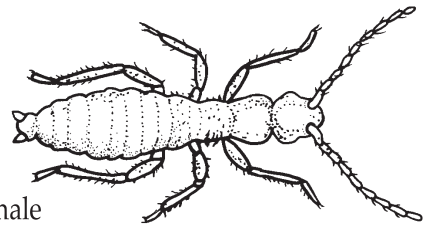
These tiny social insects have winged and wingless forms. They associate with termites or earwigs and feed on their young, along with mites and fungus. They are one of the oldest groups of living insects, having survived at least 318 million years.

Hubbard's angel fly

Zorotypus hubbardi — in Family Zorotypidae.
• This 2mm white-banded brown-to-black insect is found in soft decayed wood and old sawdust piles in the Big Thicket of East Texas.



Male



Female

LICE, BUGS and THRIPS — Superorder Hemipteroidea

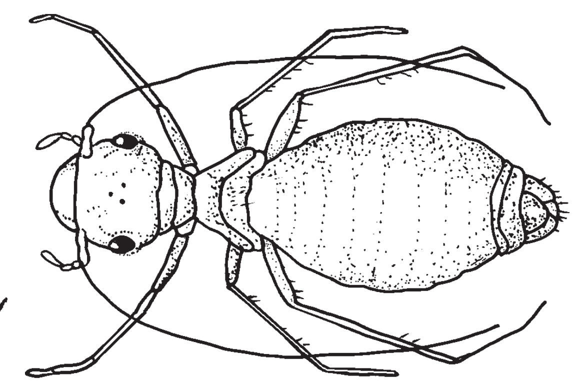
These insects have an enlarged front of the head behind which lies a powerful muscle attached to the back of the mouth for suction. Most have part of the mouth adapted for piercing; some have a pronounced beak for drawing in fluids.

BARKLICE Order Psocida — 16th in diversity — 123+ species in Texas

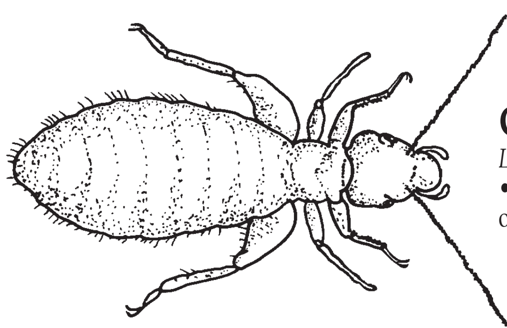
These ancient survivors have bulbous bodies and large heads with chewing mouthparts partially modified for piercing. Winged species fold the wings rooflike over the body. Some spin silk and live communally. Others live in caves where they feed on scraps left by bats, and in libraries where cookie crumbs and library paste are their food. Fossil barklice have been found in 260-million-year-old rocks.

Cave louse

Psyllipsocus ramburii — in Family Psyllipsocidae.
• This 3mm greenish gray louse is found in caves in warm and tropical areas. It enters houses to feed on dry protein such as dead insects.



3mm

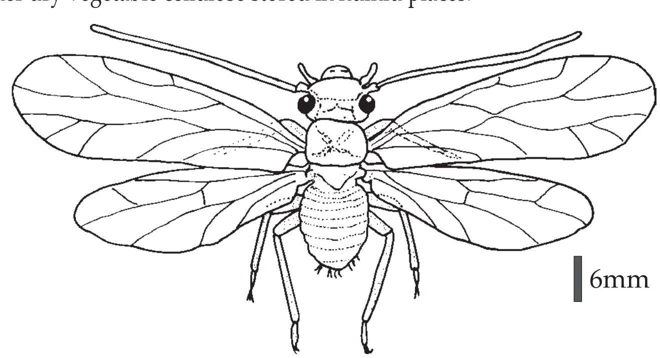


Commom booklouse

Liposcelis divinatorius — in Family Liposcelidae.
• This 1.5mm pale-tan louse infests and eats books or other dry vegetable cellulose stored in humid places.

Stout barklouse

Peripsocus californicus — in Family Peripsocidae.
• This 6mm black-banded clear-winged barklouse is found crawling on the trunks of trees during damp cool weather.



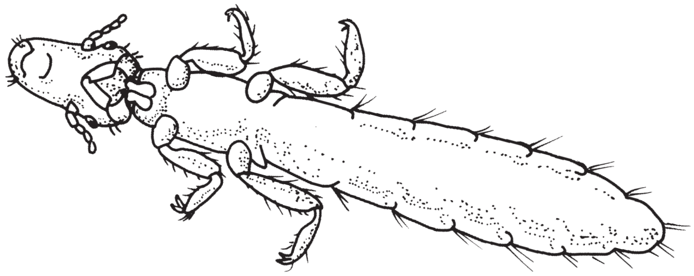
6mm

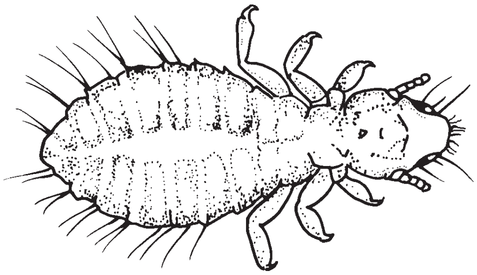
BITING LICE Order Mallophaga — 11th in diversity — 400+ species in Texas

Found on mammals and birds, these lice feed on scraps of skin, hair or feathers. They have large toothed mandibles adapted to grinding. They may have evolved from nest-dwelling barklice about a 100 million years ago.

Slender duck-feather louse

Anaticola crassicornis — in Family Philopteridae.
• This 2.5mm reddish-brown slender louse eats scraps of skin and feathers on ducks, especially the feral Muscovy ducks found in South Texas.



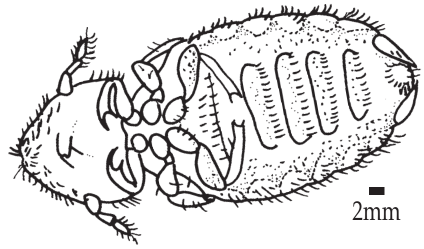


Chicken headlouse

Lipeurus heterographus — in Family Philopteridae.
• This 1.5mm brown louse eats scraps of skin and feathers on the heads of chickens. It has followed the spread of domestic chickens from India all over the world.

Cattle biting louse

Bovicola bovis — in Family Trichodectidae.
• This 2mm brown slender louse eats scraps of skin and fur on the hides of living cattle. It has followed human migration and colonization on domestic cows from India.



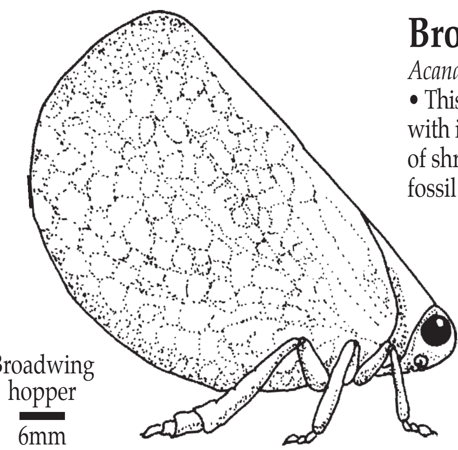
2mm

LEAFHOPPERS Order Homoptera — 6th in diversity — 2700+ Texas species

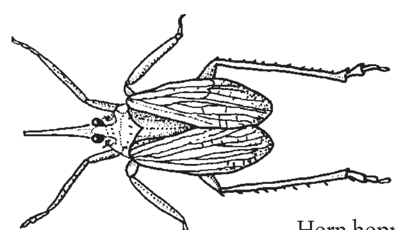
These insects have strongly veined, clear, often glassy wings. The mouthparts form a beak towards the back of the head and are adapted for piercing and sucking plant sap. They frequently excrete excess body wax. This may be as a white powder, long streamers, or hard shells of shellac. Some exude sugar syrup or honeydew with which they obtain the protection of ants. Fossil leafhoppers have been found in 260-million-year-old rocks.

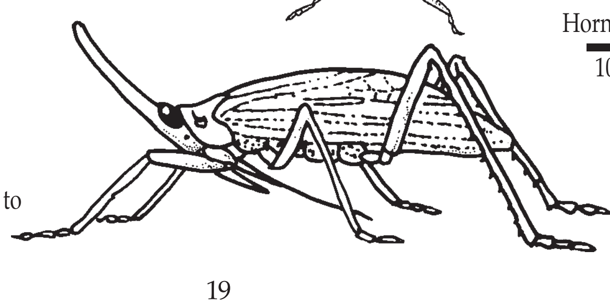
Broadwing hopper

Acanalonia bivittata — in Family Acanaloniidae.
• This 6mm green broadwinged net-veined leafhopper feeds socially with its waxy young near the tip of a growing shoot of many kinds of shrubs. Because of their broad wings and strong patterns, some fossil species have been mistaken for butterflies.



Broadwing hopper
6mm



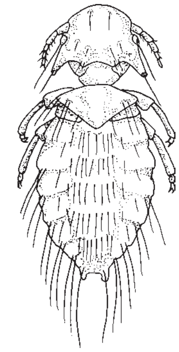


Horn hopper
10mm

Horn hopper

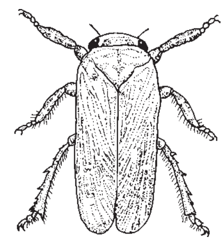
Scolops sulcipes — in Family Dictyopharidae.
• Like its relative the lantern fly, this 10mm brown leafhopper has an inflated face, extended foreward to form a horn. It is most often seen at lights at night.

more stuff . . .

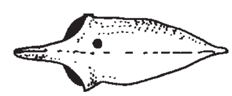


Turkey louse

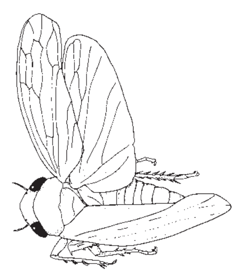
Hen and chick



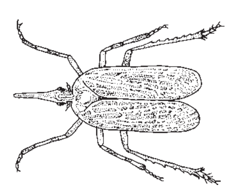
Leafhopper



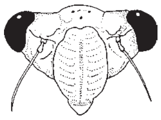
Where to put the pin in a specimen



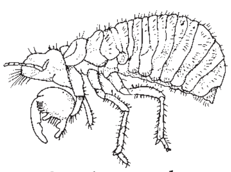
Leafhopper dorsal view



Horn hopper

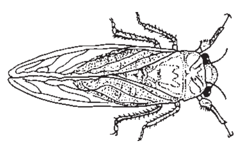


Cicada face

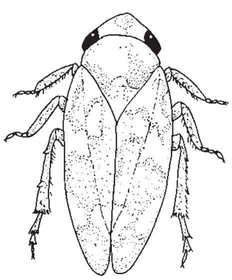


Cicada nymph

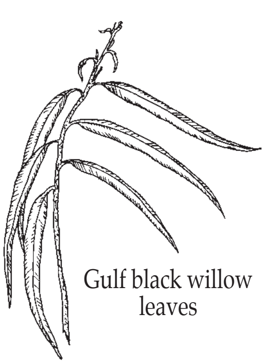
Adult cicada emerging from nymphal skin



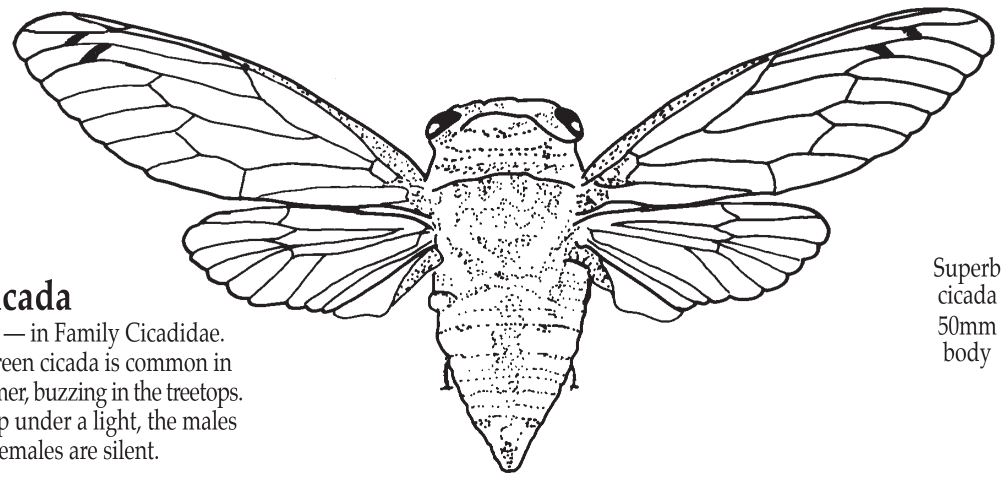
Meadow cicada



Spittlebug



Gulf black willow leaves



Superb cicada 50mm body

Superb cicada

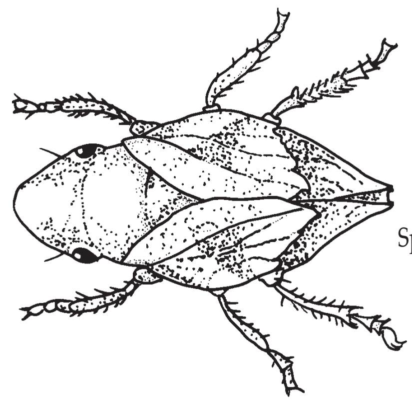
Tibicen superbus — in Family Cicadidae.

• This 50mm green cicada is common in the heat of summer, buzzing in the treetops. When picked up under a light, the males squeal but the females are silent.

Froghopper spittlebug

Lepyronia quadrangularis — in Family Cercopidae.

• The nymphs of this insect suck the sap of plants and release a clear froth that hides them and keeps them from drying out. The 5.5mm brown-banded tan-colored adult has a huge leap and resembles a tiny tree frog.



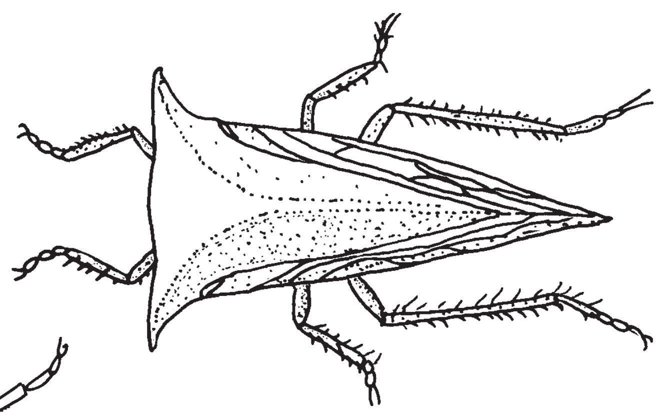
Spittlebug 5.5mm body

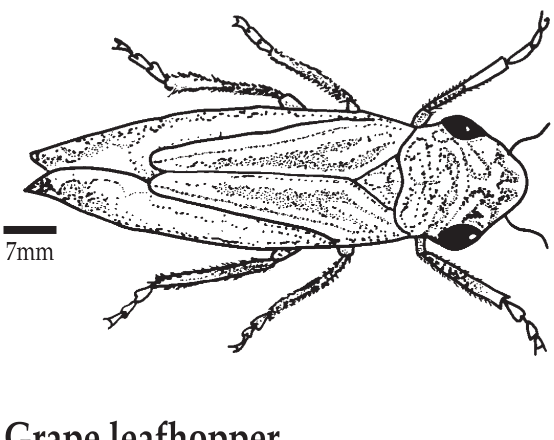
Spittlebug

Buffalo treehopper

Stictocephala bisonia — in Family Membracidae.

• This green thorn-shaped 11.5mm hopper feeds on the sap of green twigs.





7mm

Painted leafhopper

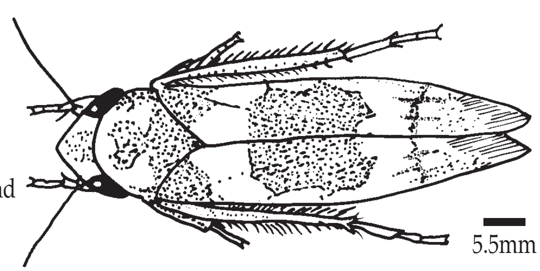
Cicadella hieroglyphica — in Family Cicadellidae.

• This 7mm bright-red leafhopper has black hieroglyphic-like marks on the head, red wings with white streaks and a yellow spot in the middle of the body. These hoppers are most common on willow.

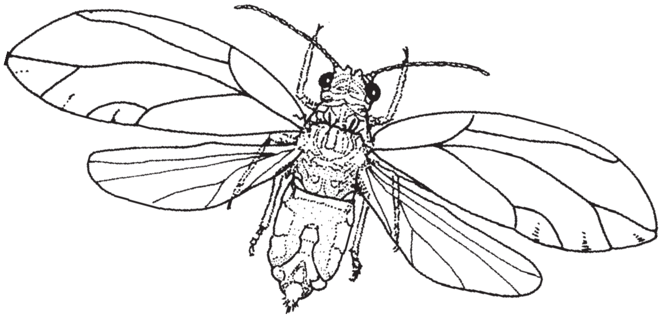
Grape leafhopper

Erythroneura comes — in Family Cicadellidae.

• This 5.5mm brown-speckled clear-wing leafhopper swarms on grapevines in fall. 10-million-year-old fossils of this species are found in South Texas. There are 369 other species in the same large genus.



5.5mm

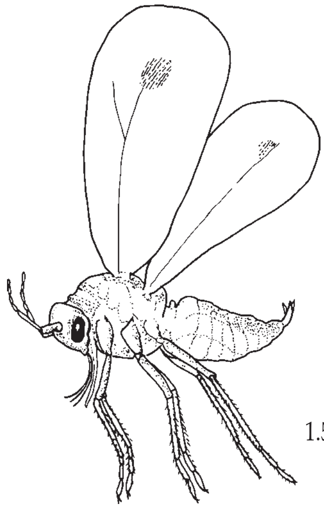


Tomato-Potato psyllid

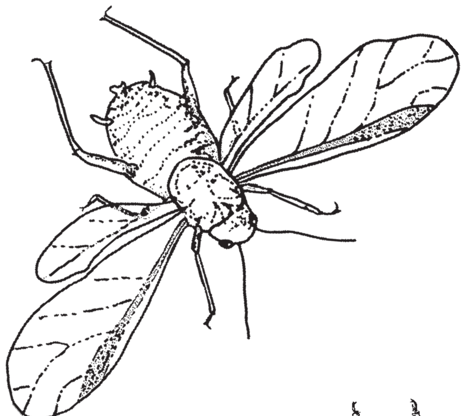
Paratrioza cockerelli — in Family Psyllidae.
• Common on peppers and other nightshades, this 4mm greenish-tan "fly" feeds on plant sap. Psyllids have been common since Permian time, before the dinosaurs, some 260 million years ago.

Greenhouse whitefly

Trialeurodes vaporariorum — in Family Aleyrodidae.
• These 1.5mm waxy-white broad-winged "flies" look like tiny moths as they rise in a cloud from ligustrum and other shrubs.

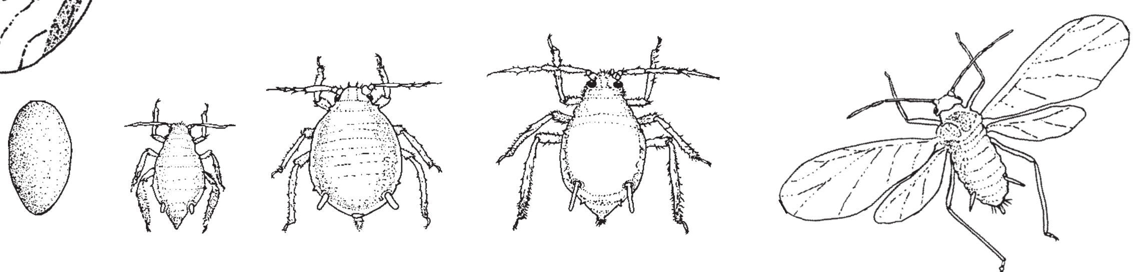


1.5mm



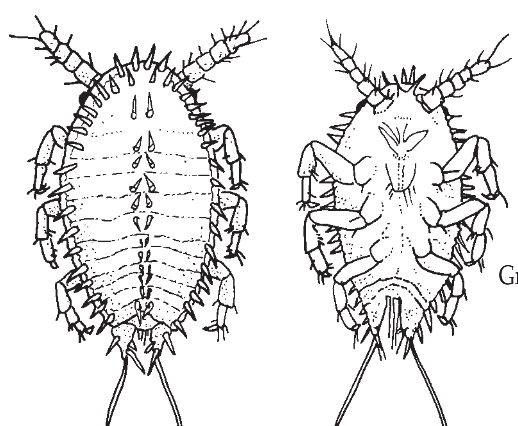
Melon aphid

Aphis gossypii — in Family Aphididae.
• This common 2.5mm green aphid feeds on the sap of cucumbers, melons, cotton and many other soft green plants. Winged males and females hatch only in winter. In summer, males are not produced and the parthenogenic females give birth to pregnant young. In this way huge populations are built up rapidly. The third generation may be seen through the translucent back of the summer female.



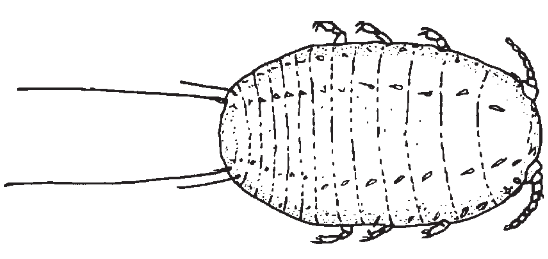
Grape phylloxera

Phylloxera vitifoliae — in Family Phylloxeridae.
• This 1mm white aphid-like bug was accidentally introduced from Texas into Europe in the 19th century where it almost wiped out the wine business. The old vinyards of Europe were saved by grafting the European heirloom grapes onto phylloxera-resistant American rootstock.



Grape phylloxera underside

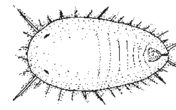
1mm



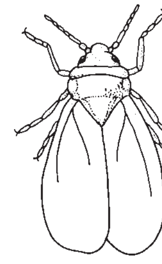
Cochineal bug

Dactylopius coccus — in Family Dactylopiidae.
• This 2mm flat waxy pink bug lives on prickly-pear cactus. It exudes a protective coat of white wax filaments. In Mexico these insects are gathered to make the edible red dye — cochineal.

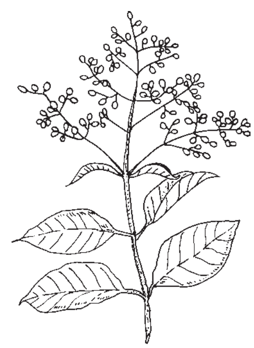
more stuff . . .



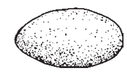
White fly larva



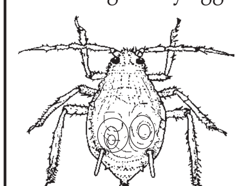
White fly adult



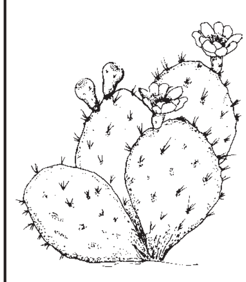
Japanese privet



Clover greenfly egg

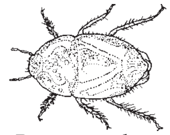


Clover greenfly female



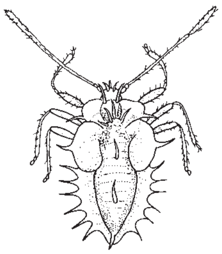
Prickly pear

more stuff . . .

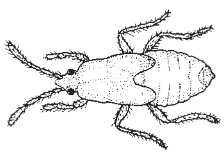


Burrowing bug

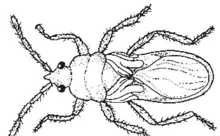
5mm



Lace bug nymph

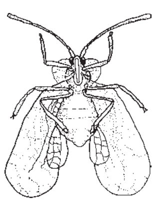


Chinch bug nymph

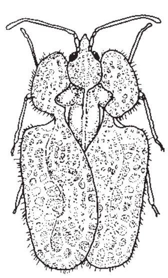


Chinch bug adult

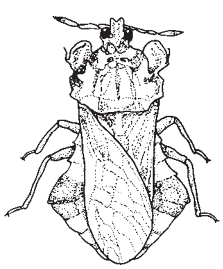
4mm



Lace bug underside



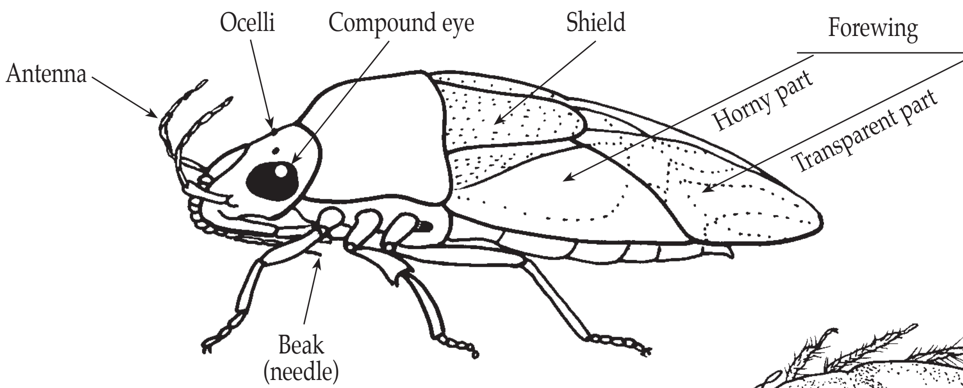
Sycamore lace bug



Ambush bug

TRUE BUGS Order Hemiptera — 5th in diversity — 1600+ species in Texas

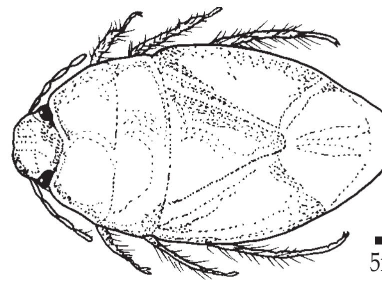
Almost all true bugs have the base of the forewing thickened to form a wing case, while the outer portion is veined and clear. The wings clip tightly shut with a latching mechanism on the edge. Hindwings are large, membranous and well adapted for driving flight. The mouthparts form a beak at the front of the head and are adapted for piercing and sucking plant sap or animal blood. Fossil true bugs have been found in 245-million-year-old rocks.



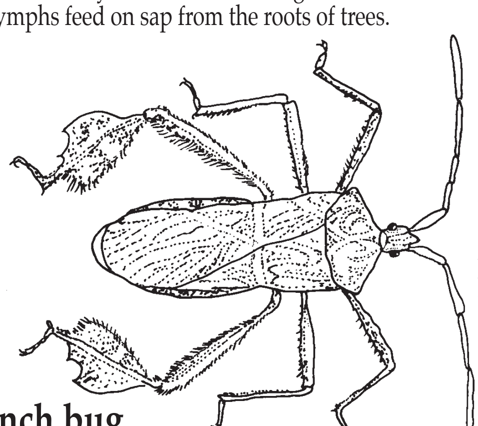
Burrowing bug

Pangeus bilineatus — in Family Cydnidae.

• This 5mm shiny black beetle-like bug is common in the soil of forests. Adults and nymphs feed on sap from the roots of trees.



5mm



Yucca plant bug

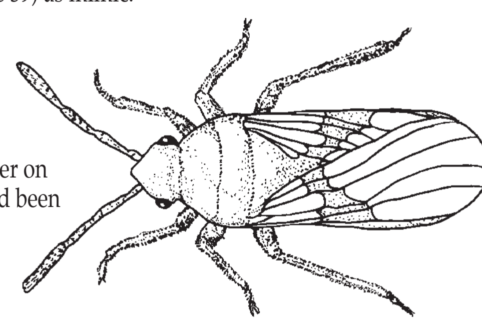
Leptoglossus phyllopus — in Family Coreidae.

• This brightly patterned brown, pale-yellow-and-red-spotted 20mm plant bug belongs to a mimicry group that includes the polistes paper wasp (see page 54) as model and a clearwing moth (see page 39) as mimic.

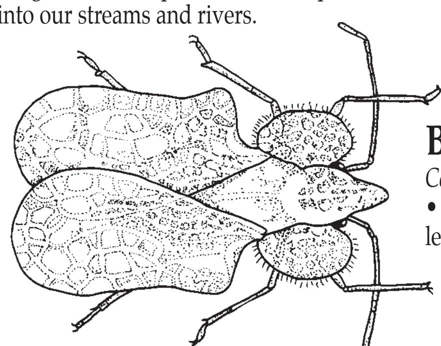
Chinch bug

Blissus leucopterus — in Family Lygaeidae.

• In an effort to eliminate this black-and-cream-colored 4mm feeder on San Augustine grass, a lot of poison has been poured on lawns and been washed off into our streams and rivers.



4mm



5mm

Beautiful lace bug

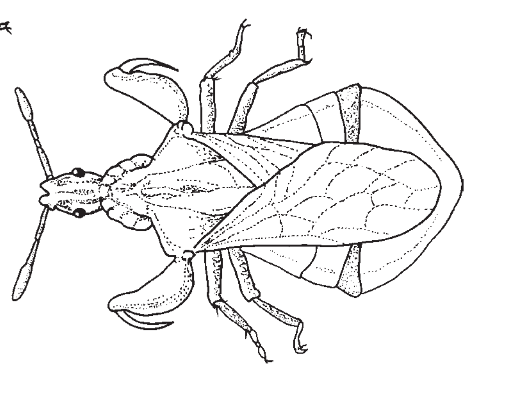
Corythuca bellula — in Family Tingidae.

• This tan-colored net-winged 5mm bug sidles across leaves of forest trees. Adults and nymphs feed on sap.

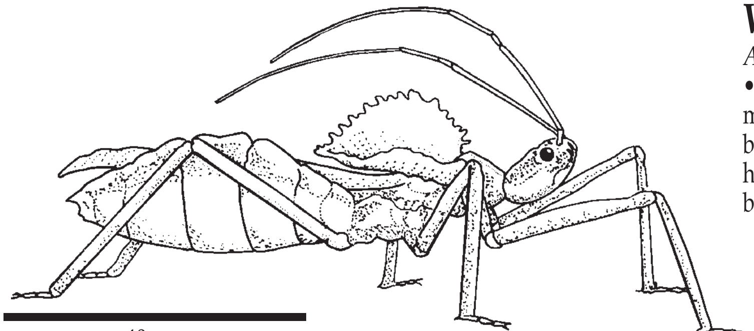
Assassin bug

Phymata erosa — in Family Phymatidae.

• This 11mm green, yellow-and-black patched bug waits on flowers to pounce on butterflies, its prey.



11mm



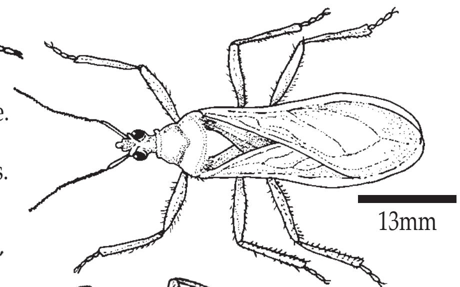
40mm

Wheel bug

Arilus cristatus — in Family Reduviidae.
• This 40mm dark-brown predatory bug may be seen on warm days in winter flying between trees or searching for insect prey. It has what looks like half a cogwheel on its back. It really stinks.

Kissing bug

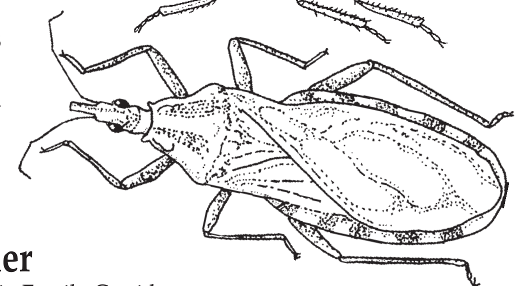
Reduvius personatus — in Family Reduviidae.
• This 13mm black-and-orange bug sucks blood from mice, rats and domestic animals.

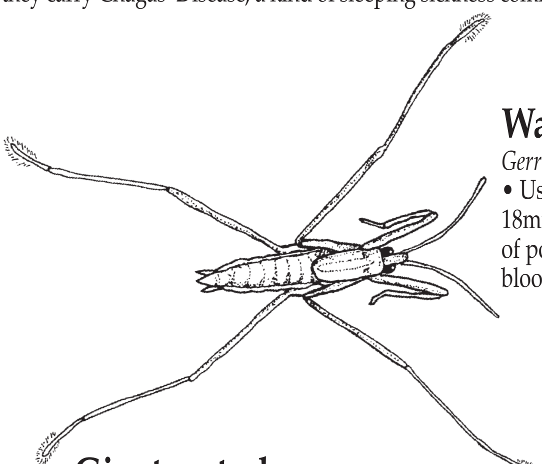


13mm

Conenose bloodsucker

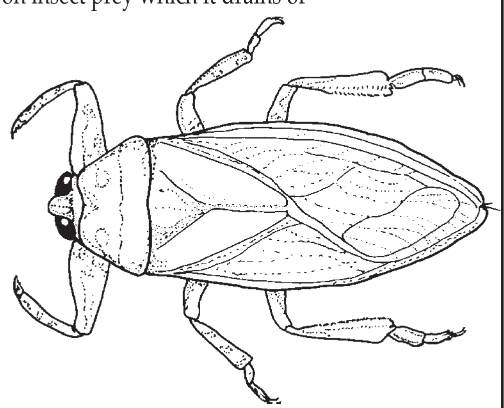
Triatoma sanguisuga — in Family Reduviidae.
• This 22mm brown bug with yellow-and-black-banded abdomen lurks in old buildings, rockpiles and caves. This insect disperses at night to suck blood from sleeping people and domestic animals. In South America they carry Chagas' Disease, a kind of sleeping sickness common in horses.





Water strider

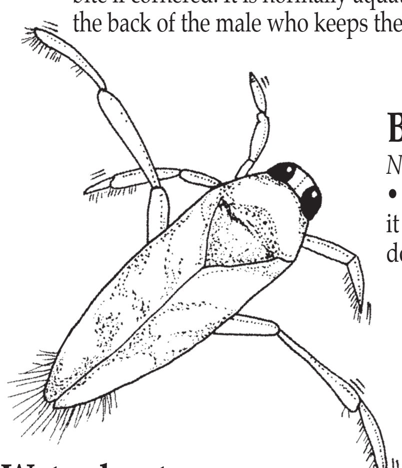
Gerris remigius — in Family Gerridae.
• Using pontoons formed from hairs on the feet, this 18mm gray-black skinny bug skates across the surface of ponds. It pounces on insect prey which it drains of blood with its beak.



Giant waterbug

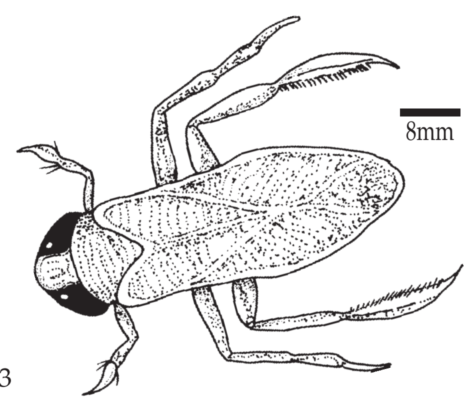
Lethocerus americanus — in Family Belostomatidae.
• Also known as electric-light bug, this 85mm greenish-gray-and-brown flat insect is attracted to lights at night. It can stab a painful bite if cornered. It is normally aquatic. The female lays her eggs on the back of the male who keeps them safe until they hatch.

85mm



Backswimmer

Notonecta undulata — in Family Notonectidae.
• This green-and-brown 18mm water bug looks silvery from the large air bubble it carries between its legs. This bubble acts as a float so the insect swims upside down. One pair of long legs are used as oars to row the bug along.

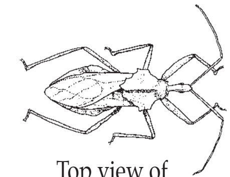


8mm

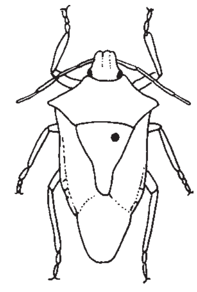
Water boatman

Arctocorixa alternata — in Family Corixidae.
• This yellow-and-brown-banded 8mm water bug often swarms in desert pools. It swims right side up and usually has fine cross-striped forewings. It is eaten by some Native Americans.

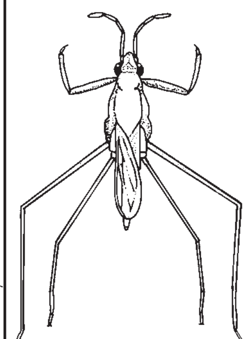
more stuff . . .



Top view of wheel bug

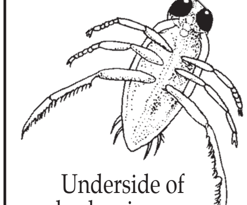


Where to put the pin in a speciman



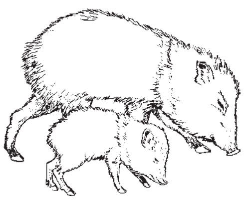
Water strider

Threadleg bug

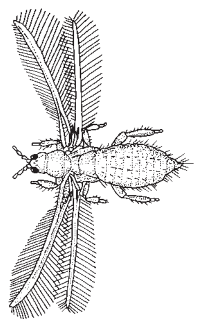


Underside of backswimmer

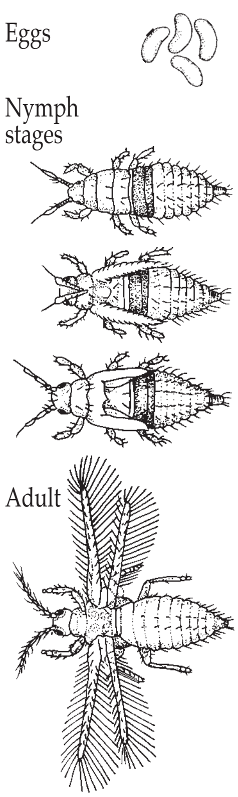
more stuff . . .



Javelinas



Pear thrips



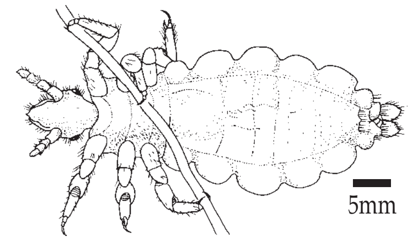
Developmental stages of the redbanded thrips

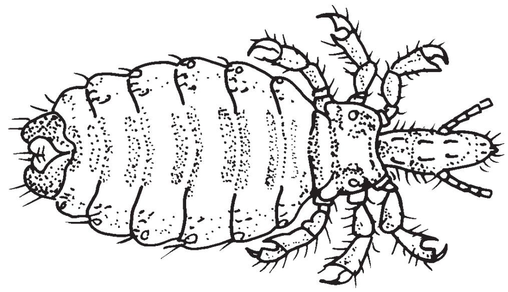
SUCKING LICE Order Anoplura — 26th in diversity — 24+ Texas species

These minute flattened tick-like insects have piercing mouthparts adapted for drawing blood. The feet are tiny clamps for holding fast to hairs. The head is very small. Each species is adapted to feed on one or a few closely related host animals. Some hosts, such as people, have several species of louse specialized to feed on them. Fossil sucking lice have been found on frozen ground squirrels in ancient permafrost.

Human head louse

Pediculus humanus — in Family Pediculidae.
• Black-and-brown 5mm cooties sometimes show up at school and pass from head to head among children. The large white eggs are laid attached to hair and are called nits. It has spread world-wide on its human host.





Hog louse

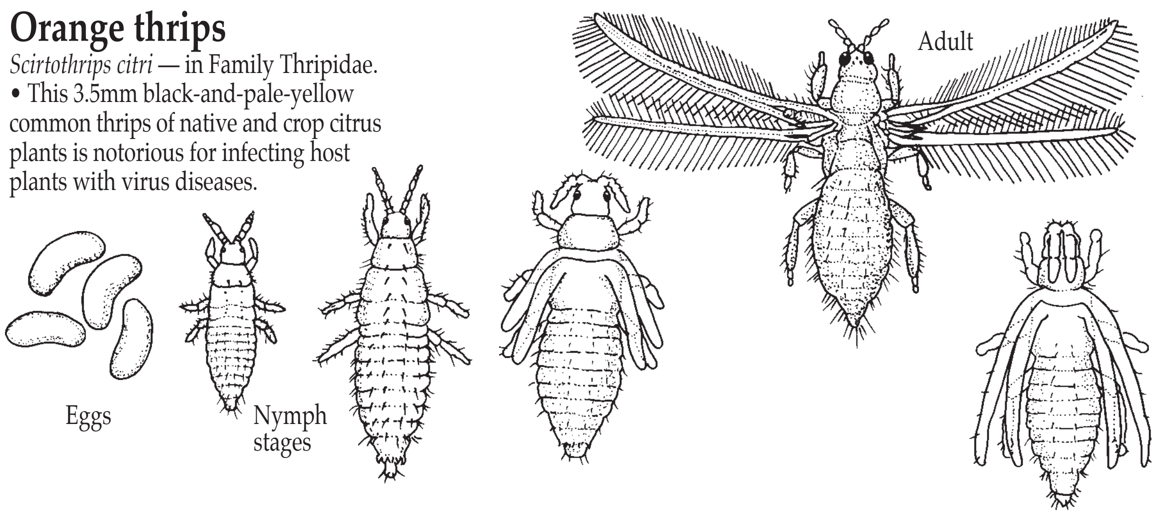
Haematopinus suis — in Family Haematopinidae.
• This dark brown, wide, flat 4mm louse is found on hogs. From Africa or Asia, it has spread world-wide with human migration. American javelinas carry different species.

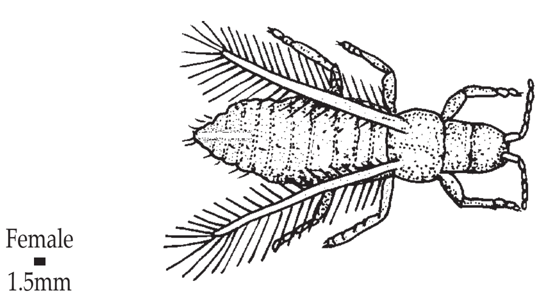
THRIPS Order Thysanoptera — 15th in diversity — 197+ species in Texas

Even adult thrips are tiny. Their wings are reduced sticks fringed with long hairs on which they are carried by the wind. Juvenile thrips and wingless adults may move from plant to plant by hitching a ride on another insect. Most feed on plants. A few are pests. Some beneficial species feed on mites. Others serve as food for hummingbirds who gather them in flowers with their barbed tongues. Fossil thrips have been found in 250-million-year-old rocks.

Orange thrips

Scirtothrips citri — in Family Thripidae.
• This 3.5mm black-and-pale-yellow common thrips of native and crop citrus plants is notorious for infecting host plants with virus diseases.





Flower thrips

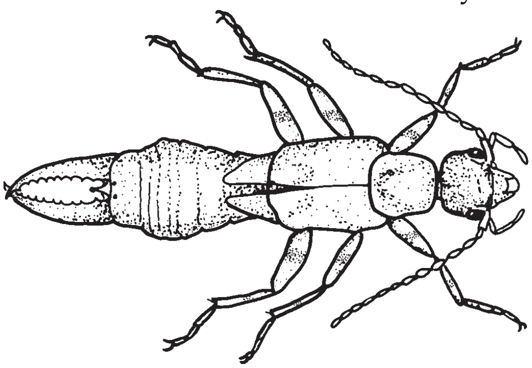
Frankliniella tritici — in Family Thripidae.
• Often a pest of crops, this black-and-cream 1.5mm insect may occur in populations of billions.

HOMONEUROUS PROTORTHOPTERAN ALLIES — Superorder Perloidea

These insects have many crossveins in the wing. The pleated fan of the hindwing is composed of a different set of veins than found in grasshoppers and their relatives or in cockroaches and their relatives. Fossil homoneurous protorthopteran insects of the extinct order Paraplecoptera occur in 290-million-year-old rocks in North Texas.

EARWIGS Order Dermaptera — 24th in diversity — 8+ species in Texas

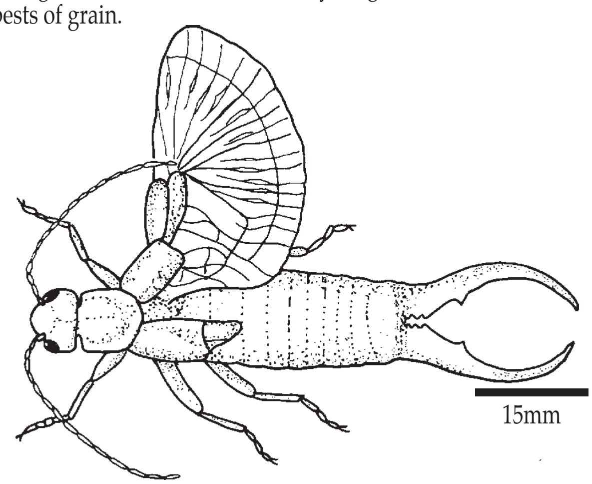
Earwigs have nothing to do with human ears. The name comes from their habit of congregating to feed on flies in the flower of devil's ear, the plant now known as jack-in-the-pulpit. The end of the abdomen bears cerci formed into pincers. These are used in courtship and may also be used for defense. Fossil earwigs have been found in 200-million-year-old rocks.



Ring-legged earwig

Euborellia annulipes — in Family Labiduridae.

• This 12mm dark-brown insect with yellow-ringed legs is a native species found where grain is stored, in packrat nests or in grain elevators. It feeds on the young and dead of insect pests of grain.



Common earwig

Forficula auricularia — in Family Forficulidae.

• This 15mm chestnut-brown-and-black species accompanied settlers from Europe and is found throughout Texas wherever there are gardens. It lives under rocks, boards and flowerpots where there is a chance of moisture. Food is mostly dead and decaying organic matter but occasionally young tender shoots are eaten in the garden.

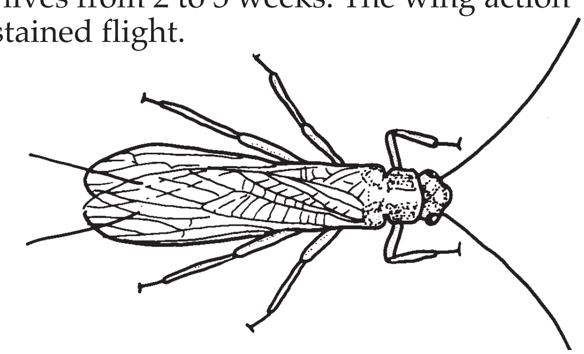
STONEFLIES Order Perlida — 21st in diversity — 76+ species in Texas

The young nymphs of these insects develop in cold-water streams where they feed on small aquatic arthropods, often taking more than one year to develop. Most adults do not feed and have short lives from 2 to 3 weeks. The wing action is not powerful and does not permit sustained flight.

Winter stonefly

Hydroperla crosbyi — in Family Capniidae.

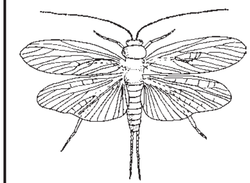
• This 16mm lemon-yellow-and-black stonefly is one of the few found outside East Texas. The aquatic nymphs live in fissures of the Edwards Aquifer, coming to the surface for emergence of the adults. Adults are found in winter and spring in rocky areas, often far from surface streams.



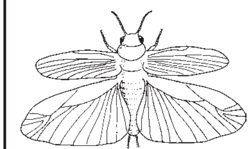
GRASSHOPPERS AND THEIR RELATIVES — Superorder Orthopteroidea

These insects typically have many long parallel veins in the forewing. The back of the hindwing is expanded as a pleated fan. Fossils have been found in 300-million-year-old rocks.

more stuff . . .



Ancient paraplecopteran



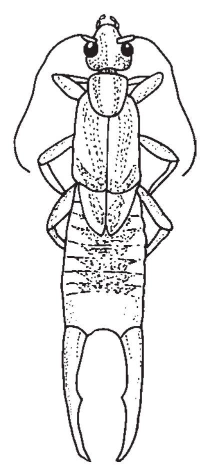
Ancient protelytropteran

Finding words you've learned

B	U	G	S	E	G	T
L	E	N	A	G	C	N
P	N	A	E	E	C	Y
U	P	O	S	R	O	M
P	I	N	M	L	C	H
A	I	V	Y	M	O	P
L	A	R	V	A	O	T
A	D	U	L	T	N	C

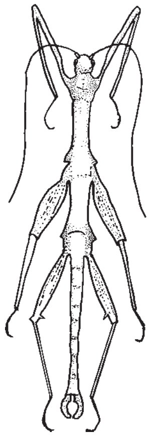
Find the words below. They can be up, down, forward, backward or diagonal within the puzzle.

ADULT
BUGS
COCOON
COMMON
EGG
INSECT
LARVA
NYMPH
PUPA

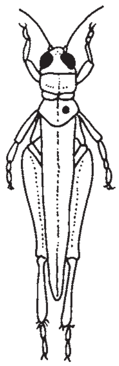


Riparian earwig

more stuff . . .

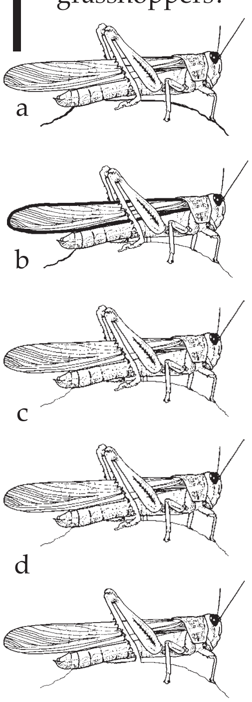


Walking stick
150mm



Where to put the pin in a specimen

Which are the two identical grasshoppers?

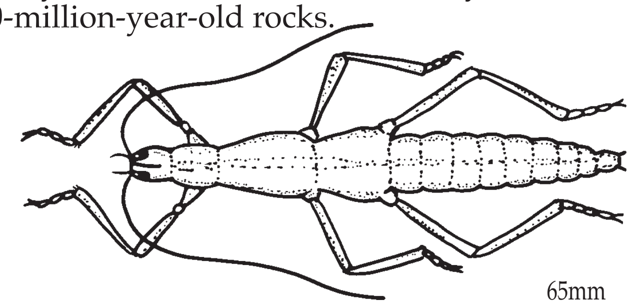


WALKING STICKS Order Phasmida — 19th in diversity — 13+ species in Texas

Not only do the adults resemble twigs, grass and leaves, but the eggshell is also disguised as a seed. Large species are rarely seen because they live in the tops of trees, but sometimes may be found knocked to the ground after a storm. They feed on leaves. Some females reproduce by **parthenogenesis**, that is without mating with males. Females of other species may remain mated for several days. Fossil walking stick insects are found in 290-million-year-old rocks.

Prairie alligator

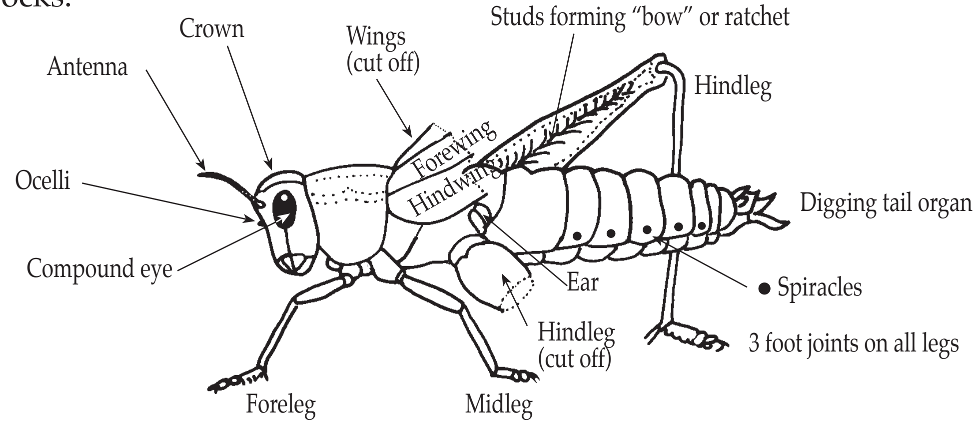
Anisomorpha ferruginea — in Family Anisomorphidae.
• Greenish-brown 65mm adults of this species may be found walking on trees and on the sides of houses in fall and winter. Mating pairs of large females and tiny males may stay coupled for several days. When disturbed, they spray an acrid fluid from glands behind the head. **Be careful, they aim for the eyes.**



65mm

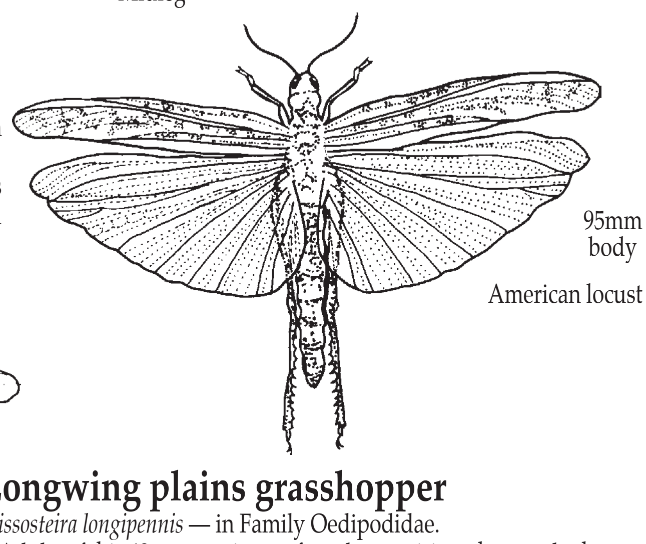
GRASSHOPPERS Order Orthoptera — 8th in diversity — 460+ species in Texas

Lengthened hindlegs with strong muscles in the femur permit powerful jumping by these insects. Nymphs use this jump to escape. Adults use the jump to launch into a driving flight. The front wing is semi-fixed and the hindwing fan is waved for propulsion. Males sing by bowing the rigid forewing with a ratchet located on the inner side of the femur of the hindleg. Fossil grasshoppers occur in 220-million-year-old rocks.



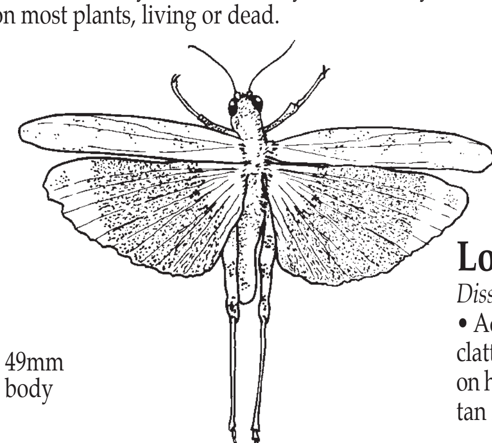
American locust

Schistocerca americana — in Family Catantopidae.
• The 95mm black-speckled tan-and-yellow adults of this species and five others are especially common in fall and winter in the Post Oak woodlands of Central Texas. Unlike their close relatives, the locusts of the Bible, they do not normally swarm. They feed on most plants, living or dead.



95mm
body

American locust



49mm
body

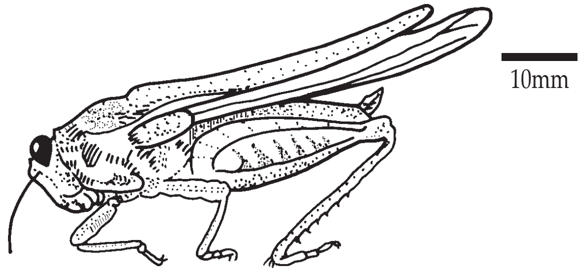
Longwing plains grasshopper

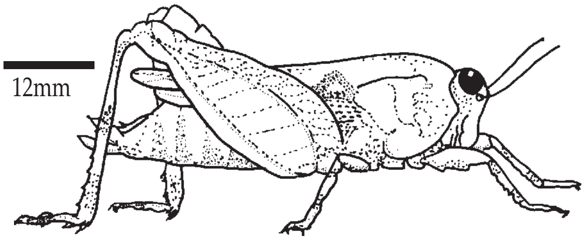
Dissosteira longipennis — in Family Oedipodidae.
• Adults of this 49mm species are found on prairies where males hover, clattering their wings in competition for territory and mates. They feed on herbaceous plants, mostly grasses. These insects have brown mottled-tan forewings and cream-tipped black hindwings.

Rough-backed pygmy grasshopper

Paratettix rugosus — in Family Tetrigidae.

• This brown-speckled 10mm grasshopper has tiny forewing flaps and large clear hindwings. It is found frequently on the ground in open woodland along streams.





Mexican grouse locust

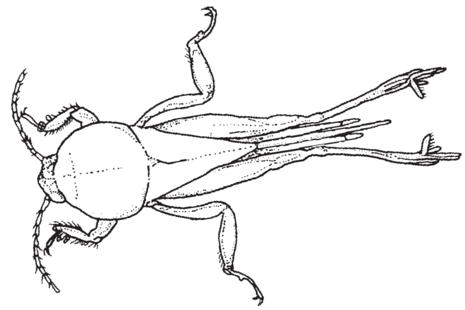
Paratettix mexicanus — in Family Tetrigidae.

• The brown-white-and-tan-speckled 12mm adults of this species are especially common in fall and winter on the gravelly floor of Post Oak woodland in Central Texas. They feed on lichens and plant detritus.

Mudhopper

Ellipes minuta — in Family Tridactylidae.

• Adults of this 6mm yellow-brown species may be found on wet sticky yellow clay around pools in the limestone regions of Texas. They live in burrows in which they survive summer drought. They have spine-pontoons on the hind feet which they use to walk on water. They feed on green slime algae.

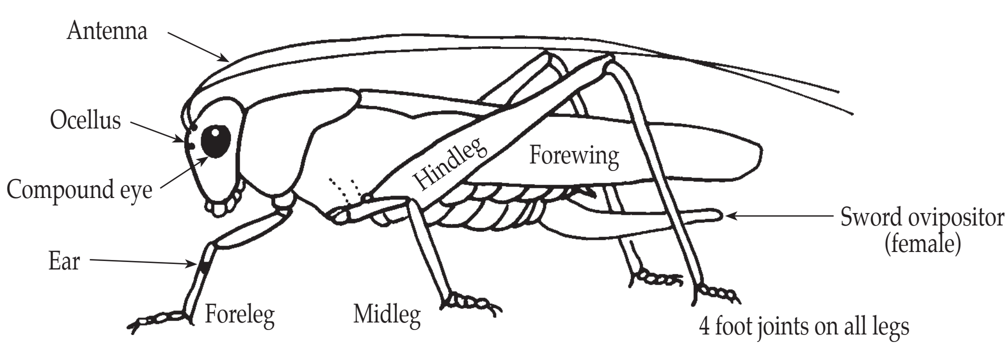


ROACHES AND THEIR RELATIVES — Superorder Blattopteroidea

These insects have many-branched veins in the forewing. The fan of the hindwing includes different veins than in the grasshoppers and their relatives.

CRICKETS Order Grylloptera — 10th in diversity — 271+ Texas species

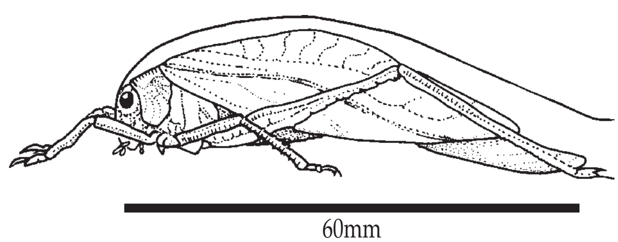
Unlike true grasshoppers, crickets have a set of strong crop teeth for grinding food, and most crickets are fierce predators or omnivores. Sound is produced by filing a ratchet on a wing vein over a vein on the other wing. There is usually a vibrating membrane near the base of the wing to magnify the sound. Like mantises, crickets have ears on their legs. Large sword-like ovipositors place cricket eggs into the ground or under bark of plants. Fossil crickets have been found in 316-million-year-old rocks.



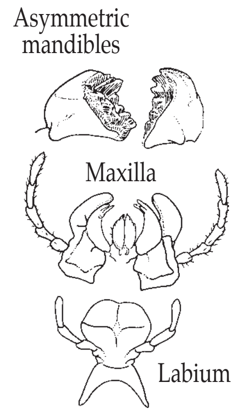
Broadwing katydid

Microcentrum rhombifolium — in Family Tettigoniidae.

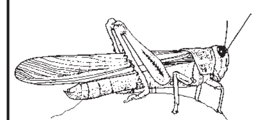
• This green 60mm leaf-winged cricket is often heard in the treetops. It is seen only when blown to the ground or dropped by predators, where it is soon devoured by fire ants. These crickets eat leaves in the treetops.



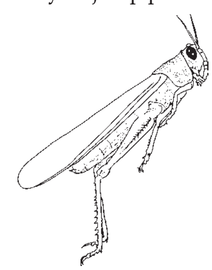
more stuff . . .



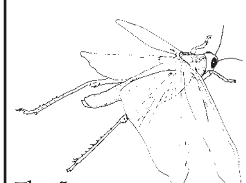
Grasshopper mouth parts



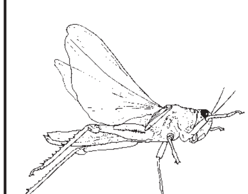
Ready-to-jump position



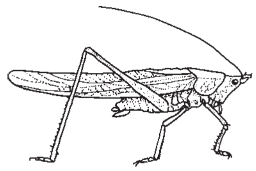
The leap

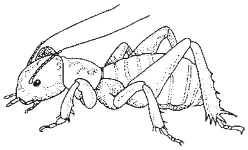


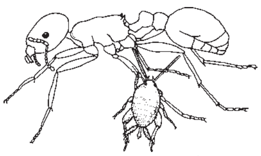
The float

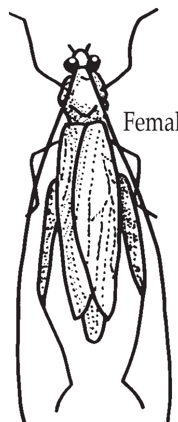


Ready-to-land position


Male conehead cricket

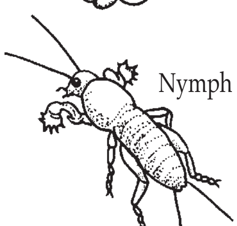

Jerusalem cricket

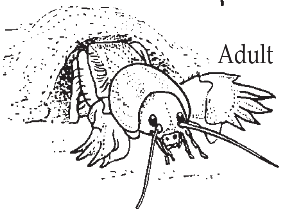

Prairie-ant cricket
hitching a ride on an ant


Female

Green
tree cricket

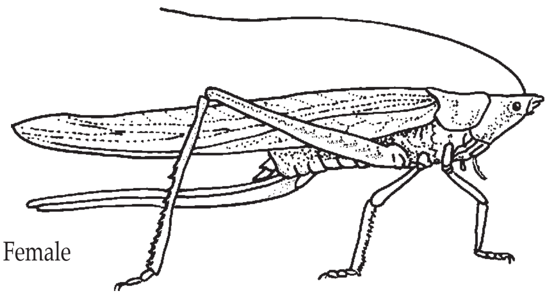

Eggs


Nymph


Adult

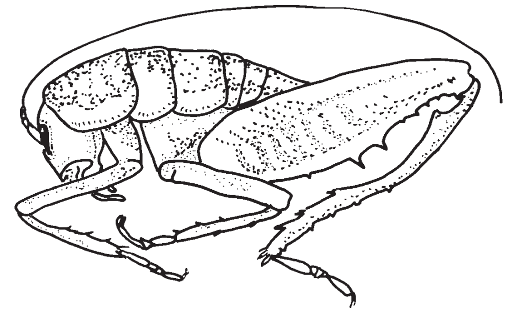
Mole cricket

68mm


Female

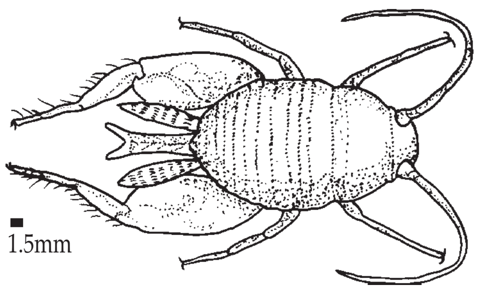
Conehead katydid

Neoconocephalus triops — in Family Tettigoniidae.
• This 68mm prairie cricket is common all year in gardens and meadows. Summer individuals are green, winter individuals are tan colored. It has strong black jaws in a red mouth and has a strong bite. Although its main food is grass, it may catch and eat other insects. It produces a hissing scratchy call by rubbing the wings together. It is often attracted to light.



Club-tailed camel cricket

Ceuthophilus nodulosus — in Family Ceuthophilidae.
• This 24mm wingless brown-mottled tan cricket lives in caves and hollow trees. It is frequent in basements, cool sheds and privies. It feeds on fungus, dead insects and decaying plants.

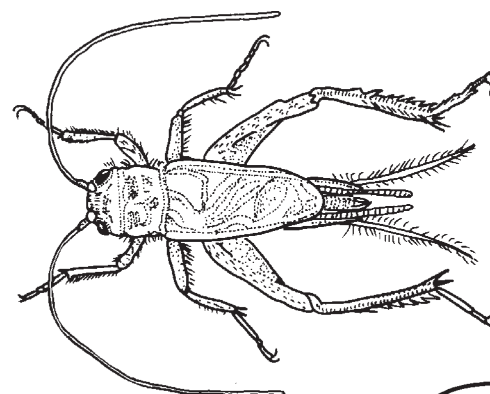

1.5mm

Prairie-ant cricket

Myrmecophila nebrascensis — in Family Myrmecophilidae.
• This 1.5mm pale-gray cricket lives in ant nests. The cricket feeds on dead insect matter in the ant nest and is also fed on regurgitated food by the ants who, in return, receive special chemical secretions from their "guest".

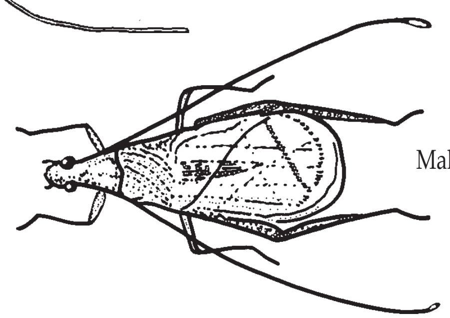
House cricket

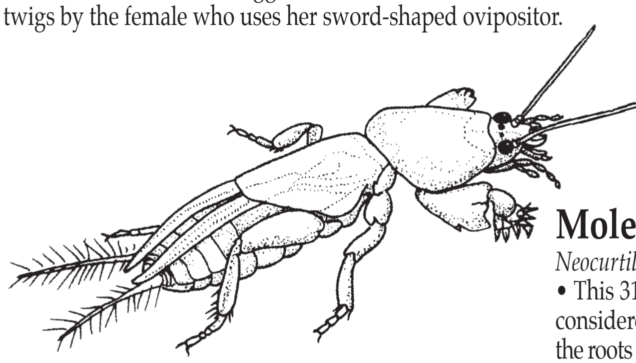
Acheta domestica — in Family Gryllidae.
• This 16mm tan cricket accompanied humans out of Africa and then spread throughout the world with European colonists. It lives in houses where it requires minimal food and moisture. Ancient legend warns of an impending death in the house, when a cricket trills in the hearth.



Green tree cricket

Oecanthus fultoni — in Family Oecanthidae.
• This 17mm pale-green musician of summer and fall comes to house lights. The timing of trills changes with air temperature. The trill frequency at any locality may be calibrated and used as an audible thermometer. Eggs are inserted under the bark of twigs by the female who uses her sword-shaped ovipositor.


Male


31mm

Mole cricket

Neocurtilla hexadactyla — in Family Gryllotalpidae.
• This 31mm grayish yellow-tan subterranean cricket used to be considered an agricultural pest for the damage done by nymphs to the roots of crops. Pesticides and the attraction of adults to commercial lighting at night has led to a sharp decline in populations. It is considered an endangered species in some midwestern states.

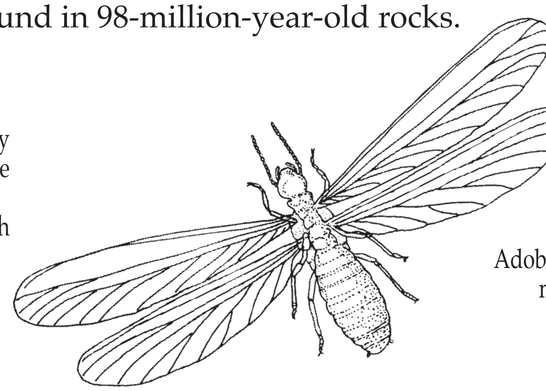
TERMITES Order Termitida — 20th in diversity — 19+ species in Texas

more stuff . . .

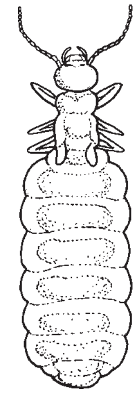
These small, soft-bodied, pale-colored social insects can digest wood with the help of single-celled organisms that live in their gut. They are found in dead trees, in buildings, in the soil, in earth mounds and in cardboard structures of their own making. Fossil termites have been found in 98-million-year-old rocks.

Adobe termite

Gnathamitermes tubiformans — in Family Termitidae.
• Colonies of these 8mm yellowish termites occur in dry pastures and desert grassland where they may cause the bald or discolored spots. They construct earth tubes up the outside of surviving dead and dying vegetation, which they eat. They are also found living in dry cow dung.



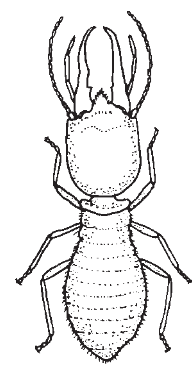
Adobe termite male



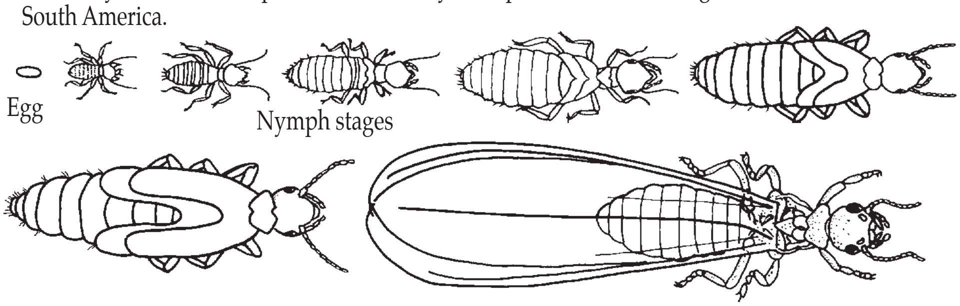
Adobe termite queen

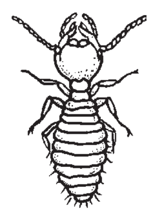
Blackhead termite

Nasutitermes corniger — in Family Nasutiermitidae.
• These 7mm dark-brown termites manufacture globular nests of corrugated cardboard on vegetation high above the ground. From a distance these look like heads or like mammals sleeping in the trees. Bacterial digestion of cellulose in the gut of these termites contributes more carbon dioxide to the atmosphere than do cattle which digest cellulose in the same way. In Texas, this species is found only in tropical woodland along the lower Rio Grande, but it ranges far into South America.



Adobe termite worker

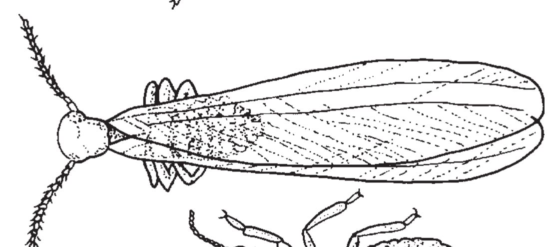


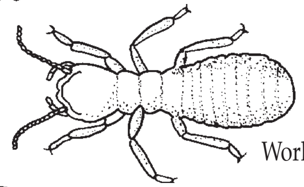


Blackhead termite worker

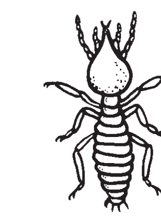
Common termite

Reticulitermes claripennis — in Family Reticulitermidae.
• These 7mm black-and-cream clear-winged termites normally live in dead roots of mesquite and other trees. With these habits, they, of course, will infest any house where woodwork touches the ground.



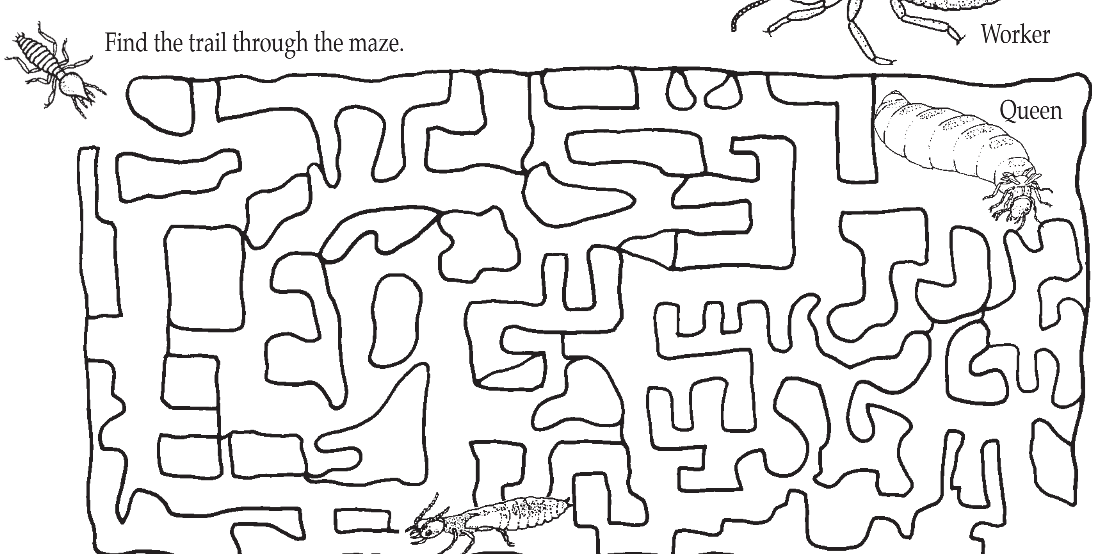


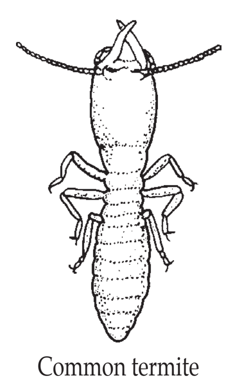
Worker



Blackhead termite soldier

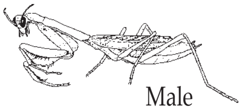
Find the trail through the maze.

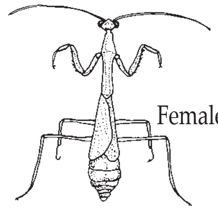




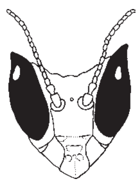
Common termite soldier

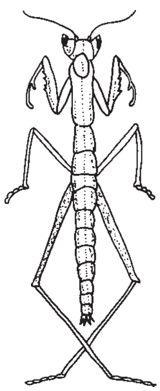
more stuff . . .


Male


Female

Carolina mantis


Face


Horned ground mantis

Finding words you've learned

J	U	M	P	E	R	R
R	W	A	L	K	E	R
S	E	A	E	B	D	E
U	W	G	M	R	L	N
P	I	I	G	L	O	N
A	L	V	M	I	H	U
C	A	R	V	M	D	R
C	R	A	W	L	E	R
S	I	G	N	A	L	R

Find the words below. They can be up, down, forward, backward or diagonal within the puzzle.

CLIMBER
CRAWLER
DIGGER
JUMPER
HOLDER
RUNNER
SIGNAL
SWIMMER
WALKER

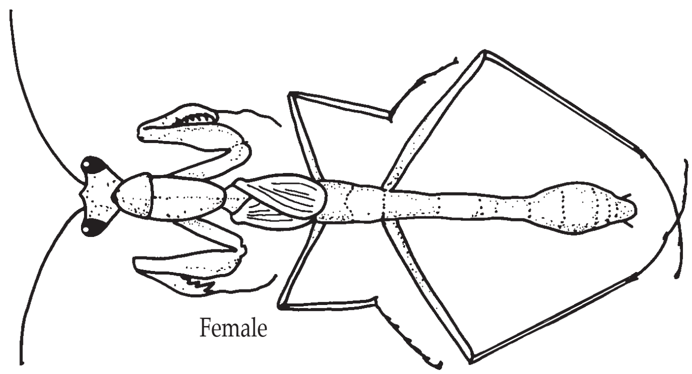
MANTISES Order Manteida — 22nd in diversity — 74+ species in Texas

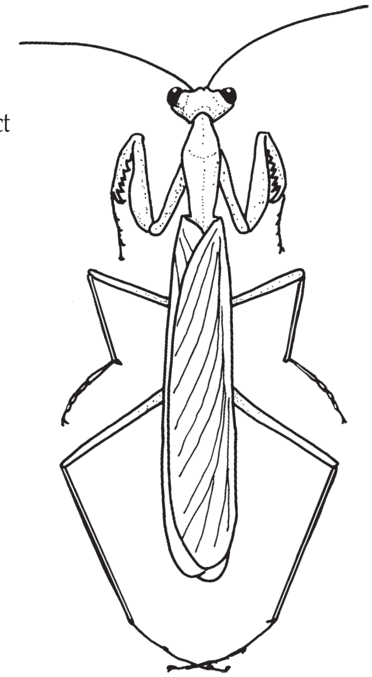
These insects are proficient hunters. They watch the eyes, even of large animals. They will track your eyes as you walk behind them while only moving their head. The spiny forelegs shoot out to grasp prey and crush it. They nibble on the torn body of their food with precise mouthparts. The order is less than 80 million years old and evolved from a superfamily of cockroaches.

Little brown mantis

Litaneutria minor — in Family Pyrgomantidae.

• The 23mm gray adults are found on dry vegetation where they wait for insect prey to land. Eggs are laid in a small case of dried protein foam made by the mother. The tiny nymphs disperse, most of them not surviving to adulthood.

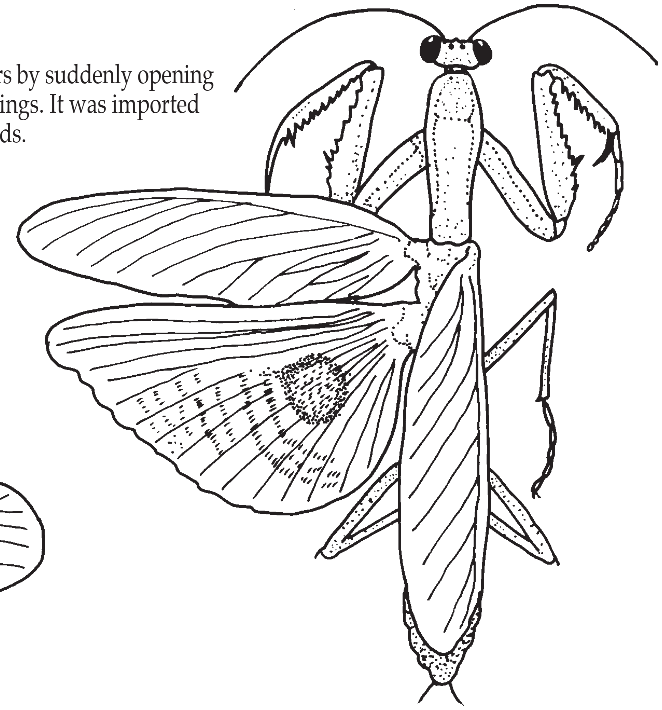

Female

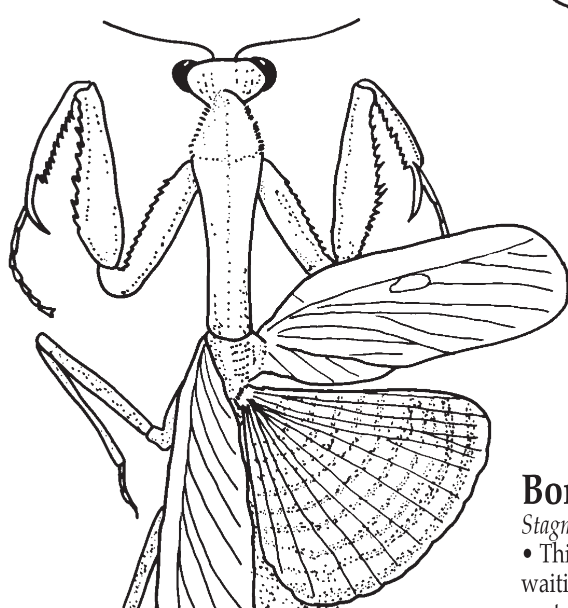

Male

Mediterranean mantis

Iris oratoria — in Family Mantidae.

• This 54mm green or brown mantis startles predators by suddenly opening its wings to display the large eyespots on the hindwings. It was imported and introduced in 1933 to control pests in cotton fields.





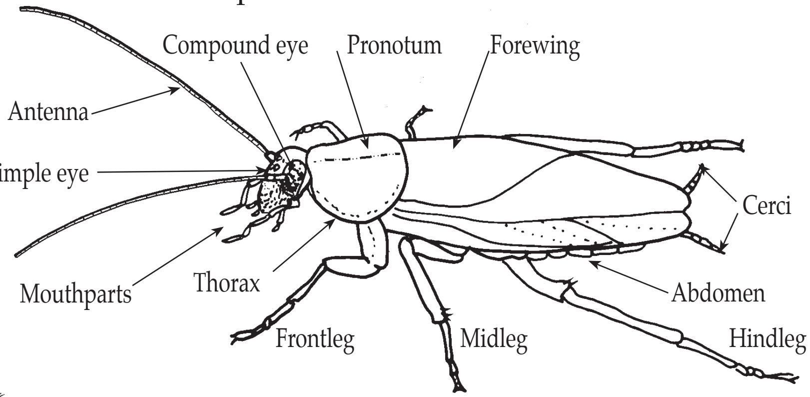
Bordered mantis

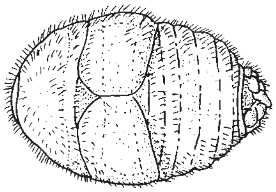
Stagmomantis limbata — in Family Mantidae.

• This 71mm green mantis is often found among sunflowers waiting for butterflies and other insects to land. It constructs a protein-plastic foam case around the egg mass in which the eggs survive the winter, protected from parasites and predators.

71mm

Although most cockroaches are winged, they rely mainly on quick legs to dart out of danger. They flourish anywhere there is food, moisture and warmth. Roaches adapted to living in houses have oily bodies. They carry bacteria in this oil to condition the food they run over. They also mark their territory with strong odors we find foul. Other roaches living in the wild have clean waxed bodies covered with velvet down and are not unpleasant at all. Fossil roaches occur in 316-million-year-old rocks.





Leafcutter-ant-guest roach
male
2.5mm

Leafcutter-ant-guest roach

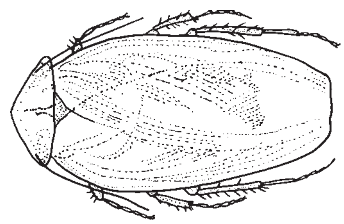
Attaphila fungicola — in Family Attaphilidae.

• Adults are found up to 15 feet underground in the fungus garden chambers of the leafcutter ant. Young individuals may ride to a new colony on the backs of their hosts. This tan 2.5mm roach was discovered 12 feet underground in a building excavation in Austin in 1904.

Boll's sandroach

Arenivaga bolliana — in Family Polyphagidae.

• Red-speckled gray-brown 30mm adult males fly to light in summer in Central Texas. Other related species occur in West and South Texas. The downy females have no wings and burrow in the dust under houses and in natural rock shelters where they feed on packrat droppings.

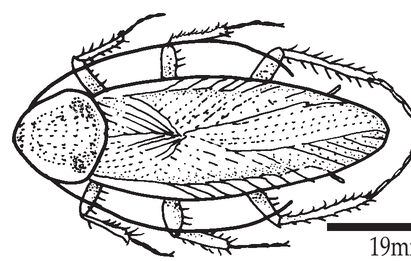


Male
30mm

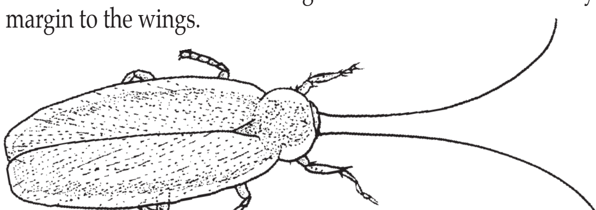
Meadow roach

Pseudomops septentrionalis — in Family Pseudomopidae.

• Tan 19mm adults are found in daytime on meadow foliage, especially along streams, in late spring and early summer. This, our prettiest cockroach is black with an orange shield over the head and a yellow margin to the wings.



19mm



Dark wood roach

Parcoblatta pensylvanica — in Family Pseudomopidae.

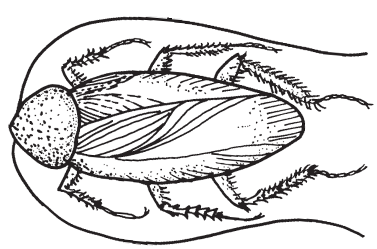
• Pale-bordered black 21mm adults are found under leaves in woodland along rivers. A fossil of this old species has been found in 38-million-year-old volcanic ash beds.

21mm

Smoky brown cockroach

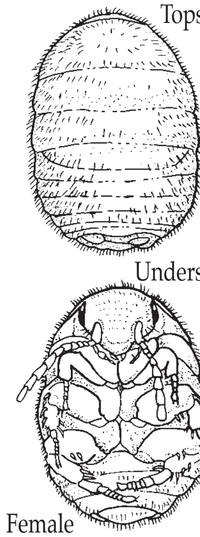
Periplaneta fuliginosa — in Family Blattidae.

• The 48mm adults may wander into houses but are much more common outdoors. Nymphs live in accumulations of damp leaves in gutters or knotholes of hollow trees. The young eat fungus and animal droppings. The dark-walnut-brown adults eat moist decaying matter. This species ranges from Florida to Austin and also occurs in southern Japan. A 72-million-year-old fossil of this species has been found at a dinosaur and redwood fossil locality in Montana. This may be the oldest known living animal species. Respect that roach when you meet it!

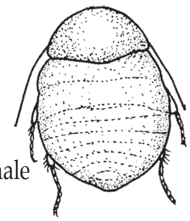


2.5mm

more stuff . . .



Leafcutter-ant-guest roach



Boll's sandroach

Say people who have eaten them "Cockroaches taste like shrimp".

Life span
American cockroach
100-500 days

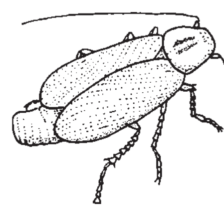
Brownbanded cockroach
115-136 days

German cockroach
90-200 days

Giant cockroach
300-600 days

Oriental cockroach
316-533 days

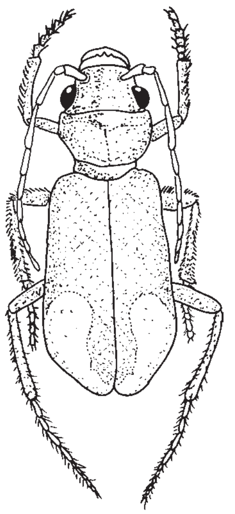
Smoky brown cockroach
191-586 days



German cockroach carrying egg case

BEETLES — Superorder Coleopteroidea

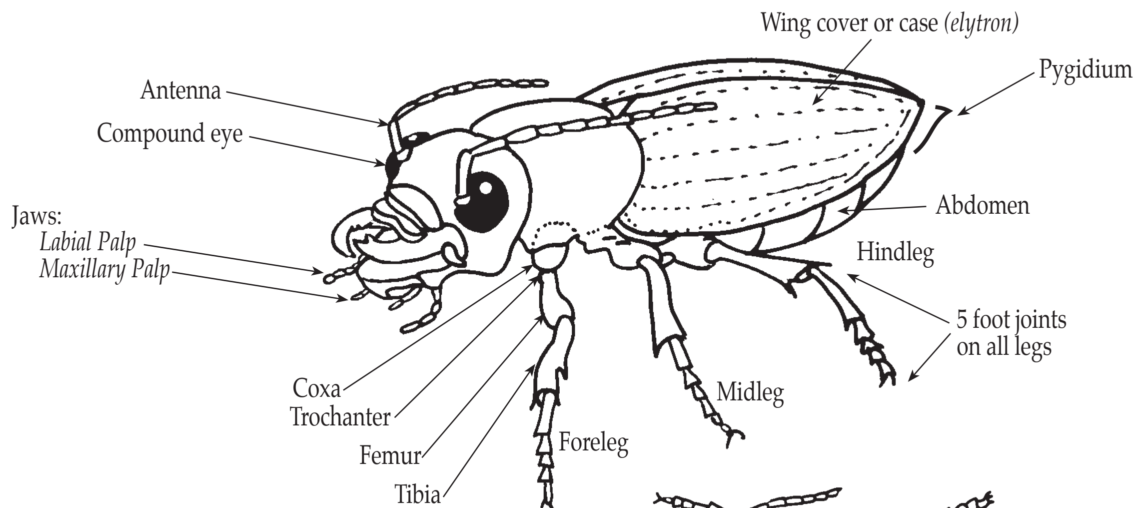
These hard-shelled roach-like insects have made the third great leap forward in insect evolution — they have developed a pupal stage. Larvae live very differently from adults and do not compete with them for food. Metamorphosis or major change in body plan occurs between pupa and adult. This separation of larvae from adults is such an asset to insect livelihood that a pupal stage evolved three different times in different groups of insects.

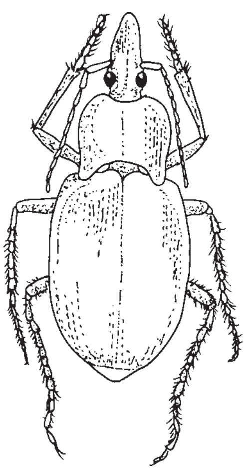


Carolina tiger beetle

BEETLES Order Coleoptera — the most diverse order — 18000+ species in Texas

As in earwigs and true bugs, at least part of the forewing of beetles is a hard shell used to protect the hindwing. As in earwigs, the hindwing is longer than the forewing wing cover called **elytron** and must be cross-folded to be stowed away. Unlike earwigs, however, the wing is not pleated but rolled and is cross-folded. Like cockroaches, beetles have well-developed chewing mouthparts. Beetles have one or more kinds of larva per species and a pupal stage. They are scavengers, omnivores, carnivores, herbivores, burrowing miners, and wood borers. They have survived for at least 260 million years. Although beetles are often grouped with all the other insects that have a pupal stage, they are structurally closest to their roach relatives.

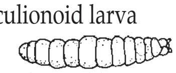




Snail-eating beetle

Mottled reticulated beetle

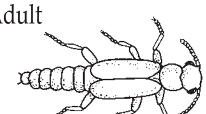
Cupes concolor — in Family Cupesidae.
• Found under the bark of dead trees, this 11.5mm brown beetle has changed little since its family first appeared in the Permian, some 250 million years ago.



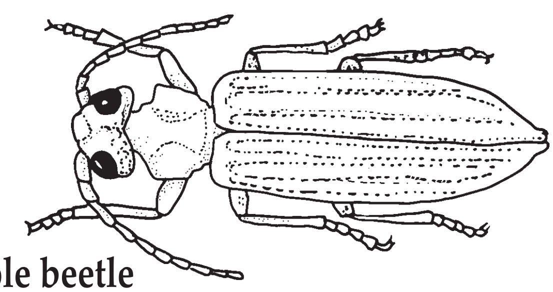
Circulionoid larva

Cerambycoid larva

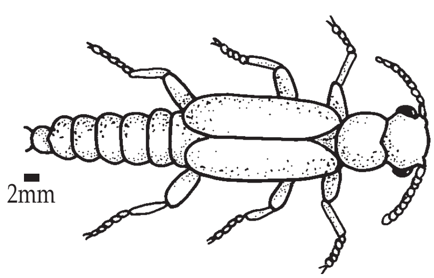
Caraboid larva



Adult



Developmental stages of the telephone pole beetle

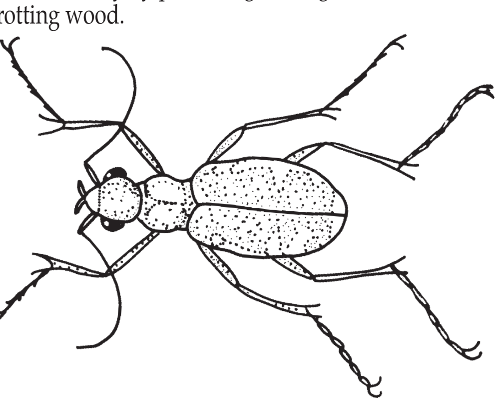


Telephone pole beetle

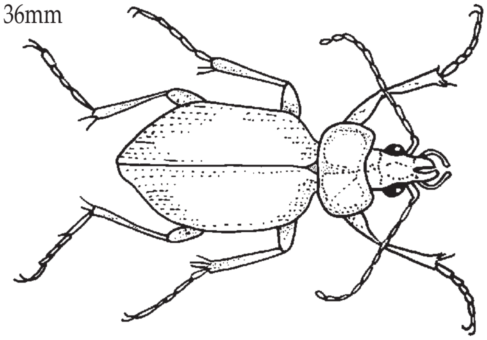
Micromalthus debilis — in Family Micromalthidae.
• This 2mm brown fly-like beetle has several unusual kinds of larvae which may produce pupae and adults, or may by parthenogenesis give birth to more larvae. They are found in rotting wood.

Splendid tigerbeetle

Cicindela splendida— in Family Cicindelidae.
• A beautiful glossy green 15mm beetle with cream-flecked copper-red wing cases found running over sandy roads in pine and oakwoods. The subterranean larvae use their head and thorax for a trapdoor.

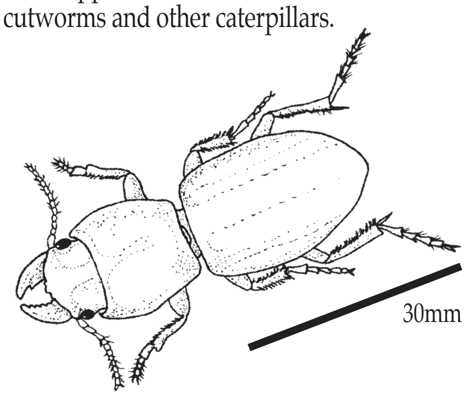


36mm



Searcher beetle

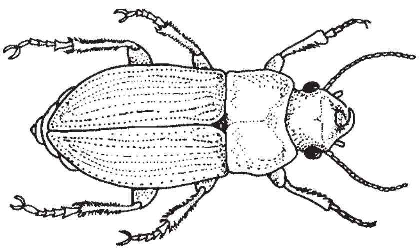
Calosoma scrutator — in Family Carabidae.
• A foul-smelling beautiful glossy green 36mm beetle with iridescent blue-and-copper trim. This voracious predator eliminates cutworms and other caterpillars.



30mm

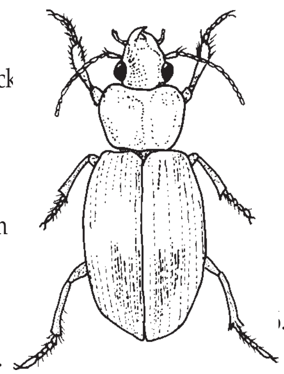
Large ground beetle

Pasimachus punctulatus — in Family Carabidae.
• This 30mm glossy black beetle is seen running over open ground even in hot sunny weather. It preys on armyworms and tent caterpillars.



Small ground beetle

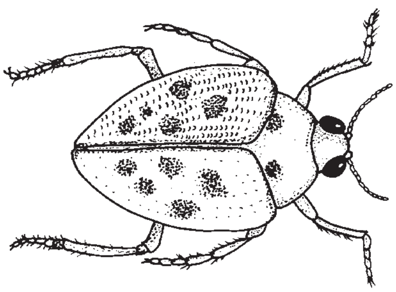
Harpalus caliginosus — in Family Carabidae.
• Found under clumps of short grass, this black 11mm beetle is a predator of cutworms.



.5mm

Cornseed beetle

Agonoderus pallipes — in Family Carabidae.
• Found eating germinating grain, this 6.5mm black-and-yellow beetle often flies to light.

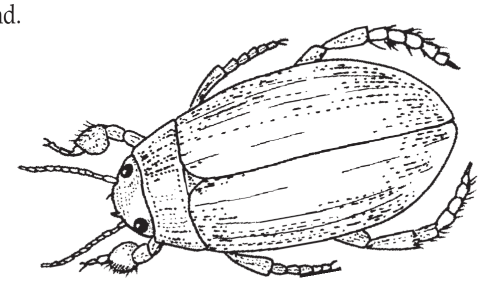


Crawling water beetle

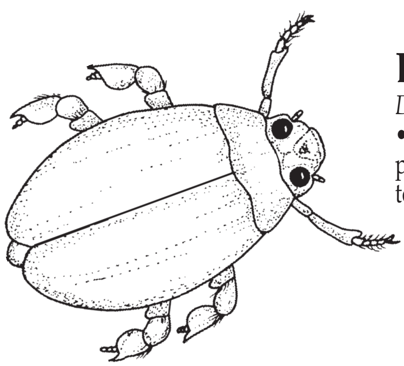
Peltodytes pedunculatus — in Family Haliplidae.
• Found in puddles and streams, this 3.5mm black-spotted yellow beetle crawls over aquatic plants. The larva eats small water animals. Adults fly from pond to pond.

Predaceous diving beetle

Dytiscus marginicollis — in Family Dytiscidae.
• Sometimes called water tigers, the adult and their larvae are voraceous predators that take minnows and tadpoles as well as insect prey. The black color of the 30mm beetle has a greenish oily sheen.



11mm

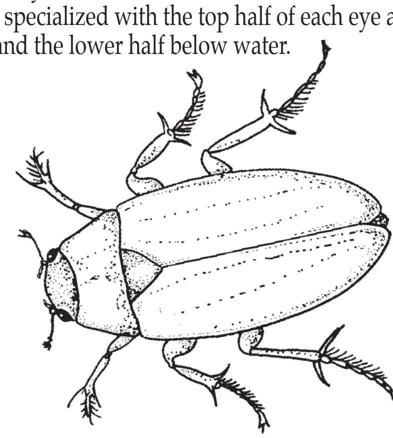


Bronzy large whirlygig

Dineutus assimilis — in Family Gyrinidae.
• This 11mm flat bronzy-black beetle scuds across the water surface of ponds. The eyes are specialized with the top half of each eye adapted to see above water and the lower half below water.

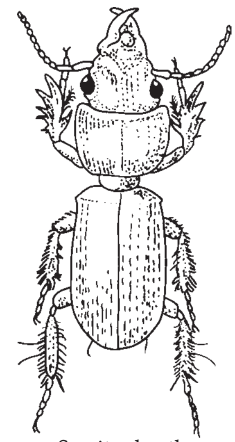
Water scavenger beetle

Hydrous triangularis — in Family Hydrophilidae.
• This 48mm streamlined black beetle and its larva feeds on decaying animal and plant detritus. Flying from pond to pond, these beetles are often attracted to light. Underneath, they have a strong double-spiked keel. Their fossils are abundant with mastodon remains in the tar pits of Los Angeles.

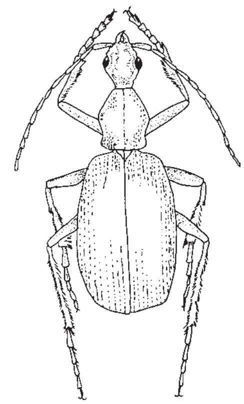


48mm

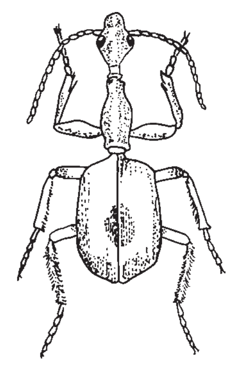
more stuff . . .



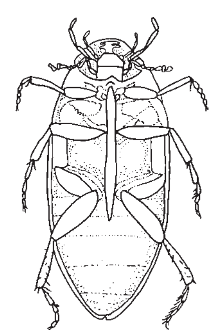
Scarites beetle



Bombardier beetle



Colliurus beetle

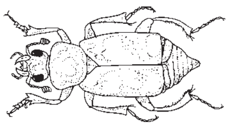


Water scavenger beetle

more stuff . . .

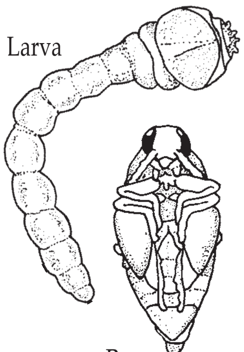
Larva

Adult



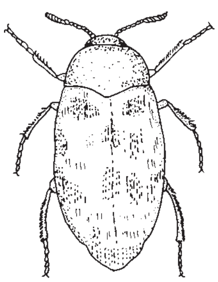
Sexton beetle

Larva



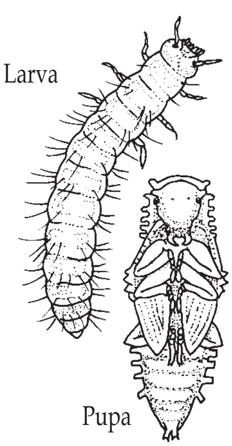
Pupa

Flathead apple tree borer beetle



Black carpet beetle

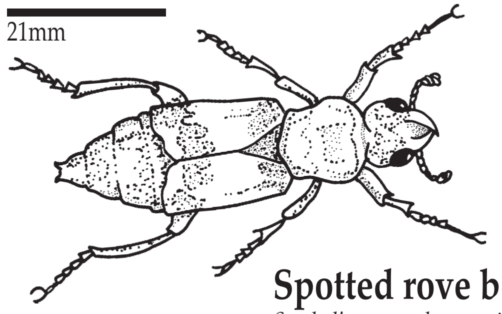
Larva



Pupa

Sawtoothed grain beetle

21mm



Sexton beetle

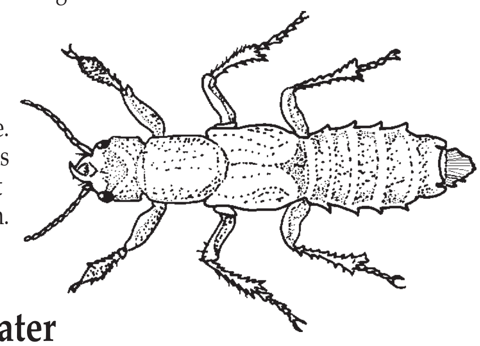
Nicrophorus marginatus — in Family Silphidae.

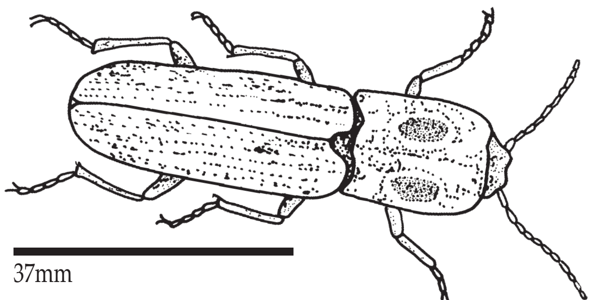
• This 21mm orange-and-black-banded beetle is attracted to the smell of dead animals. A number of beetles excavate earth from under the body, lowering it into the ground. They lay their eggs on this larval food supply before covering it with earth.

Spotted rove beetle

Staphylinus maculosus — in Family Staphylinidae.

• A velvety brown 18.5mm beetle with spots, this insect is attracted to decaying animals where it feeds on the other insects feeding on the carrion.





37mm

Eyed elater

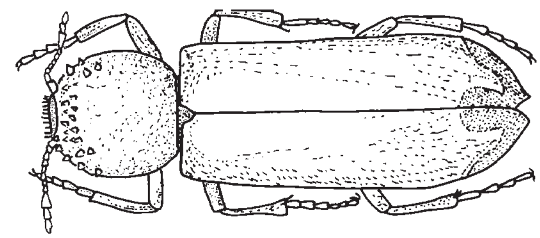
Alaus oculatus — in Family Elateridae.

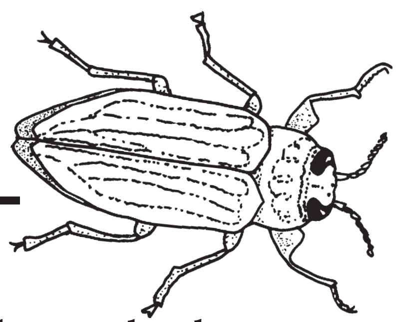
• This is a 37mm black click beetle with a striking pattern of a white waxy coating. When placed on its back on a flat surface, it will flip over with a sharp crack of the body. Larvae bore in decaying elm trees and adults are usually found wandering on the trunks of dead trees.

Appletwig borer beetle

Amphicerus hamatus — in Family Bostrichidae.

• This toothed black 21mm beetle bores in twigs of fruit trees and grapevines. It frequently flies to light.





15mm

Flathead apple tree borer beetle

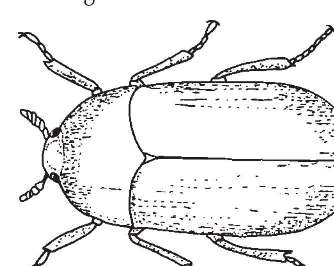
Chrysobothrys femorata — in Family Buprestidae.

• This is a flat 15mm bronze beetle with a copper and greenish sheen, found on and under bark. The larvae eat their way through the dead or dying inner bark leaving twisted flat galleries filled with their frass.

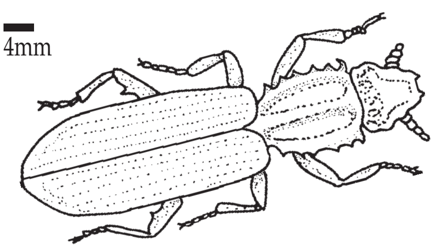
Black carpet beetle

Attagenus piceus — in Family Dermestidae.

• This 7.5mm black beetle and its black-haired larva live in and eat carpets that have stains or residues of soluble organic matter. It is an Old-World cave species that followed humans into houses around the world.



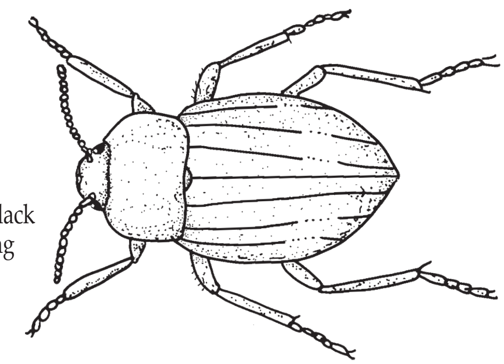
4mm



Sawtoothed grain beetle

Oryzaephilus surinamensis — in Family Cucujidae.

• This 4mm elongated chestnut-brown beetle is found in stored foods and vegetable products. This is another Old-World species that has followed humans out of rock shelters into houses around the world.



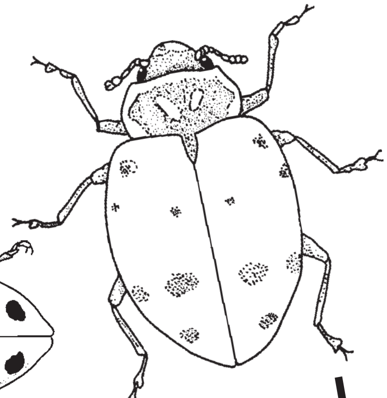
False stinkbeetle

Eleodes tricostata — in Family Tenebrionidae.

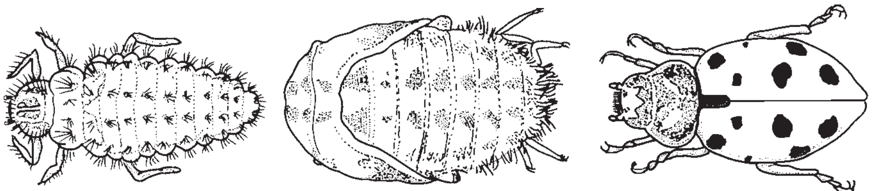
• Seen crossing roads in hot weather before rain, this 18.5mm satin black beetle stands on its head when disturbed and releases a foul-smelling oily repellant.

Ladybird beetle

Hippodamia convergens — in Family Coccinellidae.
• Red with black spots and yellow dashes on the thorax, this 7mm beetle is a garden favorite. Larvae and adults feed primarily on aphids. Spread by mail from garden stores, this species is found almost everywhere. In winter, it congregates on mountaintops or ceilings in masses of hundreds to thousands of individuals, waiting for spring. The combined strength of the foul-tasting body fluids is a deterrent to predators.

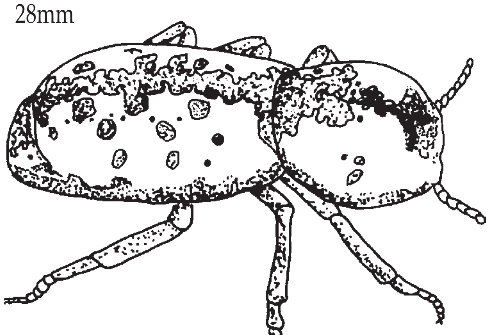


7mm



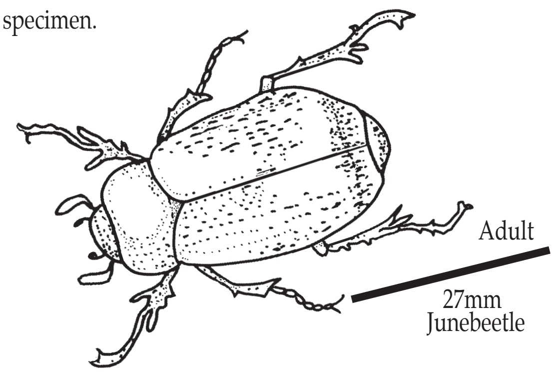
Larva Pupa Adult
Ladybird beetle

28mm



Ironclad beetle

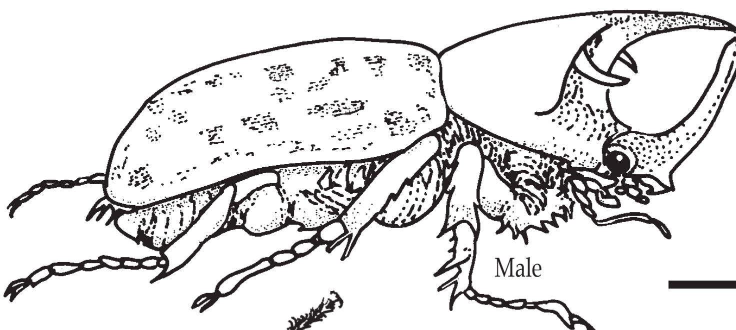
Zopherus haldemani — in Family Tenebrionidae.
• Seen gathered at fungus on fallen trees, this knobby white-on-black 28mm beetle is a Texas favorite. The exoskeleton is so hard it must be drilled to pin a specimen.



Adult
27mm
Junebeetle

Junebeetle

Phyllophaga fervida — in Family Scarabaeidae.
• This soft-brown 27mm beetle flies to light by the thousands. The j-shaped grub larva is familiar to gardeners. It feeds on roots of trees and shrubs. Adult beetles feed on leaves.

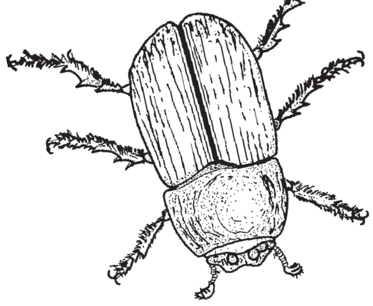


Male

Hercules beetle

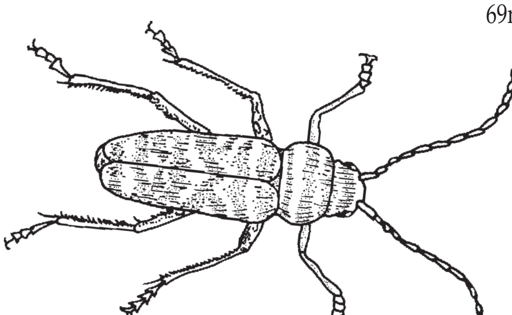
Dynastes tityus — in Family Scarabaeidae.
• This pale milky-green black-spotted 69mm beetle with the over-and-under horns is becoming scarce. The j-shaped grub larvae live for a number of years in large hollow oak trees in old growth woodland. This habitat is vanishing. The female is black, without horns.

69mm



Red-and-black dung beetle

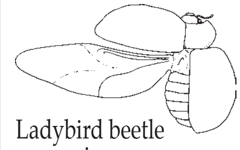
Aphodius fimetarius — in Family Scarabaeidae.
• This 8.5mm black-and-brick-red beetle flies to light. It can be found in pastures burrowing in fresh cow dung where it lays its eggs.



Painted hickory borer longhorn beetle

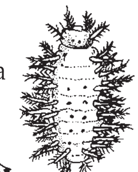
Cyllene caryae — in Family Cerambycidae.
• Jet black with fine yellow lines, this 18mm beetle reminds us of a wasp, especially when it buzzes in flight. The larvae burrow under the bark of dead and dying hickory trees.

more stuff . . .



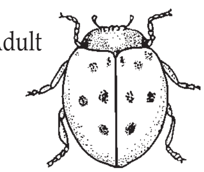
Ladybird beetle wing

Larva



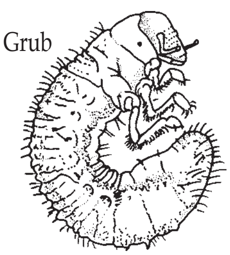
Pupa

Adult



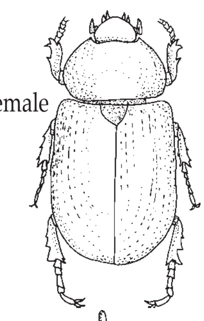
Mexican bean beetle

Grub

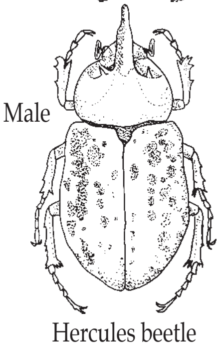


Junebeetle

Female

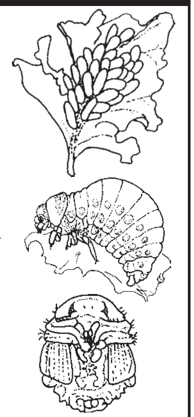


Male

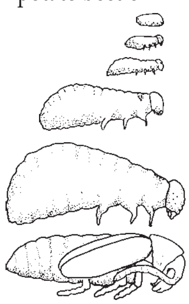


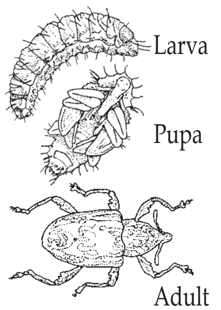
Hercules beetle

more stuff . . .

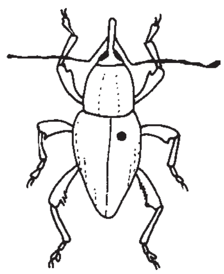


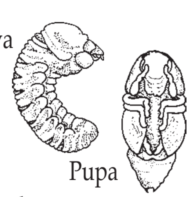
Developmental stages of the Colorado potato beetle


Developmental stages of the spotted cucumber beetle

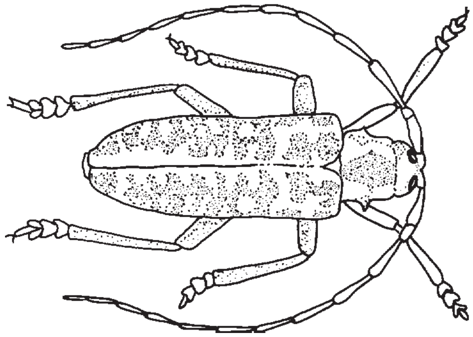


Plum curculio


Where to put the pin in a specimen



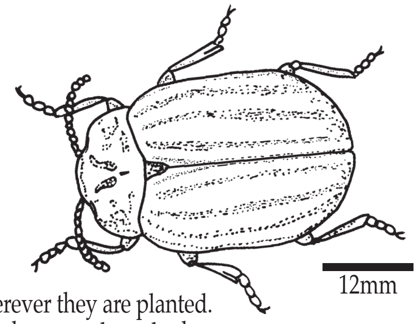
Shothole borer beetle



Cottonwood borer longhorn beetle

Plectrodera scalator — in Family Cerambycidae.

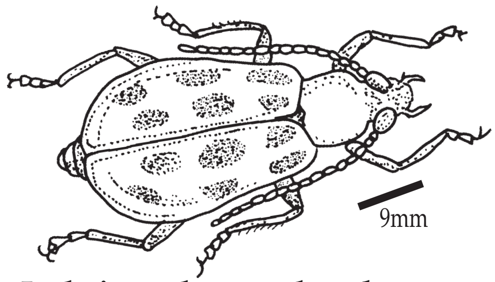
• This white-patterned black 40mm beetle is often found on the trunks of cottonwood trees in midsummer. The larvae bore in the wood of living cottonwoods.



Colorado potato beetle

Leptinotarsa decemlineata — in Family Chrysomelidae.

• This yellow-and-black-striped 12mm beetle manages to find potato plants wherever they are planted. The black-spotted dull-red hump-backed grubs feed on potato, tomato, egplant, horsenettle and other nightshade plants.



Spotted cucumber beetle

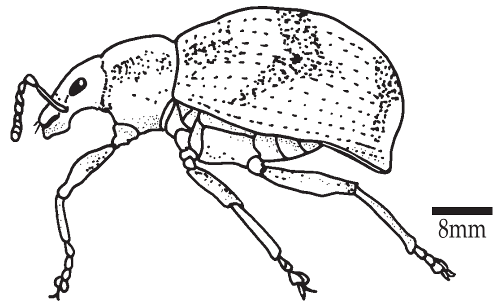
Diabrotica duodecimpunctata — in Family Chrysomelidae.

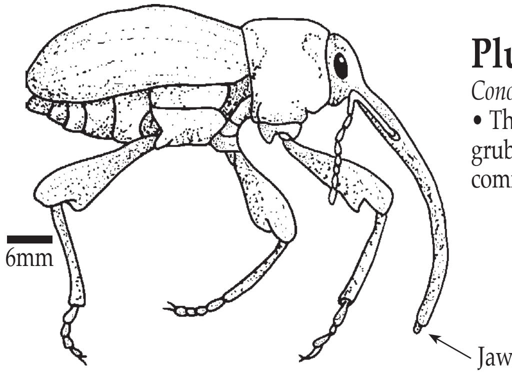
• This black-spotted pale-green 9mm beetle is often seen flying into gardens in spring and fall. The larvae prefer melon, squash and cucumber but will eat new green shoots of almost any plant.

Imbricated snout beetle

Epicaerus imbricatus — in Family Curculionidae.

• This gray-and-black-mottled 8mm beetle with an obvious snout lives in meadows and prairies where it feeds on buds and young leaves. The larvae feed on grass roots.

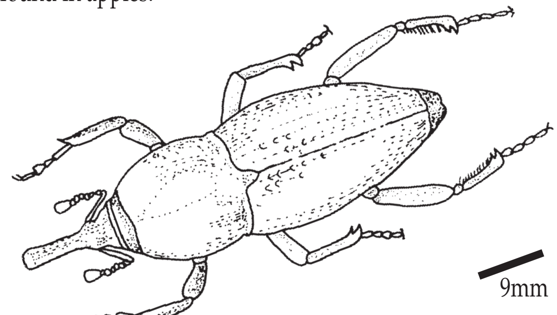


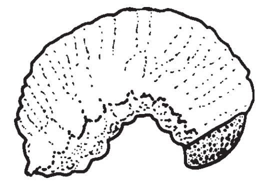


Plum curculio

Conotrachelus nenuphar — in Family Curculionidae.

• This gray-streaked dark-brown 6mm beetle is common in winter. The grubs feed in plums, cherries, peaches, almonds and apples. It is the most common "worm" found in apples.

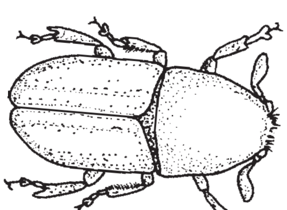



Elephant billbug larva

Elephant billbug

Calendra zeae — in Family Curculionidae.

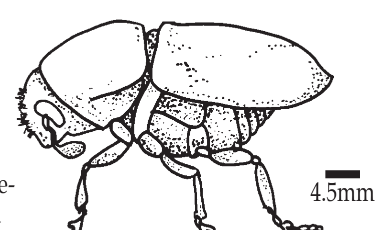
• This shiny black long-snouted 9mm beetle chews holes in the young leaves of corn and related grasses. It is common in summer along streams.


Shothole borer beetle top view

Shothole borer beetle

Scolytus rugulosus — in Family Scolytidae.

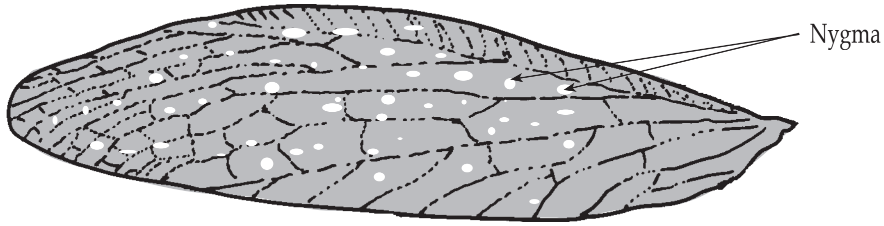
• These are 4.5mm black beetles with a minute white-dotted pattern that emerge from tiny "shot holes" in the bark of trees. The larvae make elaborate branching galleries just under the bark.



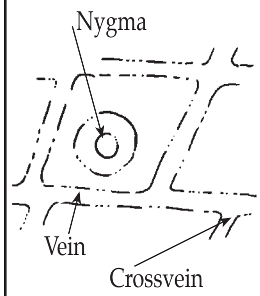
Shothole borer beetle sideview

NYGMATE INSECTS — Supraorder Telomerida — (Includes all the remaining insects.)

The early members of all the orders contained in this grouping had a hindwing similar to the forewing, and on the wing surface were circular organs called **nygma**, of unknown function. A few of their descendants still carry these organs.



more stuff . . .



THE PANORPOID COMPLEX — Superorder Panorpoidea

These insects have caterpillar larvae and a pupal stage. Well-known members are fleas, moths, butterflies and flies. The metamorphosis or total rearrangement of anatomy occurs in the pupal stage. The caterpillar can be thought of as a hatched embryo, adapted for feeding. Larvae live in different places than the adults and feed on different food. Larvae do not compete with adults and much larger populations can be supported in the same habitat. Fossil panorpoids have been found in 300-million-year-old rocks.

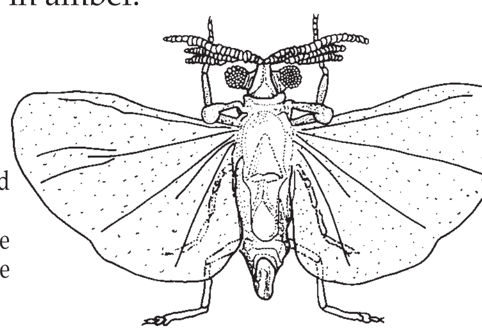
TWISTWING FLIES Order Strepsiptera — 23rd in diversity — 66+ species in Texas

Larvae and females are parasites of other insects. They are attached to the membranes between segments of the host's abdomen where they feed on blood. They are restricted in choice of host, but many twistwing flies parasitize many insects from bristletails to grasshoppers, cicadas, butterflies and bees. Of all the insects that have a pupal stage, twistwing larvae are the only ones with compound eyes, like primitive insects. Fossil twistwings have been found in amber.

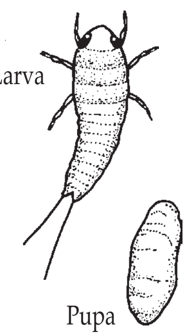
Mexican stylops

Triozocera mexicana — in family Stylopidae.

• This 2mm black and cream colored insect has forewings reduced to tiny stabilizing clubs and hindwings enlarged. Females look like tiny bedbugs. Larvae run free when first hatched but become internal parasites of silverfish and firebrats. Pupation is in the live or dead host.

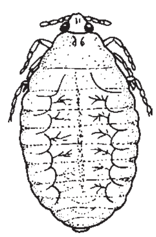


Male



Larva

Pupa



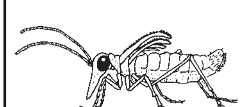
Female

Mexican stylops

SNOWSKIPS Order Raphioptera — 36th in diversity — 0+ species in Texas

None of these have yet been found in Texas, making this the only living insect order not yet known from the state. Most living species are of the genus *Boreas*. These 5mm-long black insects probably occur near the top of the Davis or Guadalupe Mountains. They should be looked for hopping around on snow or moss on a damp day in winter. In the Rocky Mountains, there are several black or brown species of these vegetarian relatives of the scorpionflies. The order has survived for the last 300 million years.

Snowskip female



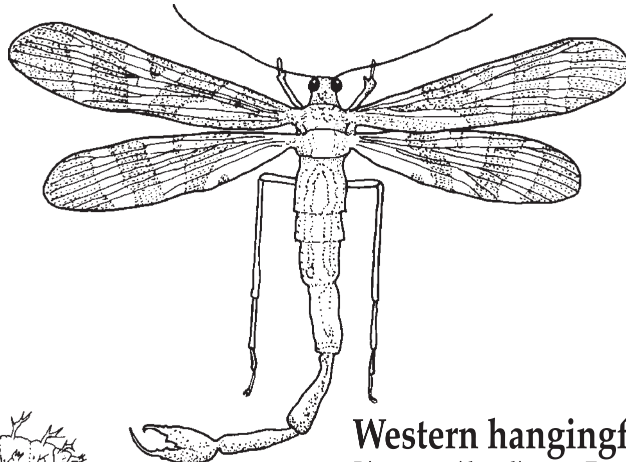
Snowskip male

SCORPIONFLIES Order Panorpida — 27th in diversity — 23+ species in Texas

Male scorpionflies have an upturned abdomen with a bulbous end that resembles a scorpion tail. When trapped, they feign a wasp-like stinging motion but are quite harmless. The spiny caterpillar is a predator and scavenger of other insects in leaf litter. The pupa is moth-like. Adults capture other insects on which they feed with their beaked chewing mouthparts. Scorpionfly relatives have survived for nearly 270 million years.

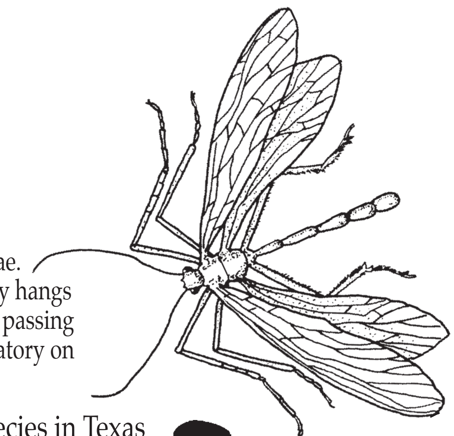
more stuff . . .

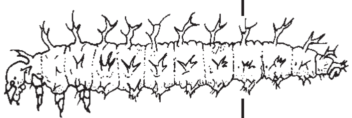
22mm



Orange-banded scorpionfly

Panorpa nuptialis — in Family Panorpidae.
• This black-banded orange-winged four-winged 22mm fly was once common in fall. Its flight and walking habit as well as coloration reminds us of a wasp. Fire-ant predation on its larvae have made it uncommon.



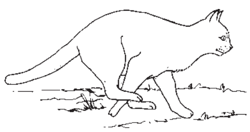


Hangingfly caterpillar

Western hangingfly

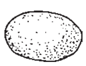
Bittacus occidentalis — in Family Bittacidae.
• This tan-winged four-winged 30mm fly hangs from vegetation along streams. It grasps passing prey in its curling feet. The larva is predatory on insects in leaflitter.

FLEAS Order Siphonaptera — 17th in diversity — 140+ species in Texas

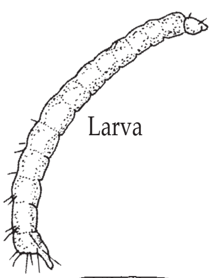


Cat

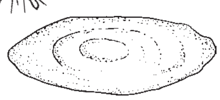
These are small wingless jumping insects that are external parasites of birds and mammals. The body is flattened into the vertical plane to permit sliding between hairs. Spines and bristles keep the flea from sliding off the host. Eggs are dropped in the nest of the host. Flea caterpillars feed on dander in the nest. The pupae are formed in a cocoon. Strong hindlegs permit adult leaps of about a foot onto a host or from host to host. Although a given species is restricted to one or a few hosts, adults may survive for a generation or two on alternate hosts, but tend to be stunted. Fossil fleas have been found in 90-million-year-old rocks associated with fossil furry flying reptiles (pterosaurs) from the days of the dinosaurs.



Egg



Larva

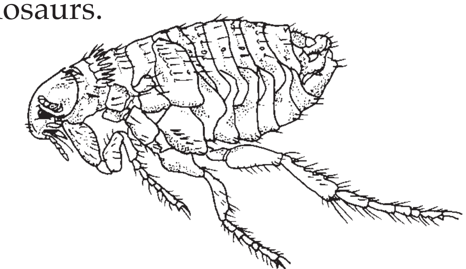


Cocoon

Developmental stages of the cat flea

Cat flea

Ctenocephalides felis — in Family Pulicidae.
• This is the common dark brown flea in houses. Brought in by cats, it drops relatively large long white eggs into rugs. The larvae feed on dander, pupate and, after 6 days, the newly hatched 2.5mm fleas jump onto pets and people. They can carry diseases and parasites.

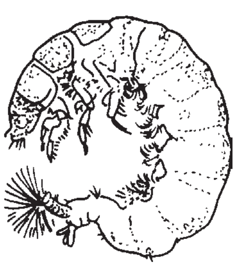


CADDIS FLIES Order Trichoptera — 7th in diversity — 344+ species in Texas

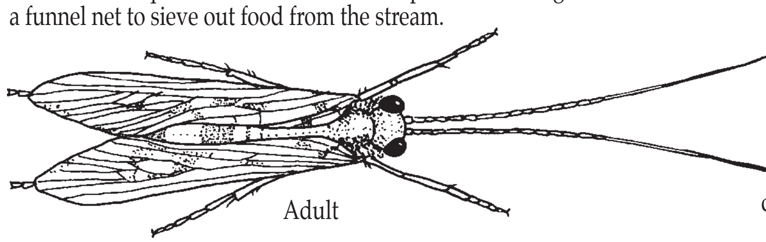
Caddis flies resemble moths in wing shape and venation and are often colored like moths. They lack the tongue of moths and have only hairs, not scales, on wings and body. Eggs are laid in water. Caterpillars called caddisworms build a case which they carry about like the shell of an hermit crab. The caddis case is constructed of leaf or twig fragments, sand grains, or trash which is held together by silk. They pupate in the caddis case. Newly hatched adults crawl out of the water and fly off weakly. Most are nocturnal.

Seine-making caddis fly

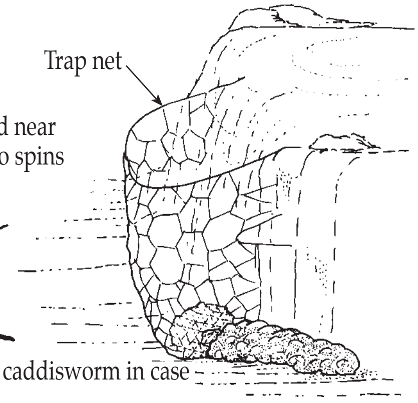
Hydropsyche scalaris — in Family Hydropsychidae.
• This is a brown-spotted tawny moth-like four-winged 12mm fly usually found near streams. The aquatic larva builds a case of pebbles held together with silk. It also spins a funnel net to sieve out food from the stream.



Caddis fly caterpillar

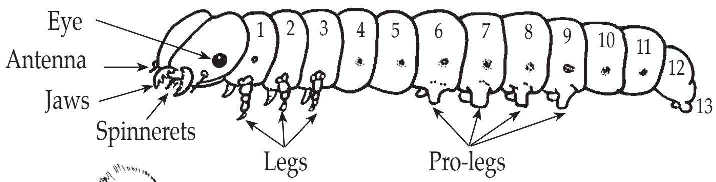


Adult



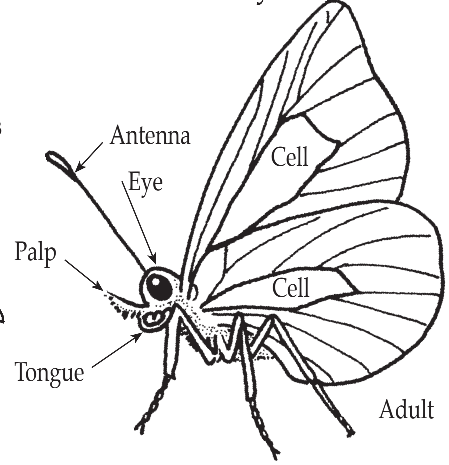
caddisworm in case

Lepidoptera is Greek for scaly-winged. Scales are articulated hairs that are expanded sideways to form flat plates reinforced by ribs and crossbars. The distance between crossbars on the scales is often the wavelength of red, yellow, green or blue light and is responsible for the vivid glowing colors of some species. Scales are also pigmented with colorful waste chemicals. Mouthparts are modified to form a long coiled tube for sucking nectar, water or fluids from animals. Teeth on the tongue allow some desert moths to feed on mammal blood. Eggs are laid on or in plants. Caterpillars are voracious feeding machines. The pupa or chrysalis is often placed in a cocoon. Silk is commercially spun from cocoons of several species of moth. The Aztecs printed their books on silk paper made from the cocoon of the edible madrone butterfly caterpillars. Fossil moths have been found in 245-million-year-old rocks.

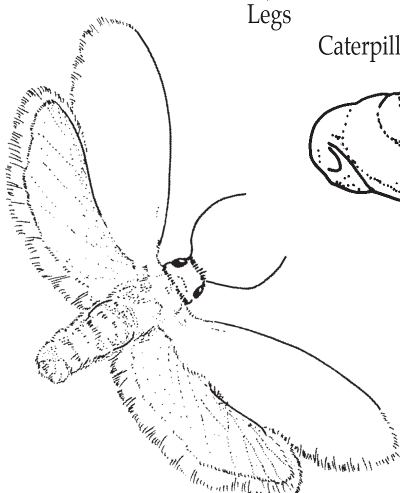


Caterpillar


Chrysalis

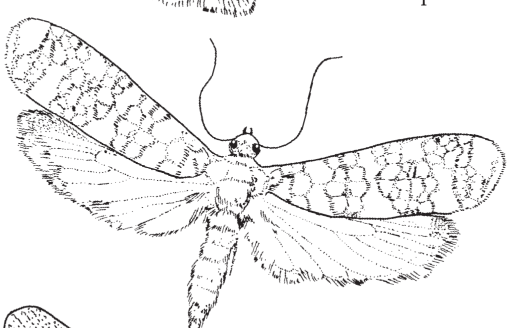


Adult



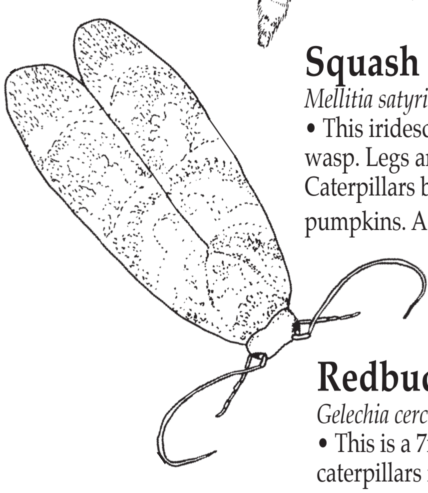
Yucca moth

Tegeticula yuccasella — in Family Incurvariidae.
• This 8mm moth with clean white forewings and gray hindwings is found in yucca flowers. The female gathers pollen, lays its eggs in the yucca pistil, then plugs the hole with pollen, guaranteeing fertilization of the seeds on which her caterpillars will feed. Yuccas do not set seed without these moths.



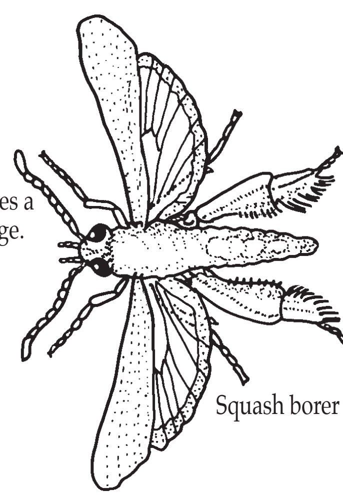
Ailanthus webworm moth

Atteva punctella — in Family Yponomeutidae.
• This striking 8.5mm moth has black-bordered white-spotted orange-red forewings. The caterpillars live communally in ailanthus trees in cities.



Squash borer moth

Mellitia satyriniformis — in Family Aegeriidae.
• This iridescent greenish-black 18mm moth resembles a wasp. Legs and palps have dashes of white and orange. Caterpillars bore in the vines of gourds, squash and pumpkins. Adults are day fliers.


Squash borer moth

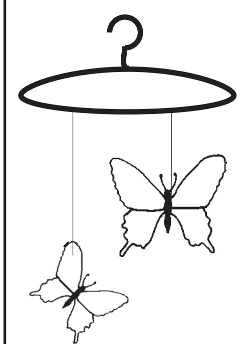
Redbud leafroller moth

Gelechia cercerisella — in Family Gelechiidae.
• This is a 7mm glossy black moth with a white head and forewings with five white spots. The caterpillars roll the edge of a redbud leaf to form a house and venture out at night to feed.

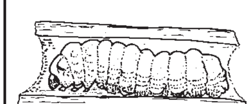
more stuff . . .

Make a mobile

Enlarge the moth and butterfly illustrations on the following pages, color them, hang them by a thread on a hanger. Hang up the hanger and enjoy your artwork.

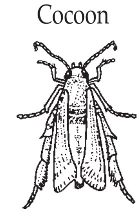



Egg


Caterpillar


Pupa


Cocoon

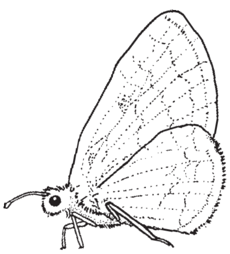

Adult

Developmental stages of the squash borer moth

more stuff . . .

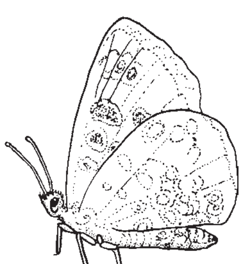
Female bagworm moth in case

Juniper



Checkered skipper

Hairstreak caterpillar



Adult

Harvester

Bagworm moth

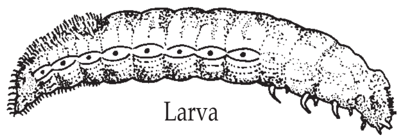
Thyridopteryx ephemeraeformis — in Family Psychidae.

• The smoky clearwing 8.5mm males have furry bodies and fly in the daytime. Caterpillars build large silk bags reinforced with twigs and walk from branch to branch inside the bag on junipers and other shrubs they eat. Females never grow wings, mate in the bag, lay their eggs in the bag and never leave it.

Adult female

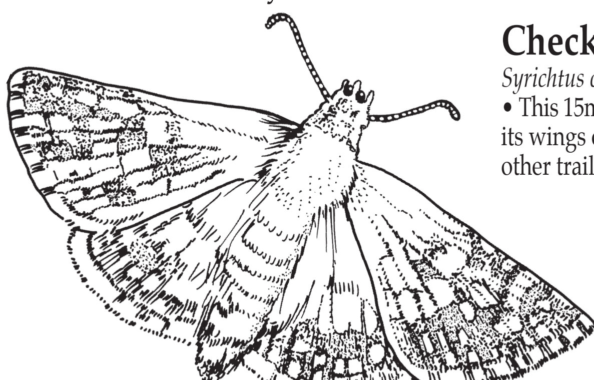
Adult male

Eggs in old skin



Larva

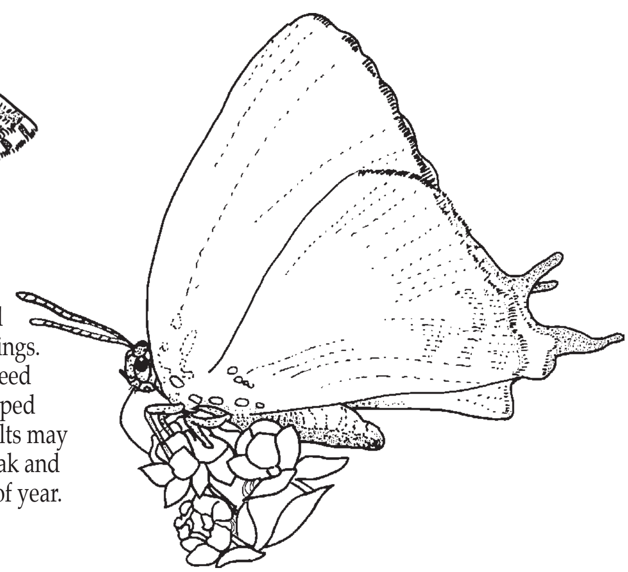
BUTTERFLIES — several unrelated groups of moths have adapted to life in the full sun, using nectar from flowers as a source of energy. Some of these have clubbed antennae and no wing-hook mechanism and are called butterflies. Others have feathery antennae and a hooking mechanism holding wings together in flight. These are called day-flying moths. Most languages have no separate word for butterfly, calling them all moths. Skippers are butterflies that may have evolved from the lineage that gave us pyralid moths. Hairstreaks, harvesters, metalmarks and swallowtails may have evolved from skippers. Snout butterflies, fritillaries and admirals may have evolved from primitive moths related to ghost moths and goat moths. Whites and sulphurs may have evolved from hedyliid moths near the inchworm lineage. Fossil butterfly scales have been found in 100-million-year-old amber. A fossil snout butterfly egg has been found in 80-million-year-old sediment. Fossil butterfly bodies with wings attached have been found in 48-million-year-old oil-shale rocks.



Checkered skipper

Syrichtus communis — in Family Pyrgidae.

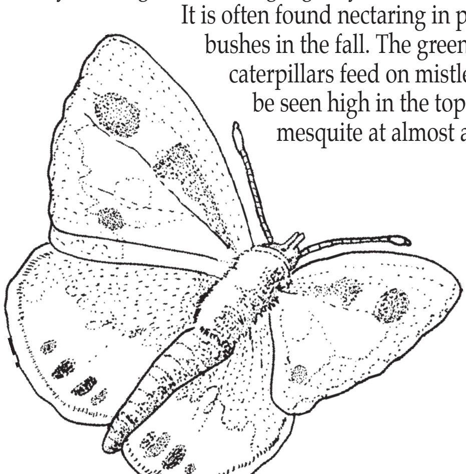
• This 15mm white-checked black butterfly is often seen on trails with its wings open moth-like. Caterpillars feed on mallows and many other trailside weeds.



Great blue hairstreak

Atlides halesus — in Family Lycaenidae.

• This sooty black 26mm butterfly has an orange-spotted body and large areas of bright glossy blue on the upper wings. It is often found nectaring in poverty weed bushes in the fall. The green slug-shaped caterpillars feed on mistletoe. Adults may be seen high in the tops of liveoak and mesquite at almost any time of year.

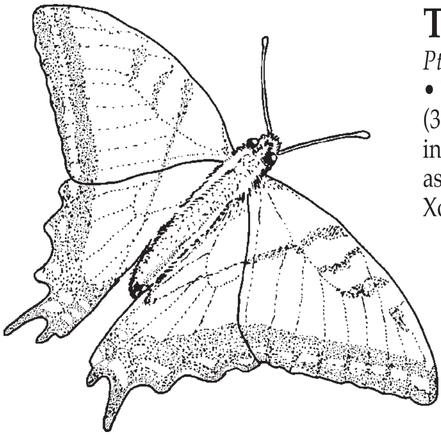


Harvester

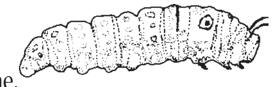
Feniseca tarquinius — in Family Liphyridae.

• This black-patterned orange 12mm butterfly with whitish underside is found near colonies of wooly aphids on which it lays its eggs. The caterpillar disguises itself with wax from the aphids which it eats. The short chrysalis has false eye pattern and looks like a minute monkey head on a twig.

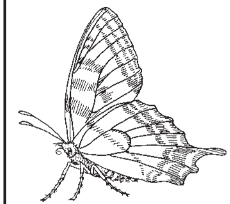
more stuff . . .



Two-tailed tiger swallowtail

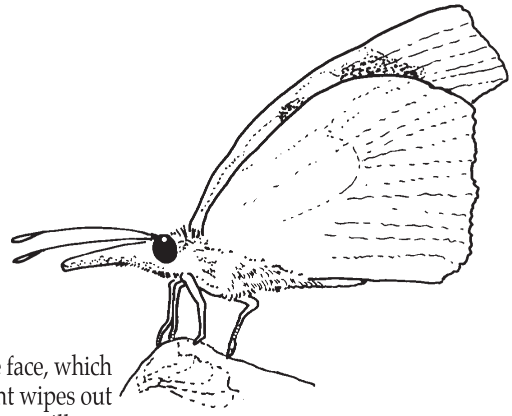


Pterourus multicaudatus — in Family Papilionidae.
• This narrow black-striped multi-tailed yellow swallowtail is the largest butterfly (35mm body, 63mm wing length) in America north of the tropics. The largest individuals come from Central Texas. Caterpillars here eat prickly ash and wafer ash but farther west eat choke cherry. The Aztecs knew this butterfly as Xochiquetzalpapalotl, a manifestation of one of their gods in butterfly form.



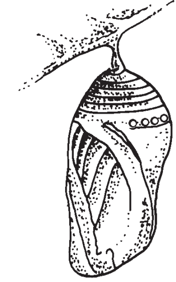
Two-tailed tiger swallowtail

35mm body
65mm wing length

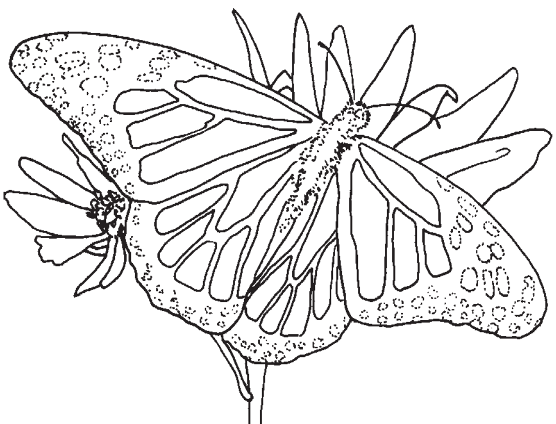


Snout butterfly

Libytheana bachmanni— in Family Libytheidae.
• The only butterfly with a long "beak" formed by the two palpi on the face, which are elongated to protect the tongue. Eggs are laid on hackberry. Drought wipes out the parasites that keep their numbers down. When rain comes, many caterpillars reach maturity on new soft hackberry sprouts. The orange-and-brown white-spotted 23mm adults that grow up in crowded conditions have the urge to emigrate and they fly off by the millions to seek new homes. They have been doing this since the time of the dinosaurs.

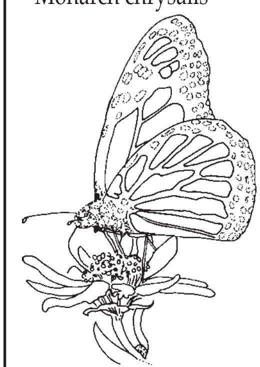


Monarch chrysalis



Monarch

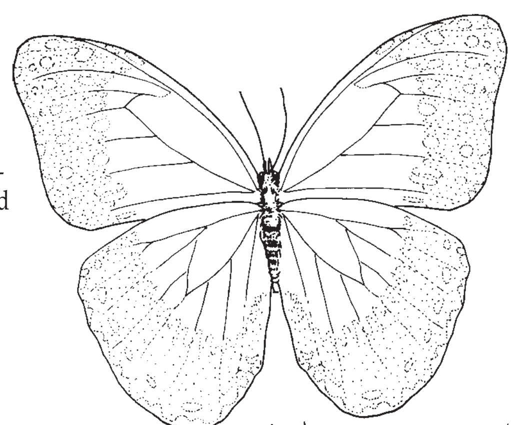
Danaus plexippus — in Family Danaidae.
• This round-winged black-banded orange 30mm butterfly has been called the storm fritillary because it rides the cold fronts into Texas on its way south. It is the only butterfly that migrates bird-like between tropical mountains and temperate prairies on a regular annual basis. Most monarchs seen crossing Texas spend winter in central Mexico and summer near the Great Lakes. A few monarchs spend the winter on the Texas coast. Some breeding monarchs summer on the Red River and in Palo Duro Canyon.

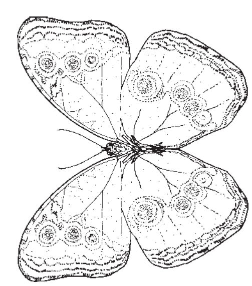


Monarch

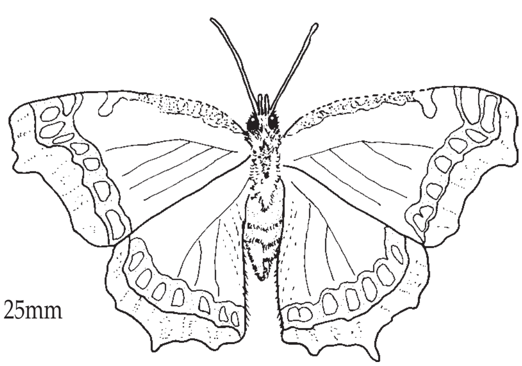
Morpho

Morpho peleides — in Family Satyridae.
• This dark 34mm butterfly is ornamented beneath with red-and-yellow eye-like rings. At rest on the forest floor, it looks like an old leaf. When approached, it suddenly opens brilliant electric blue wings. This may startle a predator and give the morpho a chance to fly away. This tropical forest butterfly of Central America once wandered into Texas near Hidalgo.





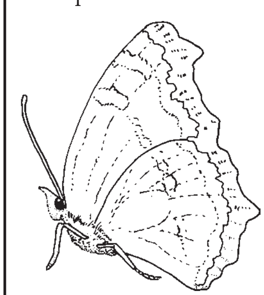
Morpho underside



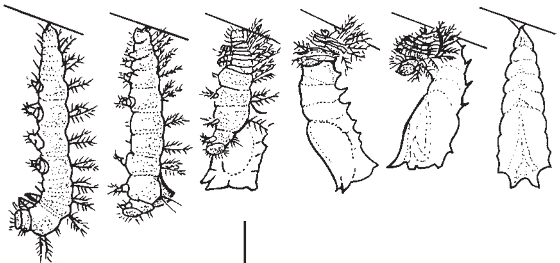
25mm

Mourning cloak

Nymphalis antiopa — in Family Nymphalidae.
• Leaf-shaped and leaf-patterned on the underside, this 25mm butterfly has a rich maroon upperside bordered by yellow, outside a row of blue dots. Caterpillars feed on willow. It is common across the northern hemisphere and has colonies at the top of some tropical mountains. It is a favorite subject for illustrators.

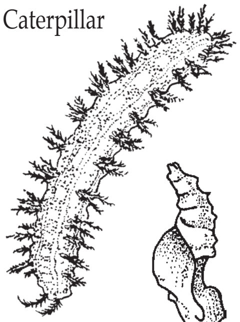


Mourning cloak



Caterpillar to chrysalis

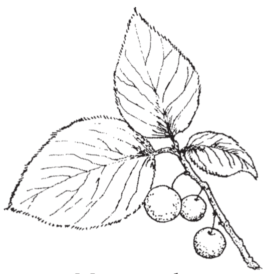
Caterpillar



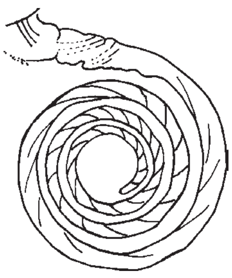
Chrysalis

Gulf fritillary

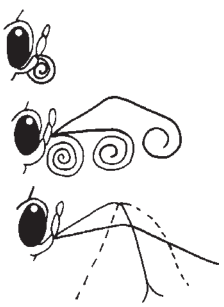
Draw a butterfly



Mexican plum



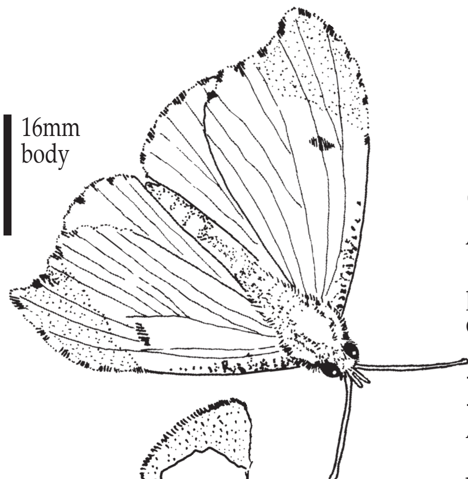
Butterfly tongue



Feeding movements

24mm body

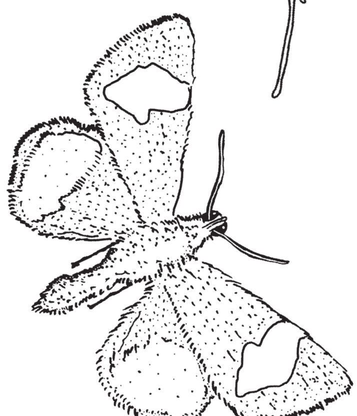
16mm body



Gulf fritillary

Agraulis vanillae — in Family Nymphalidae.

• This is a black-spotted long-winged orange 24mm butterfly with many silver patches on the underside, and common in most of Texas. Its caterpillars feed on passion-flower vine. It is the easiest butterfly to cultivate in your garden.



Falcate orangetip

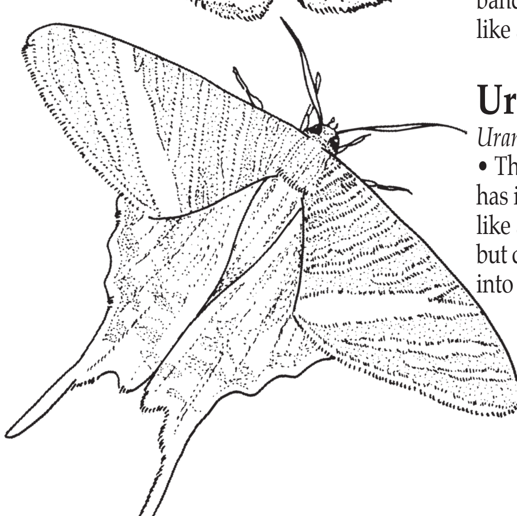
Anthocharis midea — in Family Pieridae.

• This is a delicate white 16mm butterfly with hindwings green-speckled beneath and forewings orange tipped. Caterpillars feed on new spring growth of cress. Adults fly from February to April and larvae finish development as the foodplants dry up. The rest of the year is spent in the chrysalis, waiting for spring.

Grapevine epimenis moth

Psychomorpha epimenis — in Family Agaristidae.

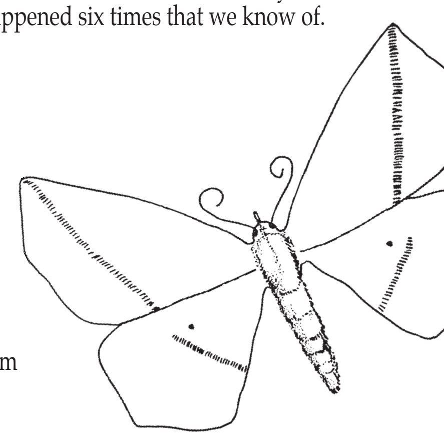
• This bright white and brick-red patched black butterfly-like 11mm moth is active in full sunlight. It visits the flowers of the first cherries and plums that bloom in the spring. The black forewing has a white patch and a blue metallic band. The black hindwing has a large red patch. It has wing hooks and ears, like a miller moth.



Urania swallowtail moth

Urania fulgens — in Family Uraniidae.

• This spectacular swallow-tailed black butterfly-like 27mm moth has iridescent green bands across the wings. It flies in the daytime like a butterfly. It normally lives on the canopy of tropical forests but during big hurricanes, individuals are occassionaly blown north into Texas. This has happened six times that we know of.



20mm

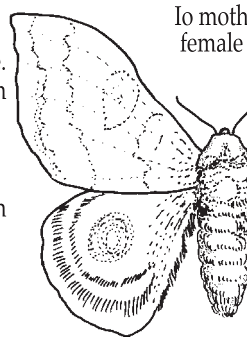
Yellow slant-line inchworm moth

Tetracis crocallata — in Family Geometridae.

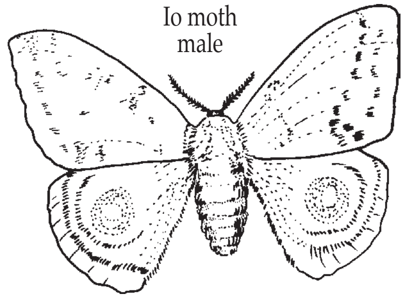
• Some inchworm caterpillars found on sumac may produce this yellow 20mm moth in late summer.

Io moth

Automeris io — in Family Saturniidae.
• This maroon-marked yellow 37mm moth will open its wings quickly to suddenly display the eye-like marks on the hindwings. This may startle a potential predator and permit the moth to escape. Caterpillars have stinging spines and feed on many different plant species.



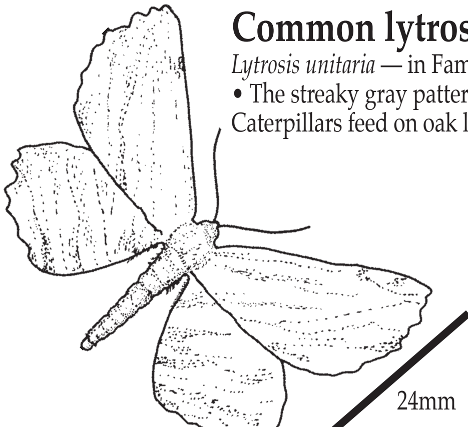
Io moth female



Io moth male

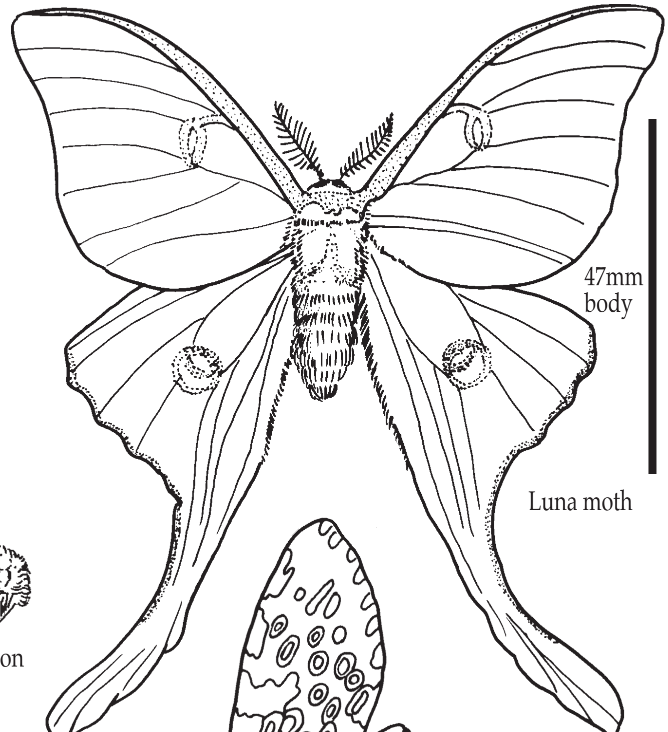
Common lytrosis inchworm moth

Lytrosis unitaria — in Family Geometridae.
• The streaky gray pattern of this 24mm moth matches the bark of red oaks, providing camouflage. Caterpillars feed on oak leaves.



Luna moth

Actias luna — in Family Saturniidae.
• This purple-marked pale-green 47mm moth with long tails was once common in the eastern half of Texas. Outside lighting has interrupted the normal breeding of this species over much of its range and it is now rare.



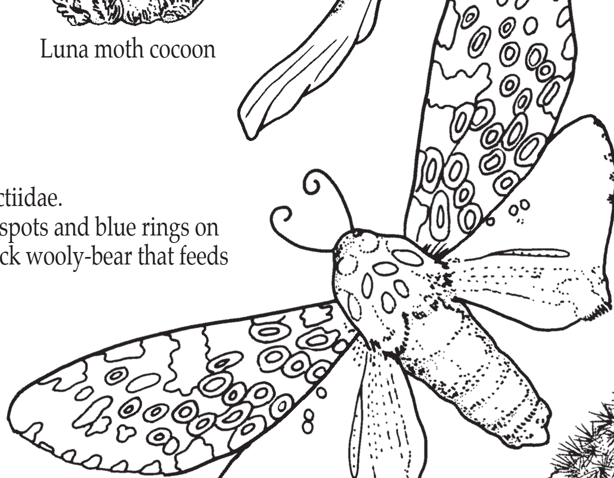
Luna moth

Luna moth caterpillar

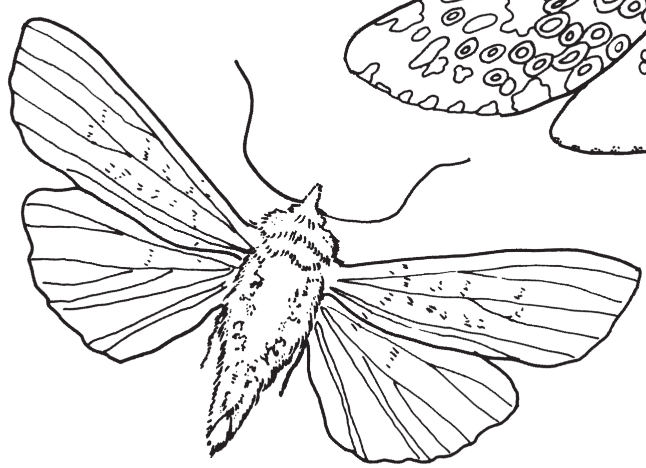
Luna moth cocoon

Giant leopard moth

Ecpantheria scribona — in Family Arctiidae.
• This white 41mm moth has black spots and blue rings on the forewing. The caterpillar is a black wooly-bear that feeds on garden seedlings and weeds.



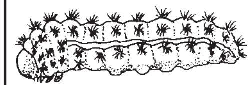
Giant leopard moth caterpillar



Armyworm moth

Pseudaletia unipuncta — in Family Noctuidae.
• This lightly speckled tan 25mm moth swarms in the fall. The caterpillars come out at night to feed and devastate new plants in gardens. The moth occurs throughout the world where there are meadows.

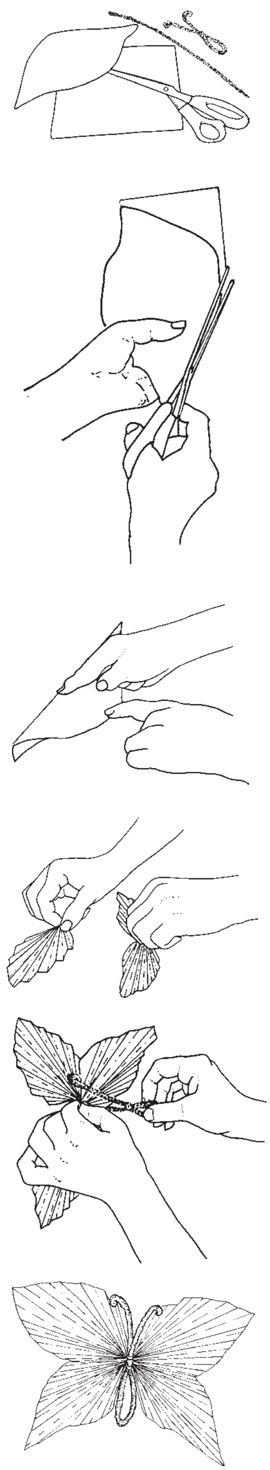
more stuff . . .



Io moth caterpillar

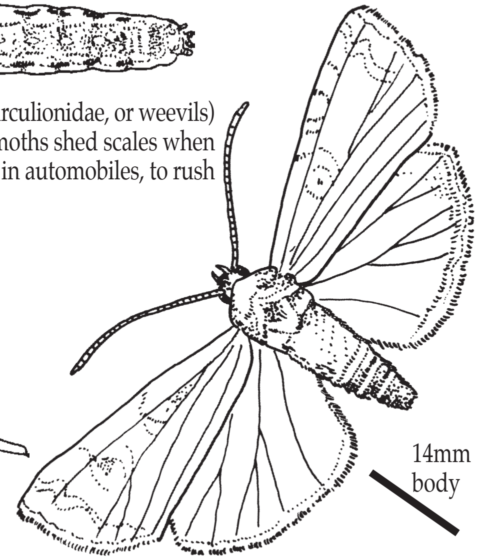
Fold a butterfly.

See page 45 for full-sized pattern.

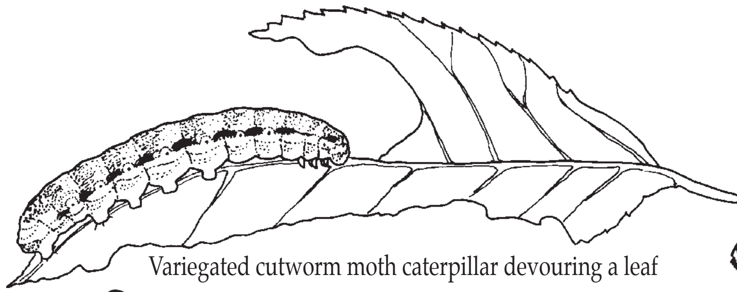


Variegated cutworm moth

Peridroma saucia — in Family Noctuidae.
• Another world-wide moth of the second largest family (after the family Curculionidae, or weevils) of living organisms. These 14mm variegated-shades-of-gray dusty-miller moths shed scales when alarmed and make potential predators sneeze. They roost in crevices, often in automobiles, to rush out at the first stop.



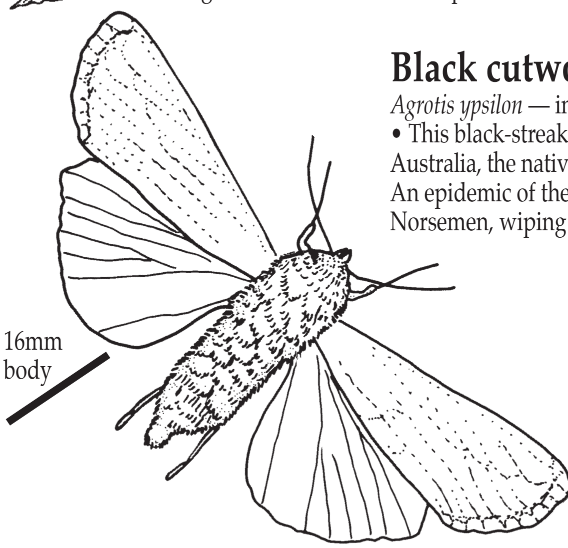
14mm body



Variegated cutworm moth caterpillar devouring a leaf

Black cutworm moth

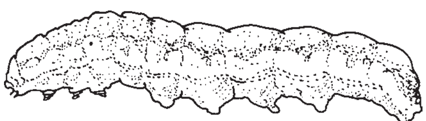
Agrotis ypsilon — in Family Noctuidae.
• This black-streaked 16mm dusty-miller moth is common throughout the world. In Australia, the native people light fires to attract the moths which they then eat roasted. An epidemic of these cutworms devastated the crops and grazing land of medieval Norsemen, wiping out their colonies in Greenland.



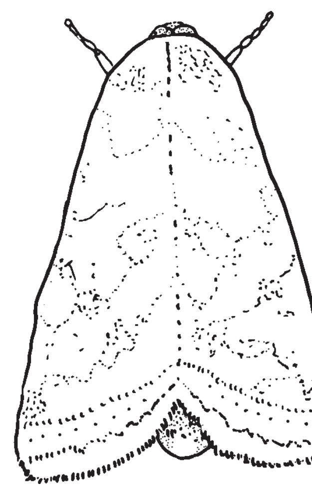
16mm body

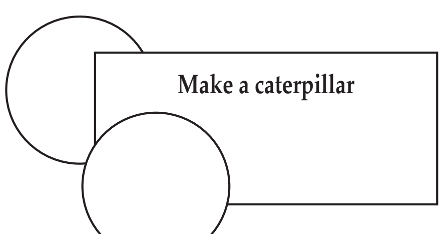
Corn earworm moth

Heliothis armigera — in Family Heliothidae.
• This yellow-and-tan 24mm moth swarms on all continents. The caterpillars feed on corn and other large grains.



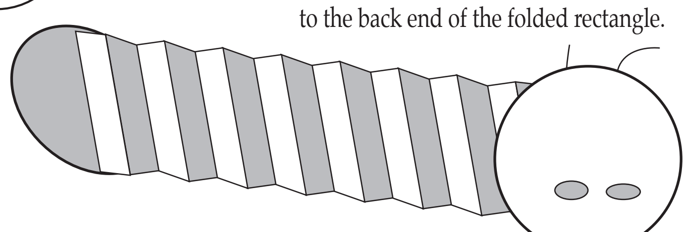
Corn earworm moth caterpillar

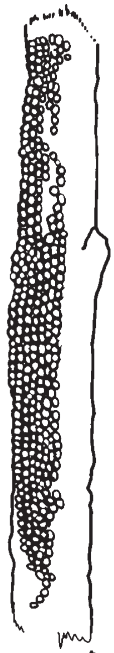




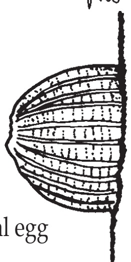
• Cut two 3-inch circles out of paper. Decorate one circle as a caterpillar face — use your imagination. Add horns or fuzzy pipe cleaners for antennae. Decorate the other circle as the back end of the caterpillar.

• Cut a rectangle, 3 inches by 12 inches. Decorate both sides of the rectangle to look like a caterpillar body. Accordion-fold the rectangle. Tape or glue the decorated face to one end of the folded rectangle and the other decorated circle to the back end of the folded rectangle.

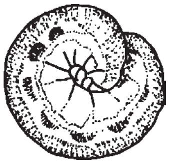




Egg mass

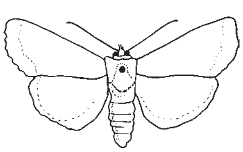


Individual egg



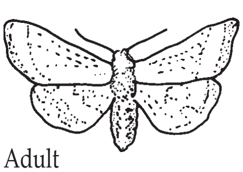
Caterpillar

Variegated cutworn moth



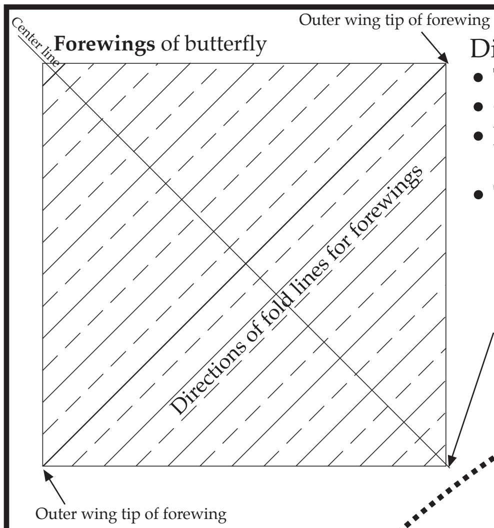
Where to put the pin in a specimen

Larva

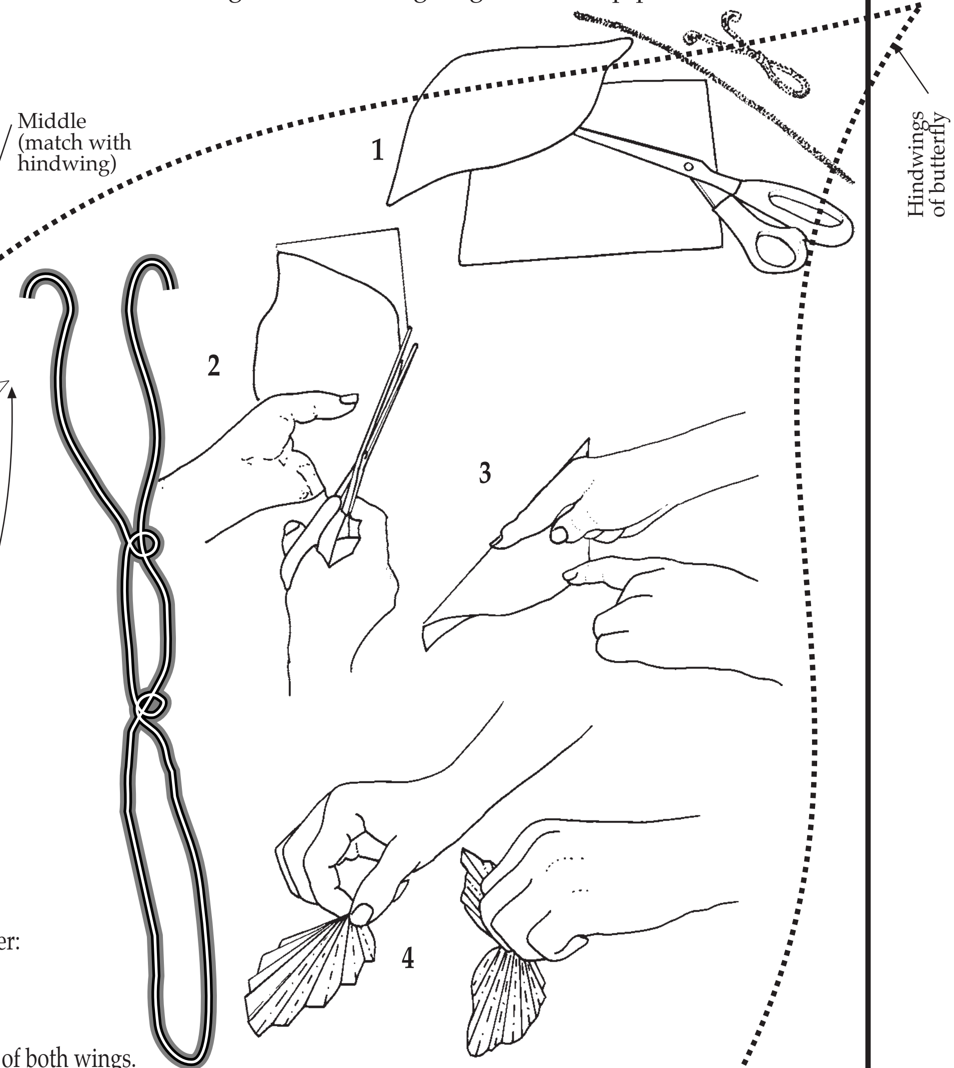


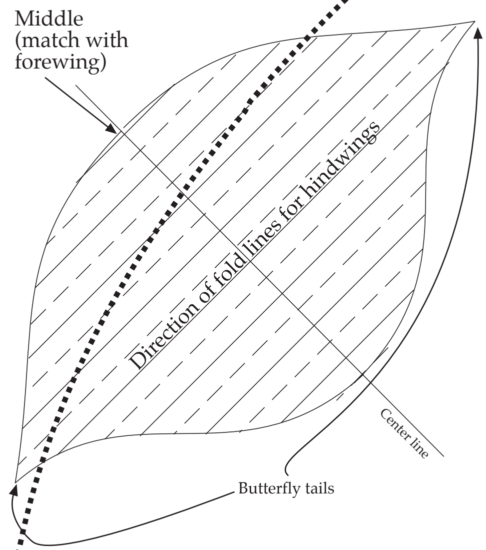
Adult

Corn earworm moth

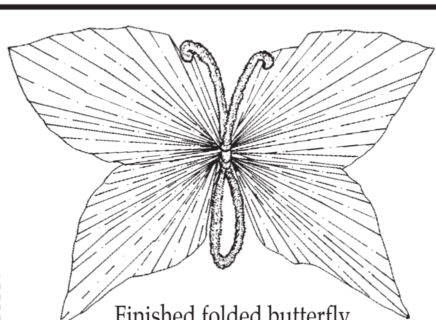


Directions:
- Trace the wing patterns on to old magazine pages.
- Cut out with scissors (2).
- Follow the fold line directions to fold forewings and hindwings (3).
  The forewing is 7 inches square. The hindwing is 11 inches across.
- Tie folded forewings and hindwings together with pipe cleaner (5).

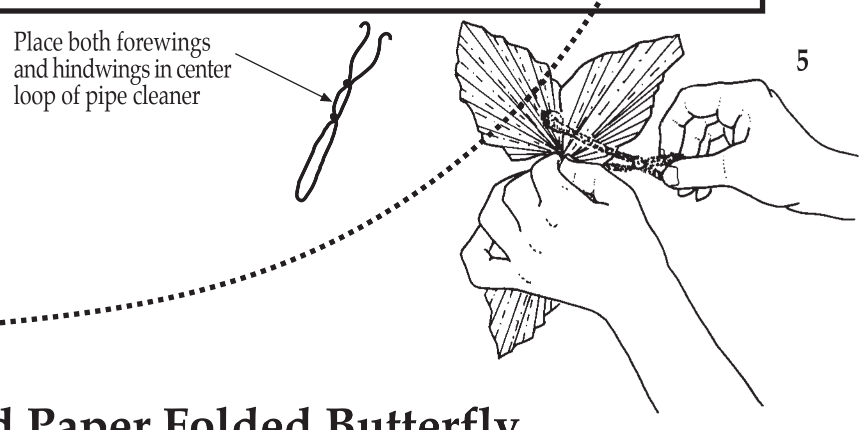




Directions for the working with the pipe cleaner:
- Fold pipe cleaner in half.
- Make a twist 2.5 inches up from fold.
- Insert both forewings and hindwings.
- Twist pipe cleaner tightly around center line of both wings.
- Shape antennae.
- Fan out wings.

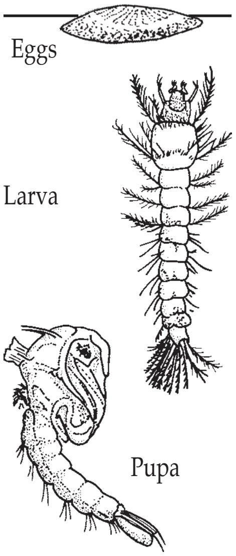


Finished folded butterfly

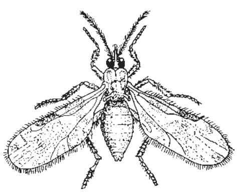


Recycled Paper Folded Butterfly

To make a paper-folded butterfly, follow the directions above. Make a mobile by tying several butterflies together or use your butterflies to decorate your room or a package.

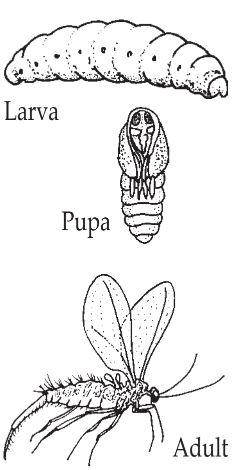


Developmental stages of the common malarial mosquito



Biting midge

Pear midge pupa



Gall midge

TWO-WING FLIES

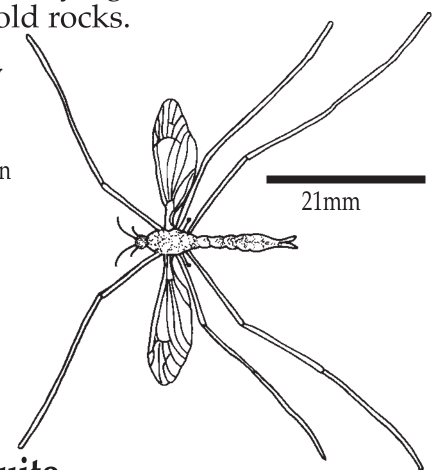
Order Diptera — 4th in diversity — 7000+ species in Texas

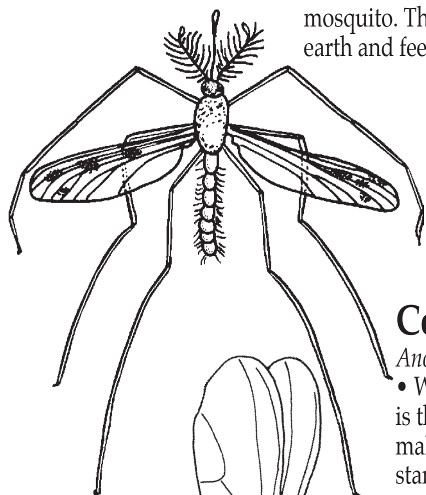
This large group includes crane flies, midges, gnats, mosquitoes, deer flies, fruit flies, blow flies, house flies and a host of other two-winged flies. The second pair of wings is reduced to form peg-like structures called **halteres** (pronounced *hall-tair-ez*) which are flight-stabilizing organs. Fly mouthparts range from chewing to piercing, sucking or lapping. The larvae are usually maggots with reduced heads and are specialized for living in soil, decaying organic matter or as parasites of plants or animals. A few, like hoverflies, have active predatory larvae. Like cockroaches, scavenger flies condition their food by carrying bacteria from site to site. A fossil fly has been found in 260-million-year-old rocks.

Common ferruginous cranefly

Nephrotoma ferruginea — in Family Tipulidae.

• This brown-veined 21mm fly looks like a giant mosquito. The larvae, called **leatherjackets,** live in earth and feed on roots.

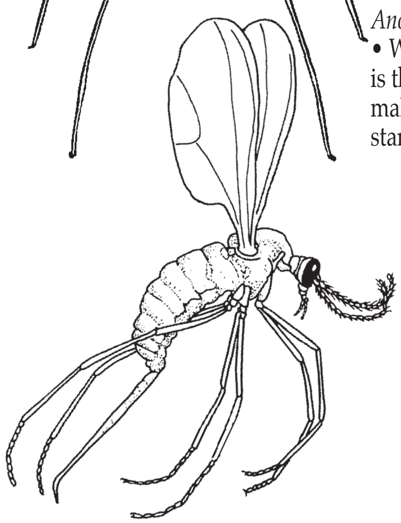


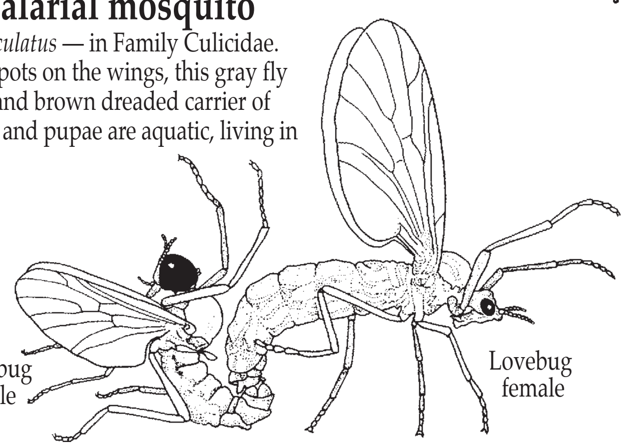


Common malarial mosquito

Anopheles quadrimaculatus — in Family Culicidae.

• With four black spots on the wings, this gray fly is the 10mm black and brown dreaded carrier of malaria. The larvae and pupae are aquatic, living in standing water.





Lovebug

Plecia nearctica — in Family Bibionidae.

• This black-and-orange 8mm fly often swarms by the millions in meadows. Many of the flies in the swarm are mating. The maggots live in mud and damp earth.

Pear midge

Contarinia pyrivora — in Family Cecidomyidae.

• The black-headed pinkish-white 3.5mm fly lays its eggs in the flowers of fruit trees. Enzymes deposited with the eggs cause lumps on the fruit, on which the maggots feed.

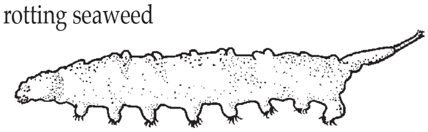
SPECIALIZED FLIES — Suborder Brachycera

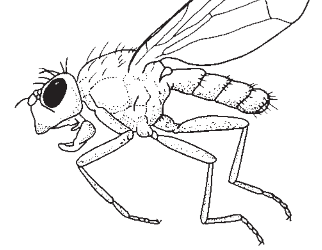
These flies have only 3 segments in the antenna. Fossil brachyceran flies have been found in 155-million-year-old rocks.

Shore fly

Ephydra riparia – in Family Ephydridae.

• The greenish-gray 7mm adult flies swarm over seaweed on the shore. Their maggots live in and on the rotting seaweed

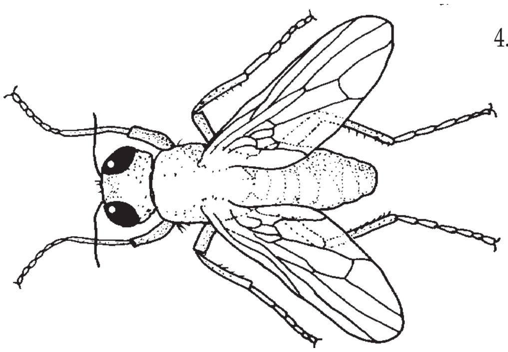




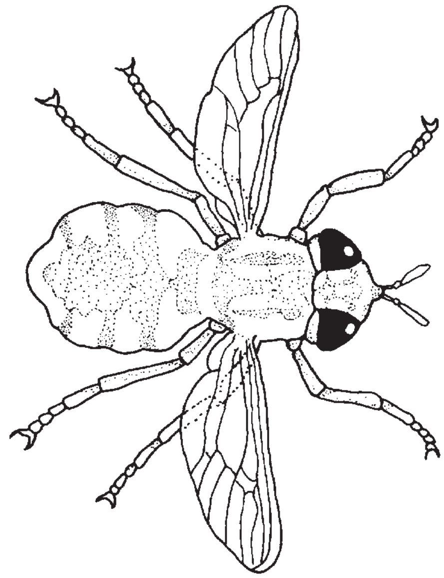
Cheese skip

Piophila casei — in Family Piophilidae.

• The larvae of these 4.5mm yellowish-gray flies are the "worms" found in aged cheese. What their original habitat was, is not known.



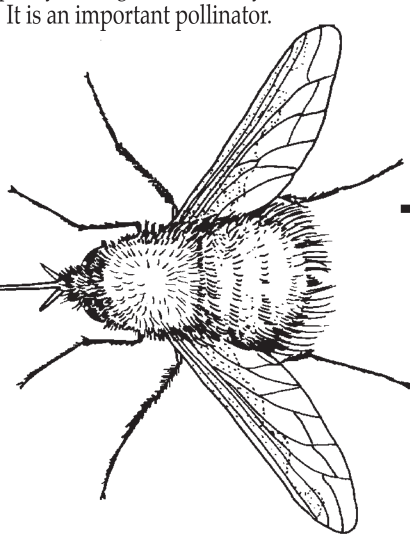
4.5mm



Black-and-yellow soldier fly

Odontomyia truquii — in Family Stratiomyidae.

• This black-and-pale-yellow-green 12mm fly is often found on flowers. It is an important pollinator.

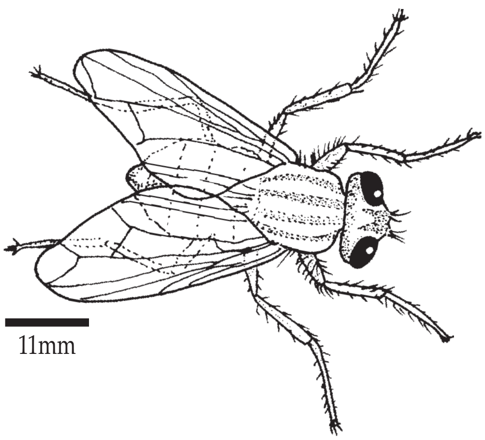


17mm body

Beefly

Exoprosopa sordida — in Family Bombyliidae.

• This yellow-and-black-banded 17mm fly with a smoky patch on the wings is common on flowers in the fall as an important pollinator. The grubs are parasites of other insects.



11mm

Housefly

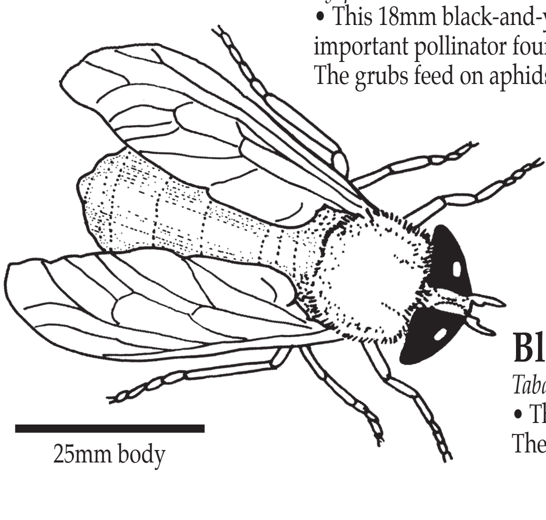
Musca domestica — in Family Muscidae.

• This gray-black 11mm household fly has spread throughout the world with humans. It conditions its food by infecting it with bacteria and yeast carried on its feet. The maggots are common in wet garbage and manure.

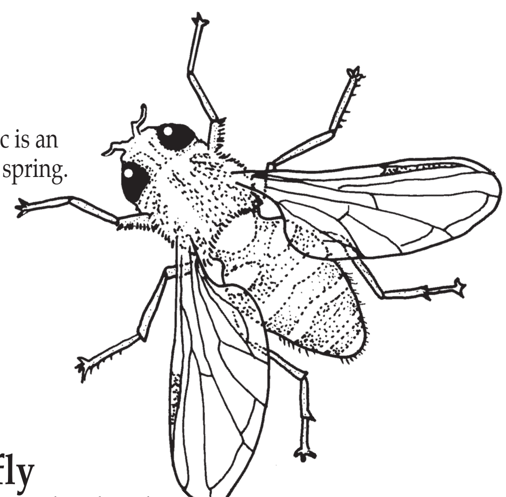
Flower fly

Syrphus ribesii — in Family Syrphidae.

• This 18mm black-and-yellow bee-mimic is an important pollinator found on flowers in spring. The grubs feed on aphids.



25mm body

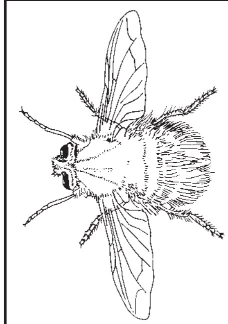


Black horsefly

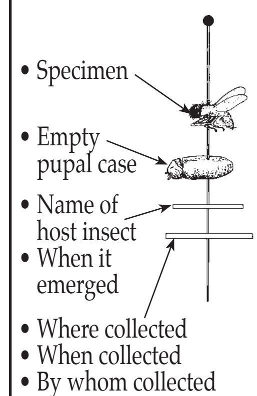
Tabanus atratus — in Family Tabanidae.

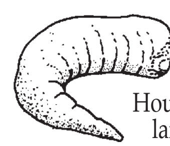
• This 25mm brownish-black horsefly torments livestock, feeding on blood. The grubs live in wet mud where they feed on worms and other insects.

more stuff . . .



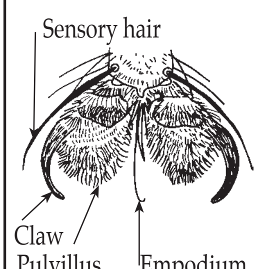
Trachinid fly — parasite of insects



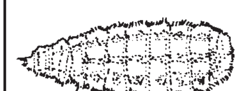


Housefly larva

Housefly pupa



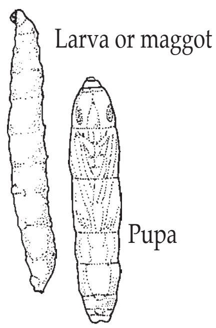
Fly foot



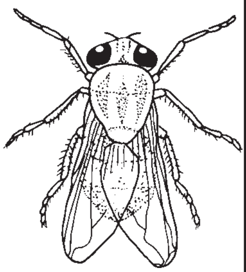
Flower fly larva (or maggot)

more stuff . . .

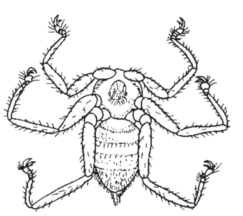
Asilid fly —
a bumble-bee mimic



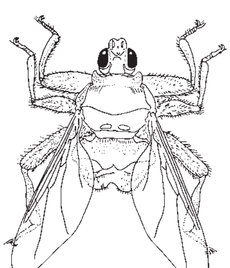
Wheat-stem maggot fly



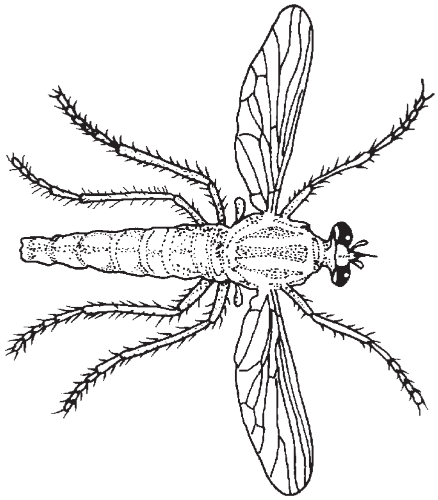
Screwworm fly



Nycteribid fly —
a parasite of the
Mexican free-tailed bat



Hippoboscid fly —
a parasite of birds



Brown robber fly

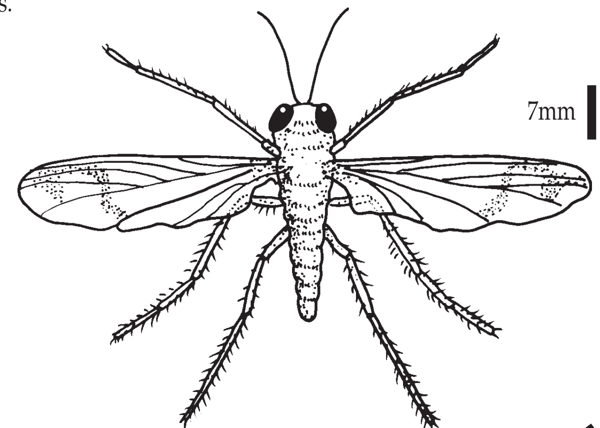
Diogmites angustipennis — in Family Asilidae.

• This reddish-brown dark-patterned 23mm fly perches on meadow weeds, waiting to dart out and catch other insects. These are held in the strong legs while the robber fly pierces the body of the prey, injects digestive enzymes and extracts nourishment. All this is accomplished while the fly is on the wing.

Copper-green-bodied long-legged fly

Condylostylus sipho — in Family Dolichopodidae.

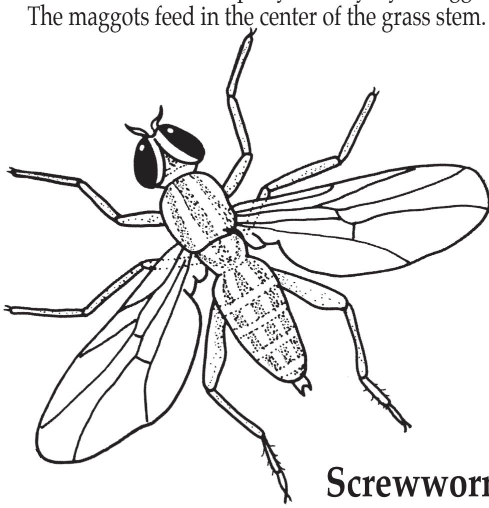
• This 7mm metallic green fly waits on leaves to pounce on other insects on which it feeds.

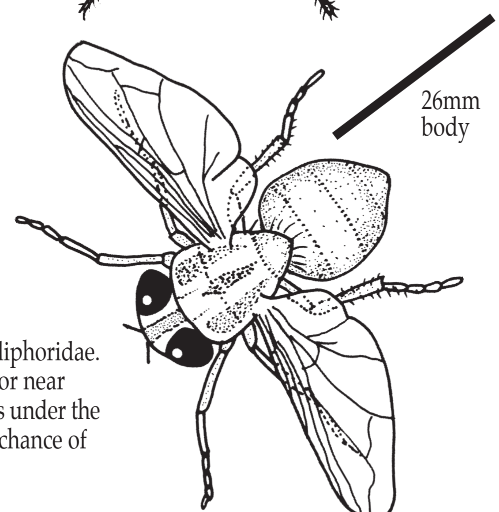


Wheat-stem maggot fly

Meromyza americana — in Family Chloropidae.

• This 7mm brown-striped yellow fly lays its eggs on grasses. The maggots feed in the center of the grass stem.

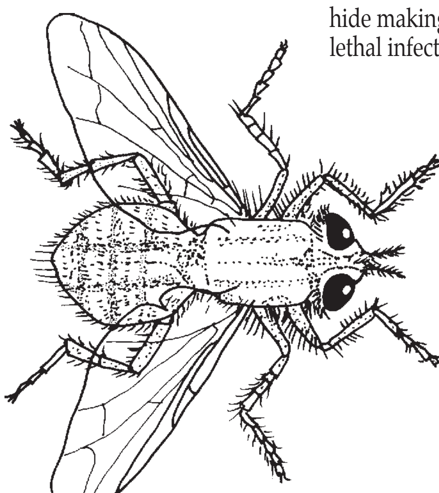




Screwworm fly

Cochliomyia americana — in Family Calliphoridae.

• This black 26mm fly lays its eggs in or near wounds on cattle. The maggot burrows under the hide making holes and increasing the chance of lethal infection of its host.



Grasshopper maggot fly

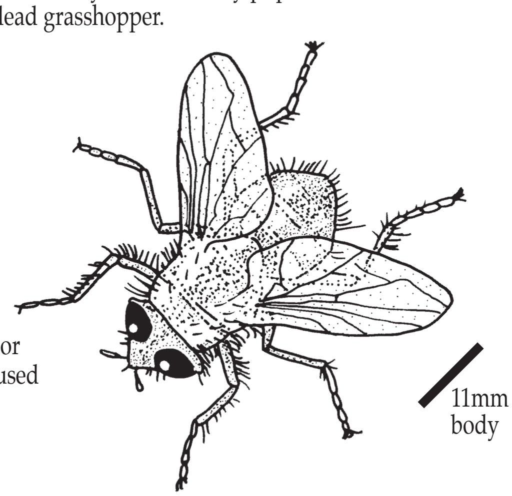
Sarcophaga georgina — in Family Sarcophagidae.

• This 16mm gray-and-black checkered fly lays its eggs on the backs of flying grasshoppers. The grubs enter the live grasshopper and eat its body contents. They pupate and emerge from the dead grasshopper.

Greenbottle fly

Lucilia caesar — in Family Calliphoridae.

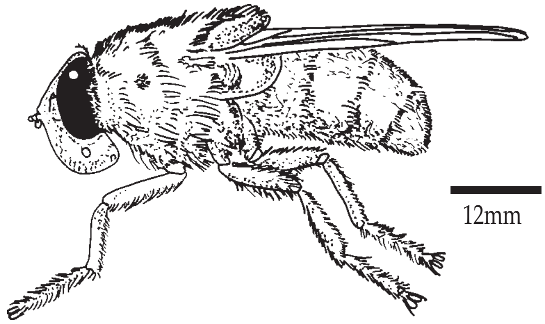
• This coppery-green 11mm fly comes to wounded animals or fresh carrion. The maggots produce enzymes that were once used to help the healing process in deep wounds in humans.



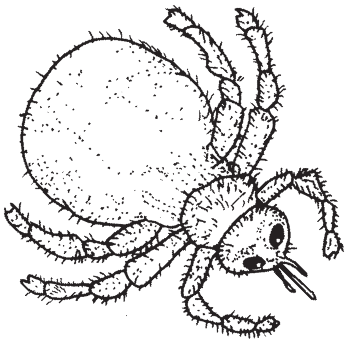
Rabbit bot fly

Cuterebra cuniculi — in Family Cuterebridae.

• The grubs of this 12mm fly live under the skin of rabbits, cats and dogs. The adult fly has black patches on a grayish body.



12mm



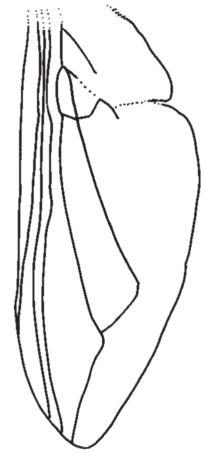
6mm

Sheep ked

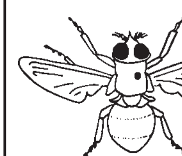
Melophagus ovinus — in Family Hippoboscidae.

• This dark-brown tick-like wingless 6mm fly is a parasite on sheep, feeding on blood. Its eggs hatch in the mother ked. Larvae feed inside the mother and are laid as pupae that soon hatch into adult keds.

more stuff . . .



Rabbit bot fly wing



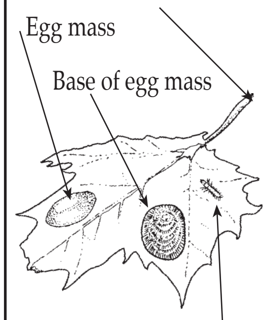
Where to put the pin in a specimen

NEUROPTEROID COMPLEX — Superorder Neuropteroidea

Larvae of the older orders in this group are nymph-like, having many adult structures. The pupa has free wing sacks, not glued to the body. Well-known members are lacewings, bees, wasps and ants.

DOBSON FLIES Order Megaloptera — 31st in diversity – 10+ species in Texas

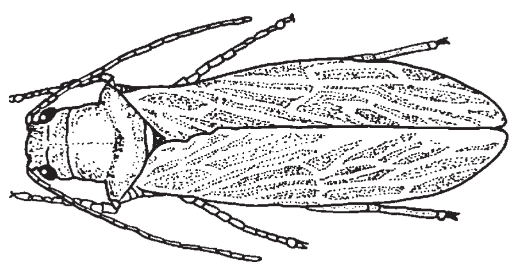
These insects have heavily veined membranous wings of primitive appearance. They have nygma, the spot organs of unknown function that are found in many fossil insects and in primitive neuropteroids and panorpoids. Flight is an awkward flutter used as a sloping parachute drop after climbing up some tree or rock. Larvae are aquatic and there is a pupal stage. Fossil dobson flies have been found in 260-million-year-old rocks.



Smoky alder fly

Sialis infumata — in Family Sialidae.

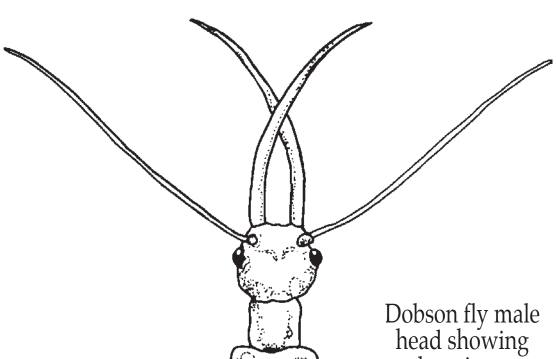
• A four-winged 11mm fly with smoky black wings and a body of black plates separated by yellow membranes. The larva is a predator in rivers. It pupates in sand at the river edge. Adults emerge in winter.



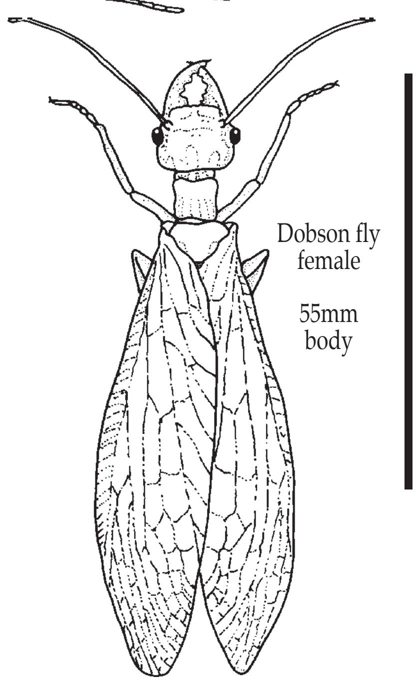
Dobson fly

Corydalis cornutus — in Family Corydalidae.

• The larvae of this gray 55mm fly are called **hellgramites** and used as bait by fishermen. They are predators in streams. The male has long jaws that are not strong. The female has powerful short jaws.

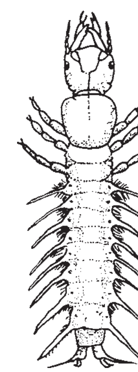


Dobson fly male head showing long jaws



Dobson fly female

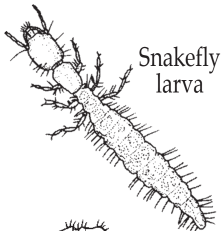
55mm body



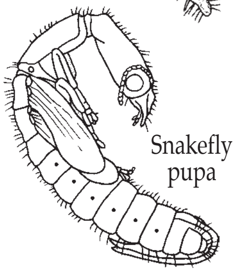
Hellgrammite or dobson fly larva

Pupa

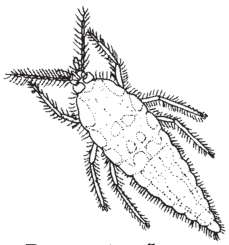
more stuff . . .



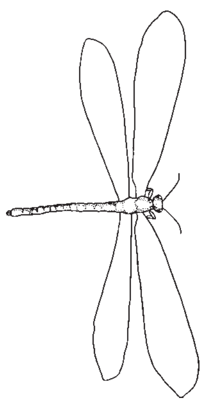
Snakefly larva



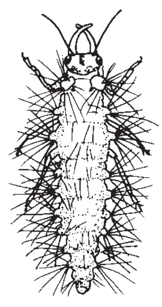
Snakefly pupa



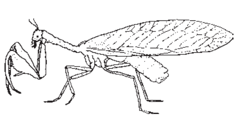
Dusty-wing fly larva



Clouded ant lion adult

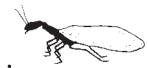


Goldeneye green lacewing larva



Say's mantis fly

SNAKEFLIES Order Raphidiida — 34th in diversity — 1 species known in Texas

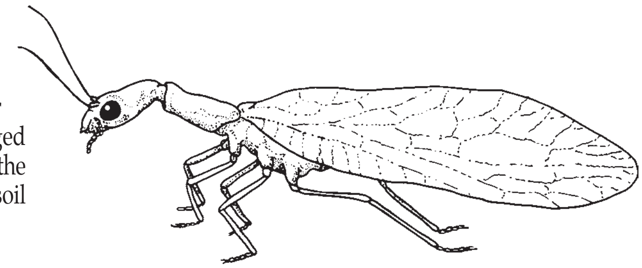


The snake-like head on a long skinny prothorax neck gives these flies their name. The long and thin, well-veined glassy-membranous wings are of nearly equal size. Females have a long wasp-like ovipositor for laying eggs in protected crevices. Larvae are predators among the insects of the leaf litter. Pupae have big floppy wing sacks. Adults have been successful specialists at the art of robbing prey from spiderwebs for at least 160 million years.

Cedar brake snakefly

Agulla adnixa — in Family Raphidiidae.

• This 18mm black-and-cream species is a rarity of cedar thickets in Central and West Texas. Snakeflies have changed little over nearly 300 million years. Adults rob spiders of the prey caught in their webs. Larvae are active predators of soil insects. The pupae are concealed among twigs.



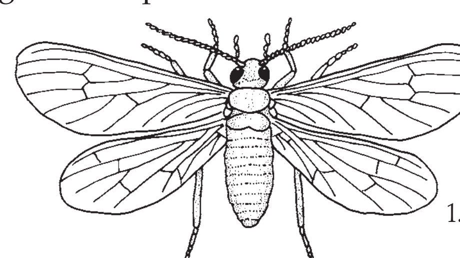
LACEWING FLIES Order Neuroptera — 13th in diversity — 218+ species in Texas

Many branched veins decorate the wing margin of these insects with close-spaced terminal forks. Most adults are predators of other insects. Owl flies catch and eat butterflies. The larvae have hollow mandibles through which they inject digestive enzymes and suck in the fluids of their prey. These little dragons often disguise themselves by decorating the body with scraps of bark or the skins of their victims. Many mantis flies lay their eggs in the egg sacks carried by wolf spiders. Others have long stinging ovipositors and lay their eggs in caterpillars.

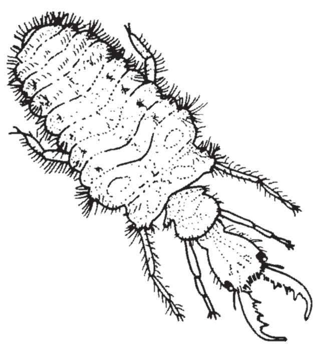
Dusty-wing fly

Conwentzia psociformis — in Family Coniopterygidae.

• This 1.5mm pink four-winged fly has powdery white wings that resemble those of the whiteflies on which it preys. The larva is like a miniature dragon that races over leaves hunting whitefly nymphs.



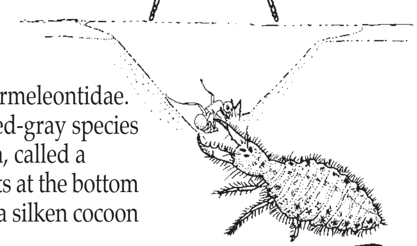
1.5mm



Clouded ant lion

Brachynemurus nebulosus — in Family Myrmeleontidae.

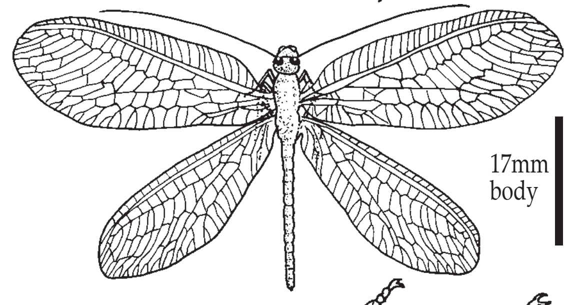
• This clouded-wing 42mm black-speckled-gray species flutters weakly to light at night. The larva, called a **doodlebug**, digs a pit in dry dust and waits at the bottom for ants to fall in. The pupa is covered by a silken cocoon covered with grains of dust.



Goldeneye green lacewing

Chrysopa oculata — in Family Chrysopidae.

• Bright golden eyes, delicate green wings and an offensive odor distinguish this 17mm insect often found congregating at lights at night. Females lay eggs at the end of long thin white stalks. The larvae eat other insects, especially greenfly aphids.

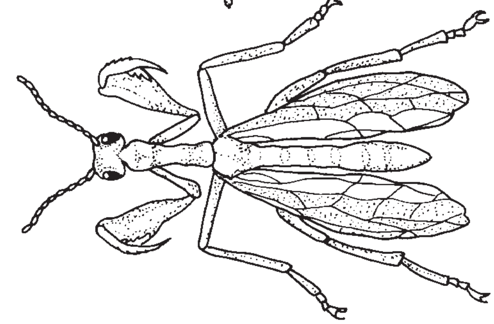


17mm body

Brown mantis fly

Climaciella brunnea — in Family Mantispidae.

• The half-brown wings identify this 21mm species. Adults flock to pest infestations in sorghum fields. Eggs are laid on grass leaves. The active tiny larvae reach out and grab a ride to the nest of a polistes paper wasp (see page 54) where they enter and feed on the wasp grubs. To escape the wasp nest, the adult mantis fly mimics the wasp. The brown mantis fly has a banded form, a black form and a red form that each mimic one of the common species of polistes wasps in Texas.



 Order Hymenoptera — 3rd most diverse
— 7500+ species in Texas

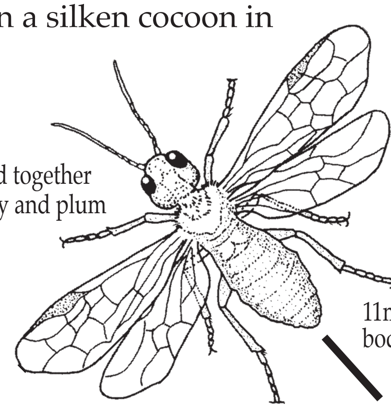
Hymenoptera is Greek for joined-winged. This refers to the row of hooks that fit into a groove on the other wing and hold the wings together. This character is shared by all winged members of the order. Fossil wasps have been found in 110-million-year-old rocks.

SAWFLIES — Suborder Symphyta

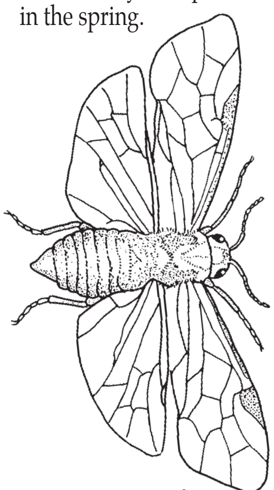
Sawflies have caterpillars that feed on leaves and spin a silken cocoon in which they pupate. Adults have thick waists.

Plum web sawfly

Neurotoma inconspicua — in Family Pamphilidae.
• This yellow-marked black 11mm sawfly has forewings and hindwings hooked together like other hymenopterans. The yellow gray caterpillars are webworms on cherry and plum in the spring.

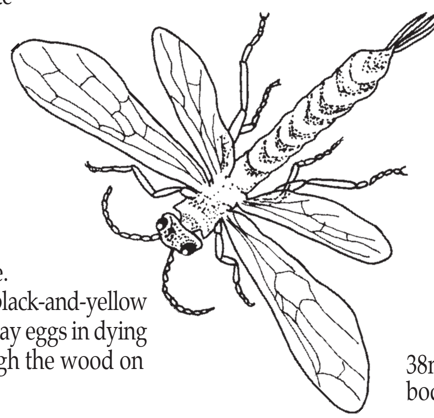


11mm body



Evergreen sawfly

Monoctenus fulvus — in Family Diprionidae.
• Green caterpillars found on juniper pupate in a brown silk cocoon and hatch into fat 15mm yellow-brown adults.



Pigeon horntail wasp

Tremex columba — in Family Siricidae.
• This banded-brown or occasionally black-and-yellow horntail wasp is 38mm long. Females lay eggs in dying elm trees. Larvae bore tunnels through the wood on which they feed.

38mm body

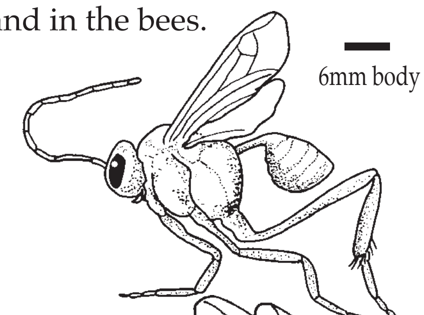
Pigeon horntail wasp caterpillar

HYMENOPTERA WITH WAISTS — Suborder Apocrita — (Includes ants, wasps and bees).

These insects have a narrow waist between the old abdominal segment 2 and the first abdominal segment which is now part of the thorax. They have grub larvae with reduced heads. These grubs are parasites, feed on provisions left by the adult, or are fed in the nest by the adult. Social colonies evolved three times in the suborder: in the ants, in the wasps, and in the bees.

Ensign wasp

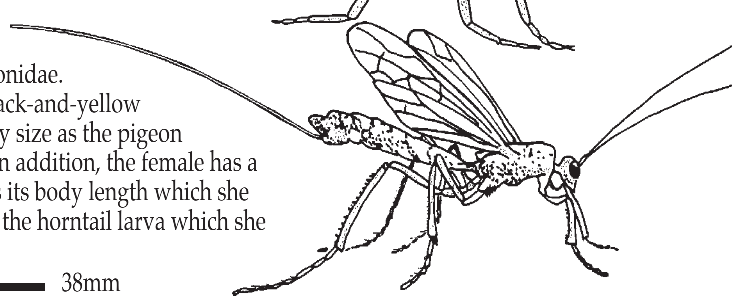
Prosevania punctata — in Family Evaniidae.
• Recognized by its short flat flag-shaped abdomen, this 6mm black parasitic wasp is often seen at windows in houses. It lays its eggs in cockroaches.



6mm body

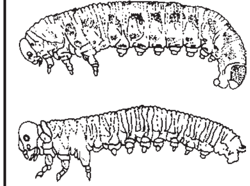
Long-tailed megaryssa

Megaryssa lunator — in Family Ichneumonidae.
• This banded-brown or occasionally black-and-yellow 38mm ichneumon wasp is the same body size as the pigeon horntail wasp on which it is a parasite. In addition, the female has a hair-like ovipositor more than two times its body length which she uses to probe wood and insert an egg in the horntail larva which she can hear feeding inside.



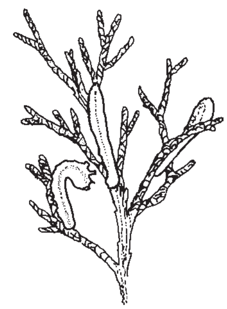
38mm

more stuff . . .

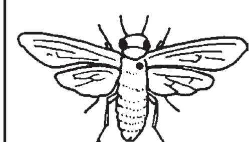


Sawfly caterpillars — notice all of the pro-legs

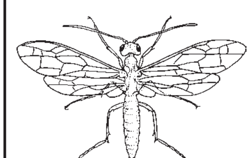
Evergreen sawfly cocoon



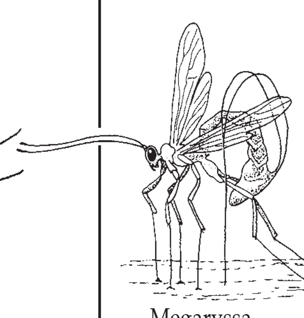
Evergreen sawfly caterpillars



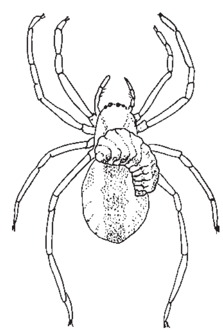
Where to put the pin in the specimen



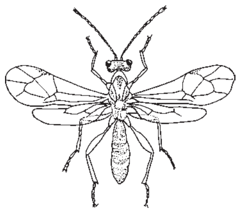
Wheat-stem sawfly



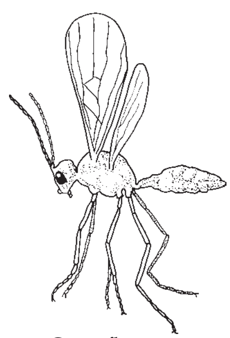
Megaryssa laying eggs



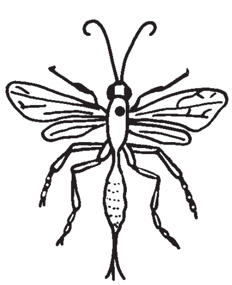
Hatched wasp larva on spider



Spider parasite wasp

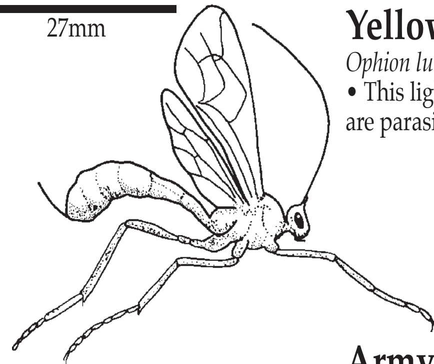


Greenfly wasp



Where to put the pin in a specimen

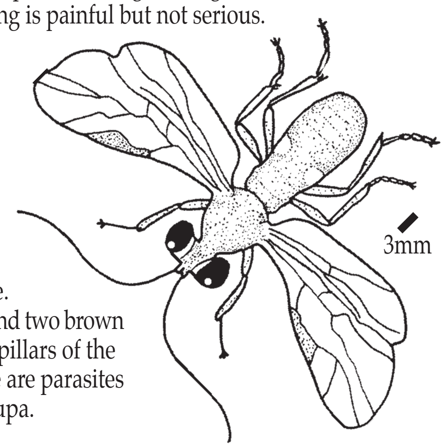
27mm



Yellow ichneumon wasp

Ophion luteus — in Family Ichneumonidae.

• This light-brown 27mm ichneumon wasp comes to light at night. The larvae are parasites of Junebeetle grubs. The sting is painful but not serious.

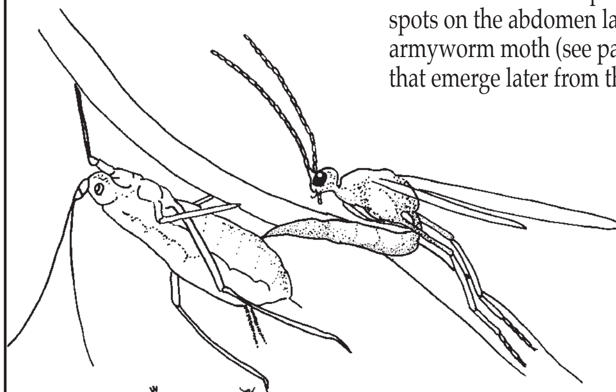


3mm

Armyworm wasp

Chelonus texanus — in Family Braconidae.

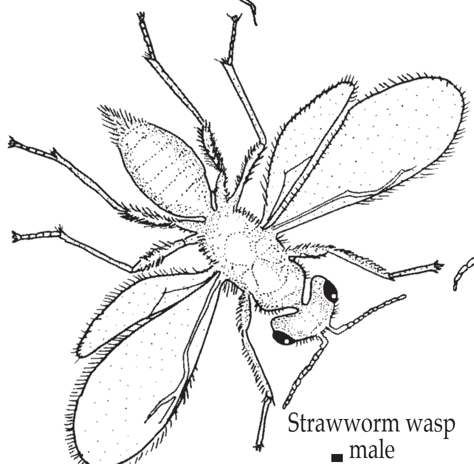
• This 3mm black wasp with brown legs and two brown spots on the abdomen lays eggs on caterpillars of the armyworm moth (see page 43). Its larvae are parasites that emerge later from the armyworm pupa.



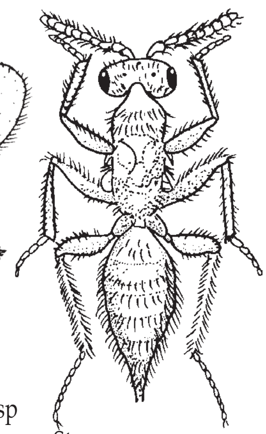
Greenfly wasp

Lysiphlebus testaceipes — in Family Braconidae.

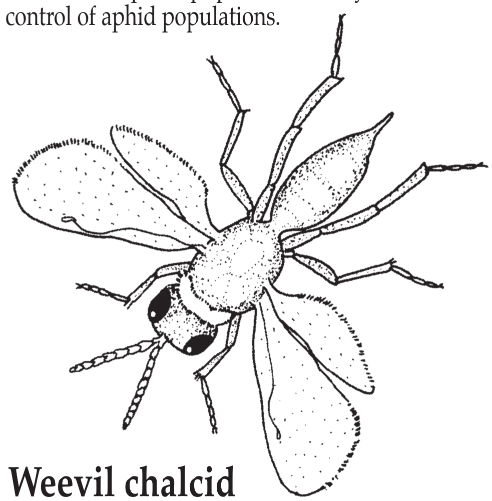
• This black 1.5mm wasp lays its eggs in aphids in which the larvae develop and pupate. It is a very important control of aphid populations.



Strawworm wasp male
1.5mm body



Strawworm wasp female



Weevil chalcid

Eurytoma tylodermatis — in Family Eurytomidae.

• This 1.5mm iridescent black wasp lays its eggs in the grubs of weevils.

Strawworm wasp

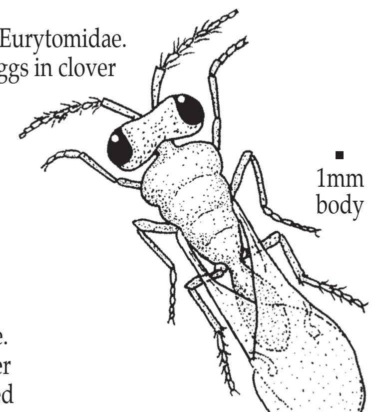
Harmolita grandis — in Family Eurytomidae.

• This 1.5mm black wasp lays its eggs in grass straw. Males have tiny clear wings covered with minute hairs. Females are wingless and ant-like.

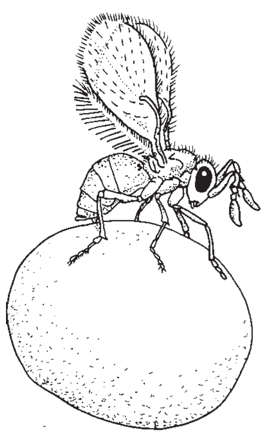
Clover seed chalcid

Bruchophagus funebris — in Family Eurytomidae.

• This 1mm brown wasp lays its eggs in clover seeds on which the larvae feed.



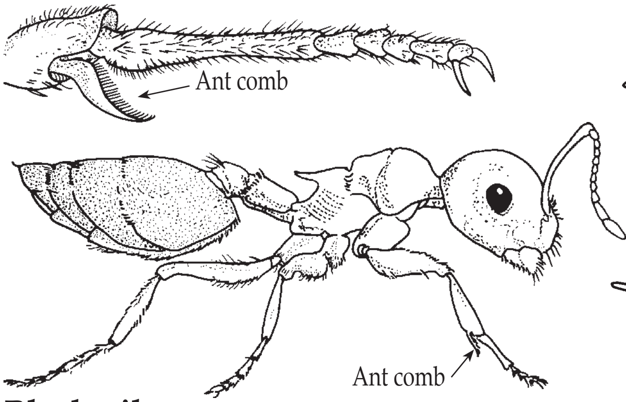
1mm body

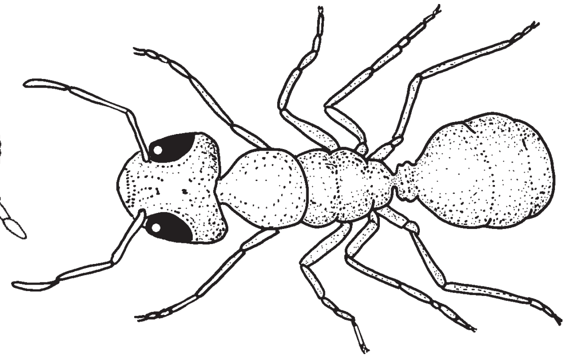


Trichogramma wasp

Trichogramma evanescens — in Family Trichogrammatidae.

• This 1.5mm black wasp lays its eggs in the eggs of other insects. Its larvae feed and pupate inside the egg. It is used for biological control of pests in grain silos.



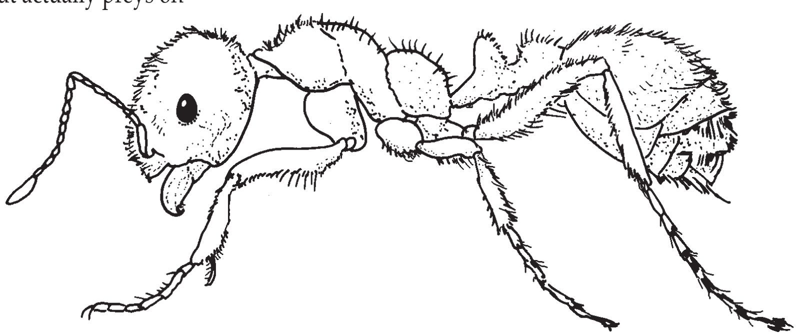


Blacktail ant

Crematogaster clara — in Family Formicidae.
• This black-to-reddish-brown 8.5mm ant is common in attics which it colonizes by entering on telephone lines. It builds a messy nest of chipped wood and seeds but actually preys on other insects, especially termites.

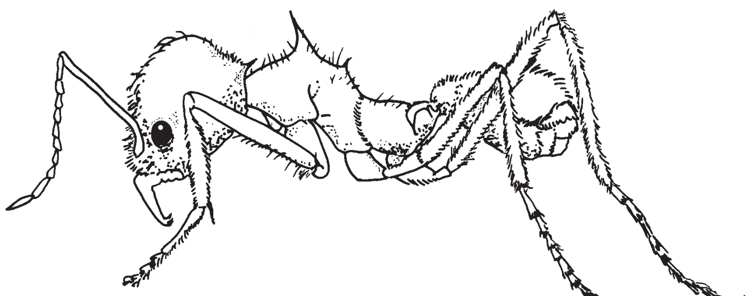
Carpenter ant

Camponotus pennsylvanicus — in Family Formicidae.
• These 10mm black ants tunnel in damp rotting wood. They have changed very little in the last 60 million years.



Red imported fire ant

Solenopsis invicta — in Family Formicidae.
• This reddish-brown 6.5mm ant, a native of South America, was introduced by accident near Mobile, Alabama in 1930. It has since spread east to North Carolina, north to Tennessee and Arkansas and west to the Texas High Plains. Its main method of travel is in lawn-grass sod on trucks. It sporadically reaches New Mexico, Arizona, Nevada and California in new lawns. The nest is domed and has a crust. The worker ant grasps the skin of the attacker with its legs and jaws while it inserts its sting. The sting produces a pustule and a red inflamed area around the pustule. Many people are seriously allergic to this fire ant. The ants attack any small animals on the ground. They are responsible for killing young horned lizards, quail and about half the caterpillars of butterflies in infested areas. They enter caves and exterminate the rare and endangered animals that live in them. Their populations decline during prolonged drought, but with rainfall, they build up again rapidly. A growth hormone that keeps them from reaching sexual maturity works slowly to eradicate colonies. A fly that lays its eggs in the head of the ant as a brain parasite may help reduce their numbers.

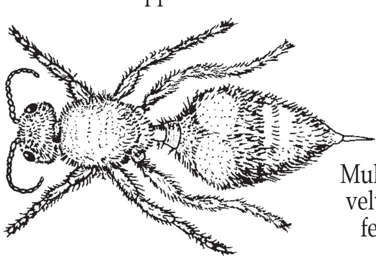


Texas leafcutter ant

Atta texana — in Family Formicidae.
• This 10mm red-brown ant is seen carrying green leaves to its burrow. Nests of these ants may be more than a hundred years old and up to fifteen feet deep. In an underground chamber, ants use green-leaf mulch to grow the fungus on which they feed.

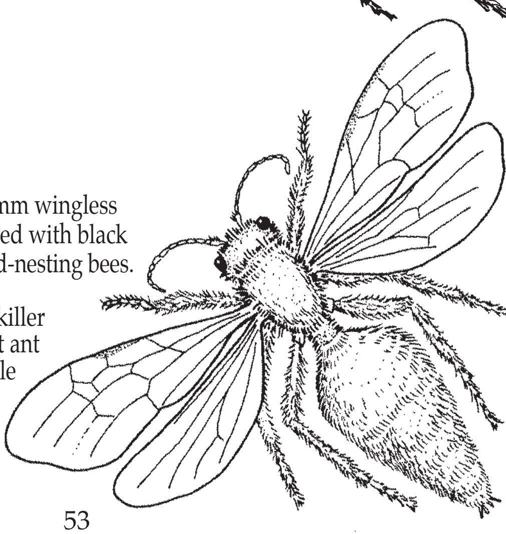
Mule killer velvet ant

Dasymutilla occidentalis — in Family Mutillidae.
• Named for its powerful sting but, as in all velvet ants, only the 17mm wingless female can sting. She can also squeak if disturbed. The body is covered with black and brilliant copper-red hairs. The larvae feed on the larvae of ground-nesting bees.

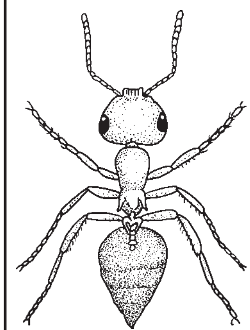


Mule killer velvet ant female

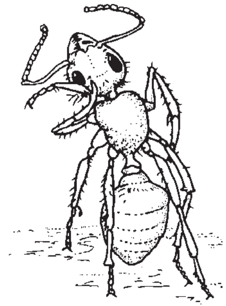
Mule killer velvet ant male



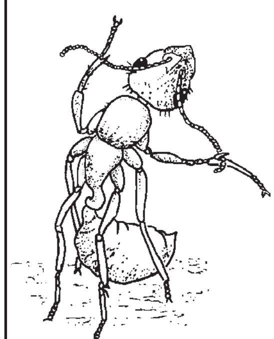
more stuff . . .



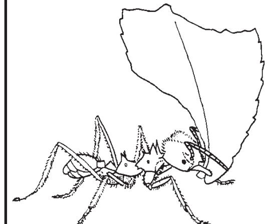
Blacktail ant



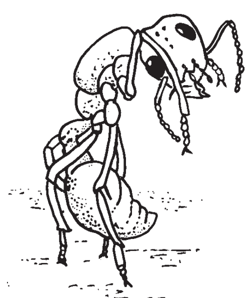
Ant grooming back



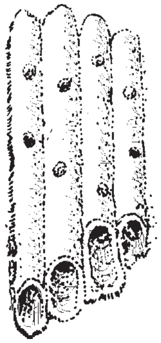
Ant grooming antenna



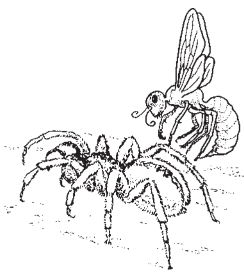
Leafcutter ant carrying leaf



Ant grooming head



Mud-dauber nest

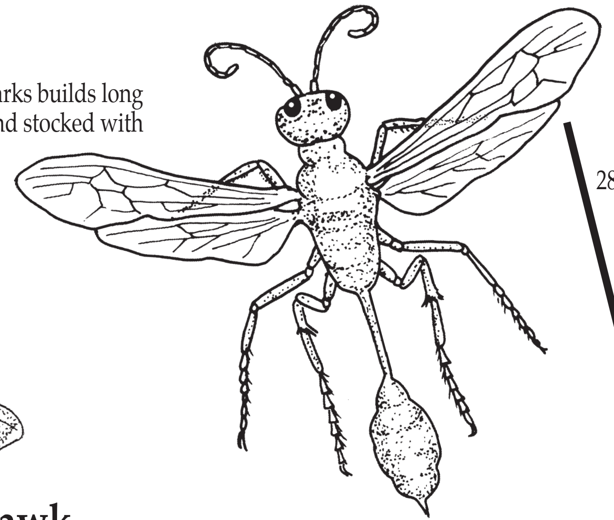


Tarantula hawk attack

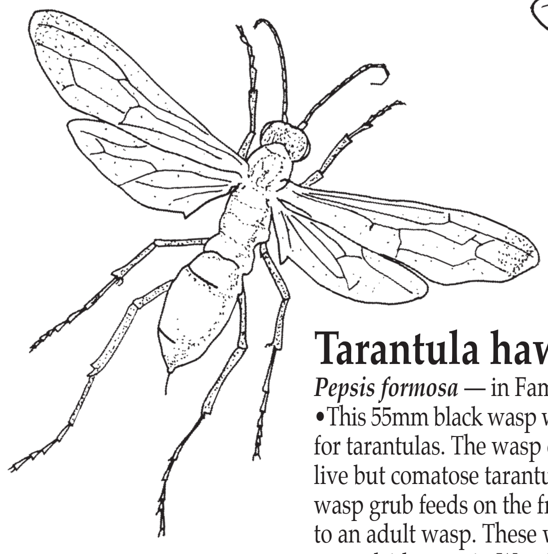
Mud-dauber wasp

***Sceliphron caementarium* —** in Family Sphecidae.

•This glossy black 28mm wasp with narrow yellow marks builds long nest tubes of mud, containing several cells with eggs and stocked with live but paralyzed spiders.



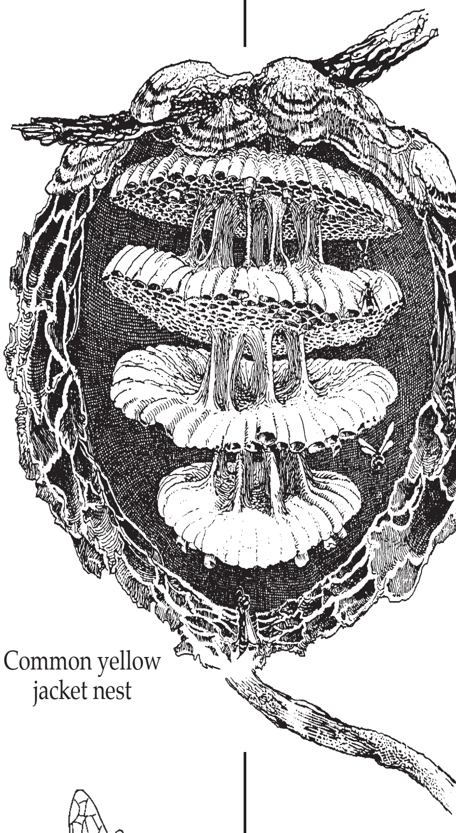
28mm



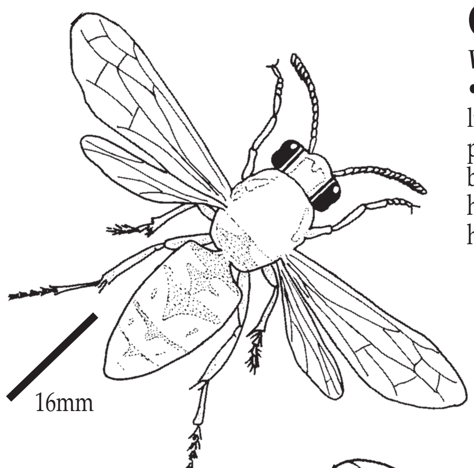
Tarantula hawk

***Pepsis formosa* —** in Family Psammocharidae.

•This 55mm black wasp with orange wings flies three or four feet above the prairie, searching for tarantulas. The wasp digs a burrow, catches and sting-paralyses a tarantula. It places the live but comatose tarantula in the burrow, lays an egg on it and fills the hole. The young wasp grub feeds on the fresh live paralyzed tarantula before it pupates and metamorphoses to an adult wasp. These wasps are frequently seen feeding at flowers of soapberry bushes at roadside rests in West Texas.



Common yellow jacket nest



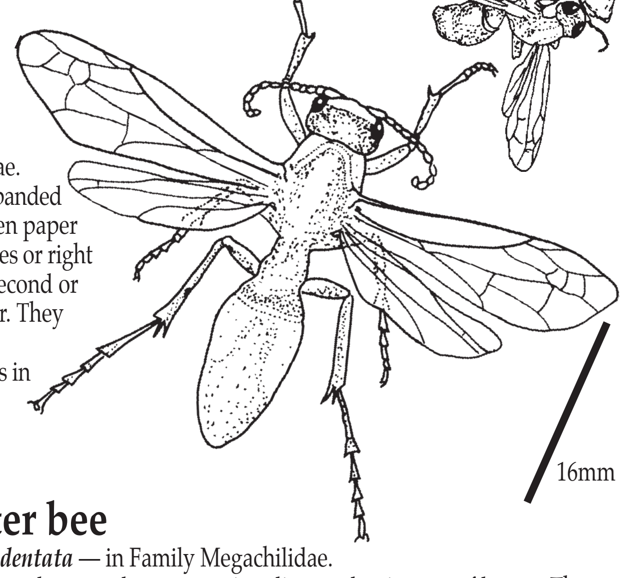
16mm

Common yellow jacket

***Vespula maculifrons* —** in Family Vespidae.

•This yellow-and-black-banded 16mm wasp lives in large colonies which occupy a stack of paper combs inside a paper shell. They usually build in a hollow tree or shed near a feral honeybee nest. These wasps catch and sting honeybees to feed to their own larvae in the nest.

Polistes paper wasp nest

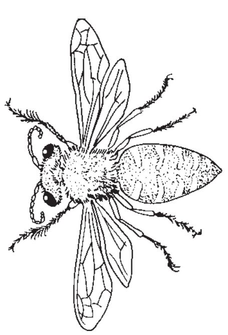


16mm

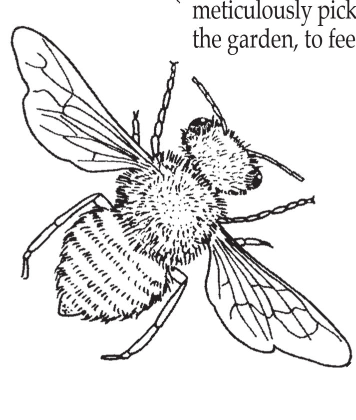
Polistes paper wasp

***Polistes fuscatus* —** in Family Vespidae.

•This 26mm yellow, brown-and-black-banded wasp nests in small colonies on an open paper comb built under leaves, branches, eaves or right over doorways. They often sting the second or third person slamming the screen door. They are gardeners' friends because they meticulously pick caterpillars off plants in the garden, to feed their own larvae.



Bee-hunting wasp



Leafcutter bee

***Coelioxys octodentata* —** in Family Megachilidae.

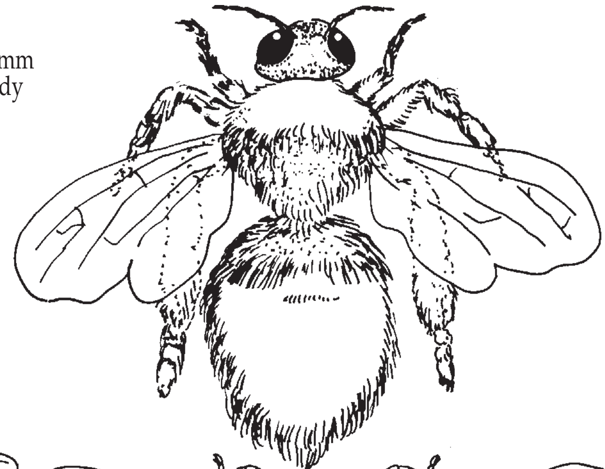
•This black 23mm bee may be seen cutting discs and strips out of leaves. The bees use these leaf patches to line the ends and sides of the hole they bore in dead dry wood. They then fill this leaf-lined container with pollen, lay an egg on it and seal the chamber. The larva feeds on the stored food.

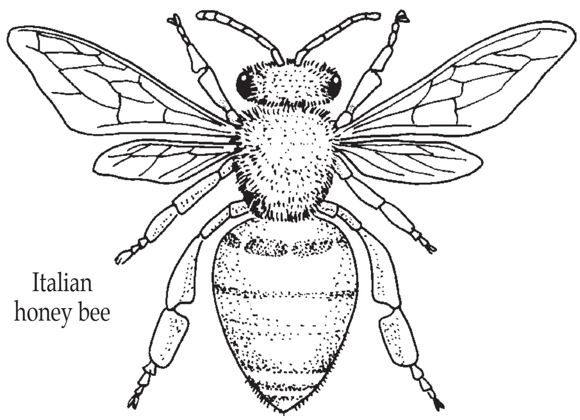
American bumblebee

Bombus americanorum — in Family Bombidae.

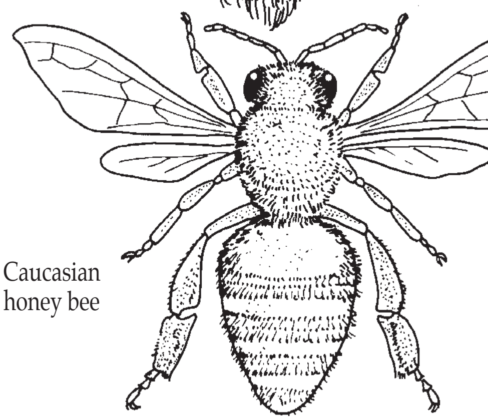
• This 28mm furry black-and-yellow bee gathers pollen and nectar which it stores in brood chambers dug underground. It is an important pollinator that may be wiped out by careless use of insecticides in the garden or on the farm.

28mm body





Italian honey bee



Caucasian honey bee

Domestic honey bee

Apis mellifera — in Family Apidae.

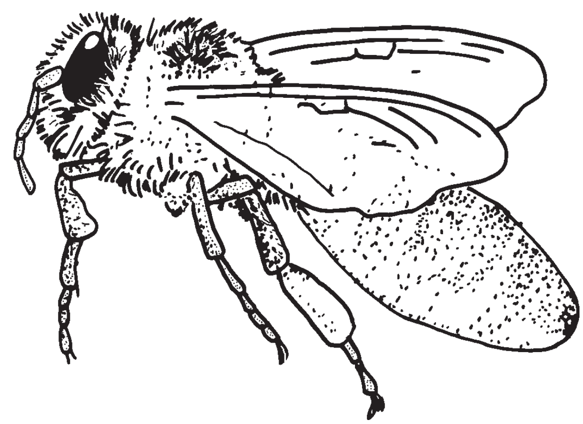
• This is the bee of Egypt and Mesopotamia, the ancient lands of milk and honey that form the cradle of Western Civilization. The 15mm strains from central and northern Europe tend to be light orange in color and easy to handle but susceptible to mite and fungus diseases. The strains from Mediterranean countries, India and China are dark in color, often black. They are harder to handle but more resistant to disease.

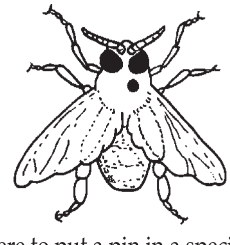
15mm body

African honey bee or "killer bee"

Apis adansonii — in Family Apidae.

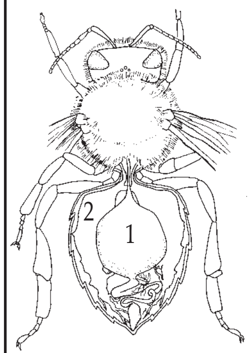
• This is the light-orange-and-black 14.5mm wild bee of central and southern Africa. Its nest has been raided by people and honey badgers for thousands of years, so it is very nervous, protective of its nest and quick to anger. It is slightly smaller than the domestic honey bee, lighter in weight, higher pitched in buzz, slower in flight, and carries less poison. However, there are more bees per nest and they are less tolerant of trespass. They produce more honey than the European honey bee. When food is scarce, they move on to a new area. **If attacked, you can outrun them.** Do not wear light blue clothes around these bees. Most injuries are to machine operators who accidentaly damage hives and because of motor noise, do not hear the bees coming. African honey bees have been hybridized with domestic honey bees in the laboratory but they do not normally do so in the wild. African honey bees attack a domestic beehive, kill the queen and males, use the workers as slaves, gradually replacing the population of the hive with their own. Beware of feral beecombs in caves and rock ledges. African bees have spread north to Texas since 1956 when they were introduced on the Amazon in Brazil. At present, they occupy Texas north to Dallas and Amarillo, east to Houston, west to El Paso, then through southern New Mexico to southern Arizona and southern California. In winter they die back to central and south Texas and southern California.



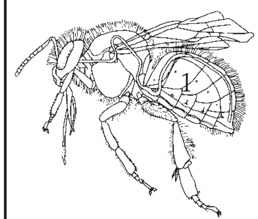


Where to put a pin in a specimen

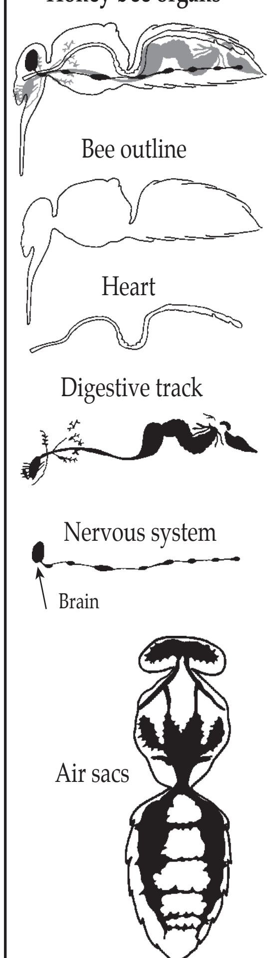
more stuff . . .



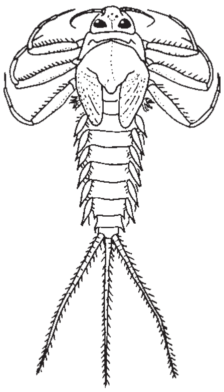
A bumblebee with the abdomen open to show: 1) the honey crop and 2) the air sacs of the respiratory system.



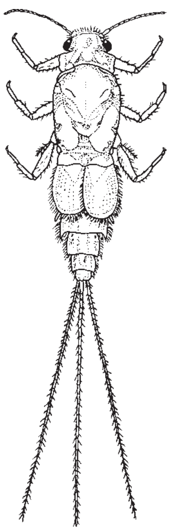
Honey bee organs



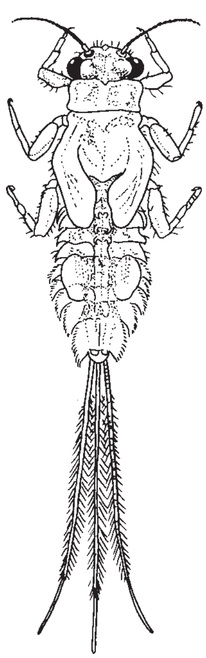
more stuff . . .



Mayfly nymph



Fairy mayfly nymph



Mayfly nymph

STIFF-WINGED INSECTS — Supraorder Plagiopterata

These insects achieved power flight by evolving a strong base plate for all the veins in the wing. Because of this rigid plate, they cannot flex the wings back parallel to the abdomen, although damselflies can bend the abdomen up parallel to the wings. Fossil dragonflies and mayflies had nygma or circular organs on the wings although no living species do. Since aquatic nymphs do not compete with the aerial adults, members of this group never evolved a pupal stage.

MAYFLIES AND THEIR EXTINCT RELATIVES — Superorder Ephemeroidea

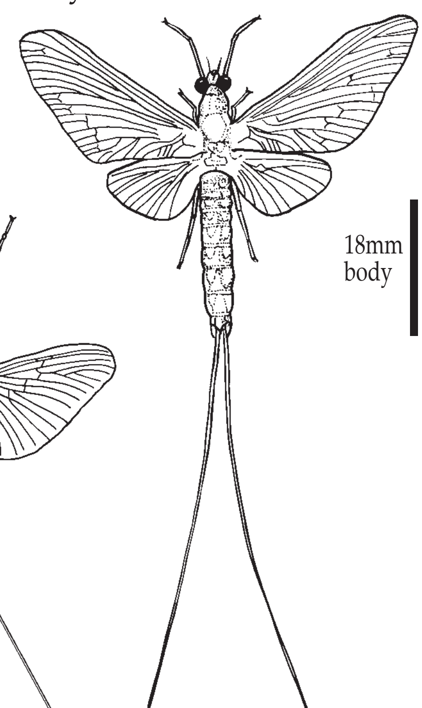
These insects have one or more of their later nymphal stages with fully developed wings, capable of flight. Unlike living mayflies which have lost their adult mouthparts and do not feed after the nymphal stage, the adults of the extinct orders Palaeodictyoptera and Megasecoptera had piercing beaks for feeding on plant and animal fluids.

MAYFLIES Order Ephemerida — 18th in importance — 98+ species in Texas

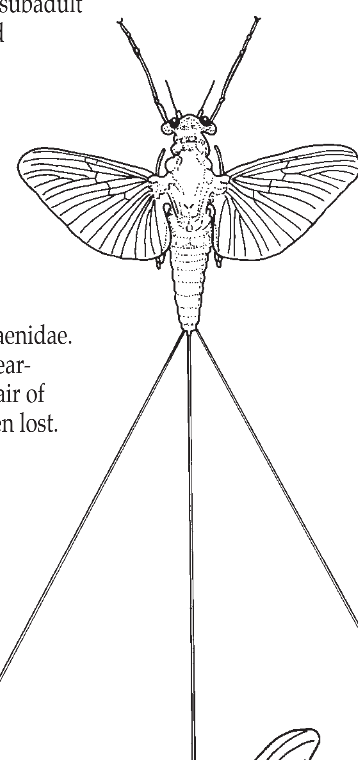
The slender, lacy-winged adults do not have mouthparts and live for only a day or two. During that time they mate and lay eggs on water plants. The aquatic nymphs have chewing mouthparts and feed on small plants and animals. They take up to 4 years to develop into flying adults. Fossil mayflies have been found in 300-million-year-old rocks.

Large mayfly

Hexagenia bilineata — in Family Ephemeridae.
• This 18mm mayfly is greenish grey with yellow soft parts. There is a synchronized emergence of subadults from the aquatic nymphs. Mayflies are the only living insects with a flying nymph. The subadult flying nymphs have cloudy wings. The clear-winged mature adults emerge the following day. Massive flights are a hazard to motoring, obscuring windshields and slicking pavement.



18mm body

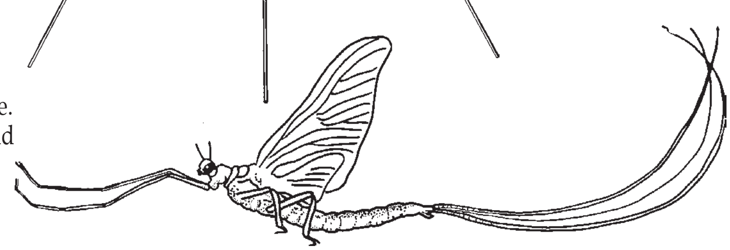


Fairy mayfly

Caenis diminuta — in Family Caenidae.
• This 5mm gray-and-white clear-winged mayfly has only one pair of wings, the hindwings have been lost. The nymphs live in ponds.

Common mayfly

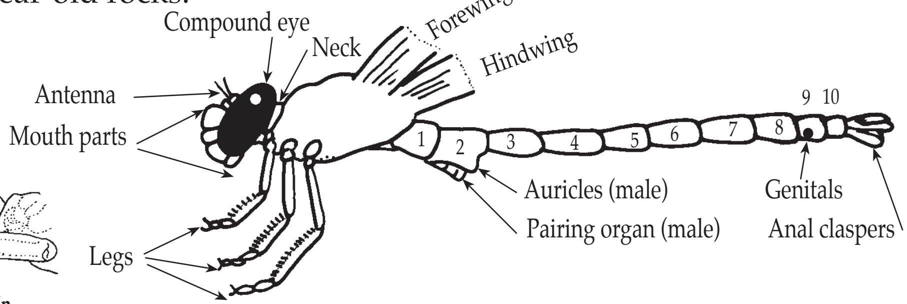
Pentagenia vittigera — in Family Palingeniidae.
• This 10mm clear-winged mayfly has a broad black band along the leading edge of the forewing. It is found adult in summer, often during drought and far from water.

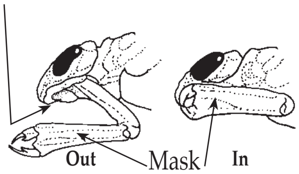


The strong jaws of the nymphs are retained by the adults. The nymphs are underwater dragons that prey on other insects, fish and frogs. The adults are hawks of the air that feed on butterflies and other insects, swooping from above.

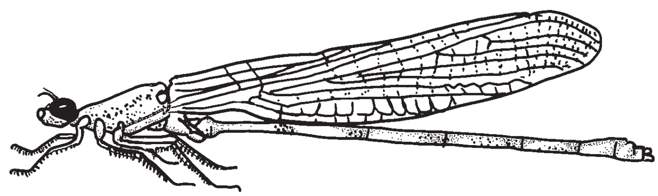
DRAGONFLIES Order Odonata — 12th most diverse order — 239+ species in Texas

The large transparent wings of these accomplished hunters of other insects move individually with great control. Dragonflies can hover or fly backwards or forwards with ease. The aquatic nymphs have a large retractable shovel-shaped lower lip. They use this as a catch-arm for snatching prey. Fossil dragonflies have been found in 320-million-year-old rocks.





Dragonfly nymph
with under-lip grabber called a **mask.**

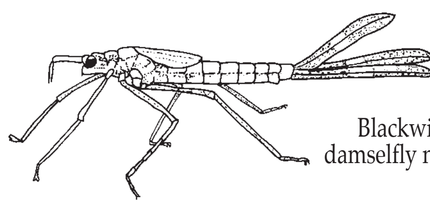


Civil bluet damselfly

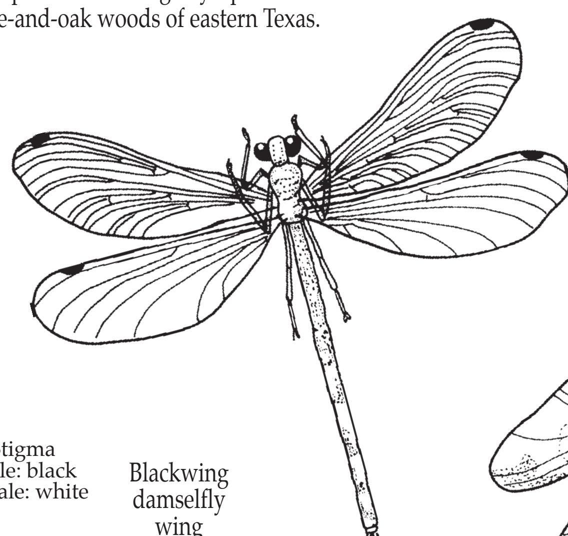
Enallagma civile — in Family Coenagrionidae.
• This is a common 31mm damselfly with pale blue-banded black abdomen. The nymphs live in sluggish streams.

Blackwing damselfly

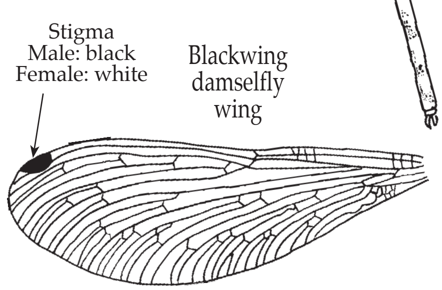
Calopteryx maculatum — in Family Calopterygidae.
• This is a common black-winged 55mm damselfly with a metallic green body. The female has a white dot near the apex of each wing. Nymphs live in streams of the pine-and-oak woods of eastern Texas.



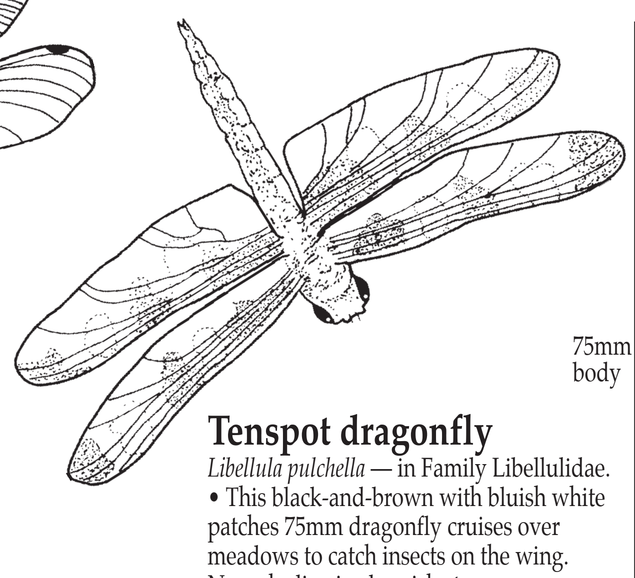
Blackwing damselfly nymph



Adult



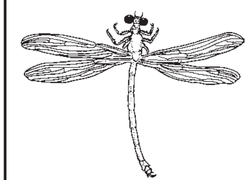
Blackwing damselfly wing



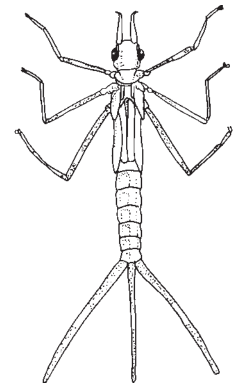
Tenspot dragonfly

Libellula pulchella — in Family Libellulidae.
• This black-and-brown with bluish white patches 75mm dragonfly cruises over meadows to catch insects on the wing. Nymphs live in sluggish streams.

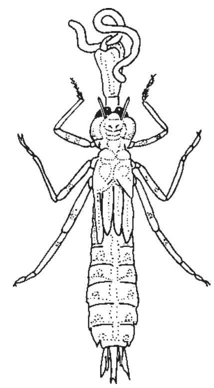
more stuff . . .



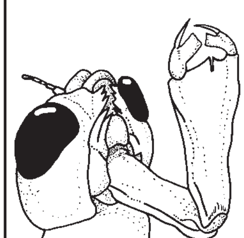
Blue damselfly



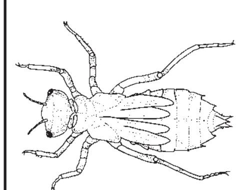
Blackwing damselfly nymph



Dragonfly nymph with lunch

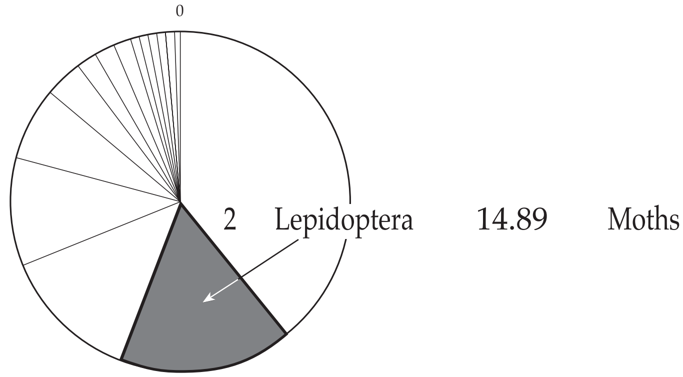


Dragonfly jaws close-up

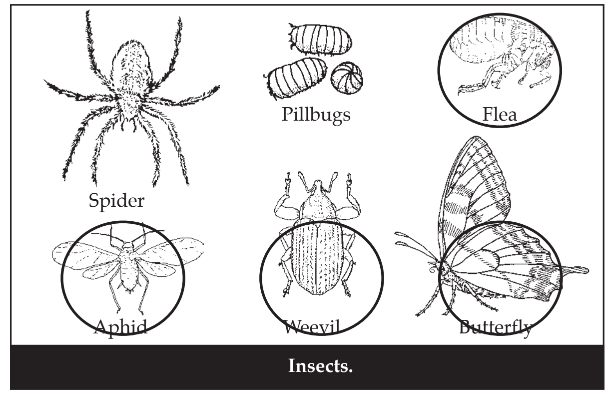


Tenspot dragonfly nymph

Page 2: Color the area on the pie chart that represents **Moths**.



Page 4: Circle the animals that you think are insects.



The spider is an arachnid (eight legs, two-part body, no wings or antennae).
The pillbug is related to crabs.

Page 18:
Finding words
you've learned

N	I	G	N	U	F	C
Y	E	M	O	L	D	S
W	N	L	T	H	T	S
O	S	I	L	N	A	P
O	A	R	A	O	K	O
D	P	L	I	N	P	R
C	P	H	A	R	D	C
S	E	B	D	O	O	F

CROPS
FOOD
FUNGI
MOLD
PLANTS
POLLEN
SAP
WOOD

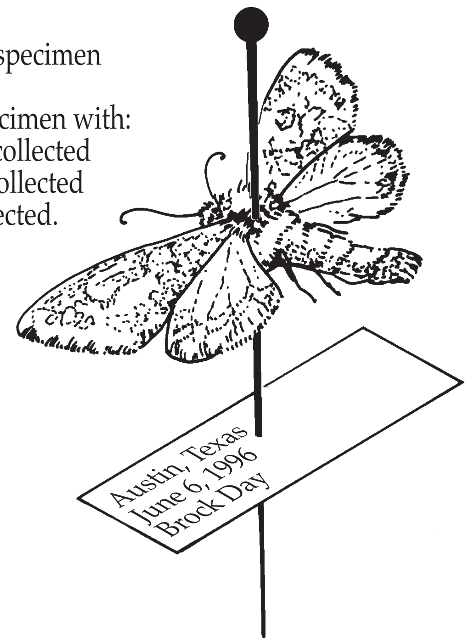
Page 25:
Finding words
you've learned

B	U	G	S	E	G	T
L	E	N	A	G	C	N
P	N	A	E	E	C	Y
U	P	O	S	R	O	M
P	I	N	M	L	C	H
A	I	V	Y	M	O	P
L	A	R	V	A	O	T
A	D	U	L	T	N	C

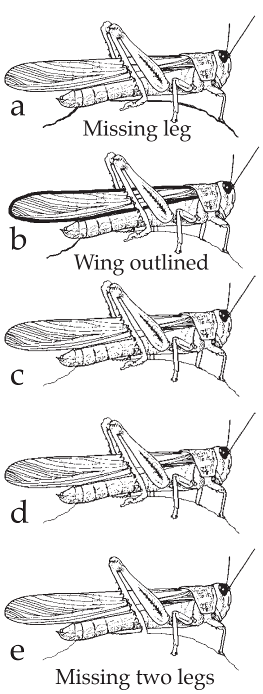
ADULT
BUGS
COCOON
COMMON
EGG
INSECT
LARVA
NYMPH
PUPA

Where to pin a specimen

Label every specimen with:
- Where it was collected
- When it was collected
- By whom collected.

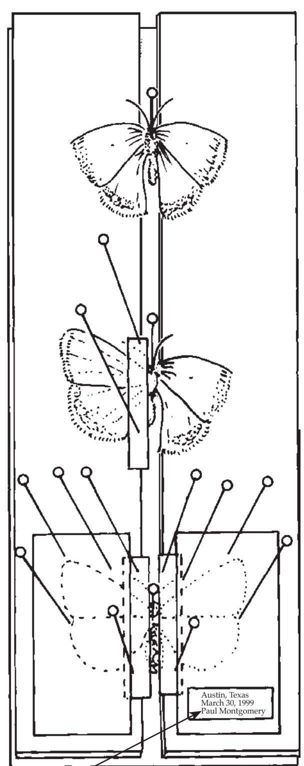


Page 26:
Which are the
two identical
grasshoppers?



c and d

How to spread a
dead butterfly specimen



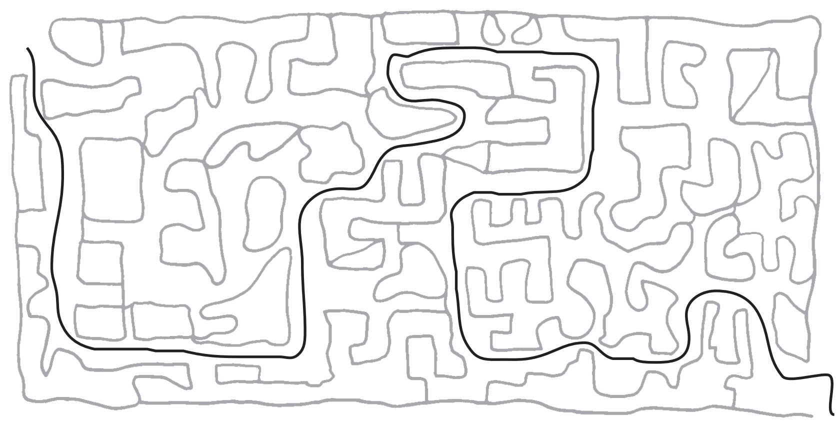
Label every specimen with:
- Where it was collected
- When it was collected
- By whom collected.

Page 30:
Finding words
you've learned

J	U	M	P	E	R	R
R	W	A	L	K	E	R
S	E	A	E	B	D	E
U	W	G	M	R	L	N
P	I	I	G	L	O	N
A	L	V	M	I	H	U
C	A	R	V	M	D	R
C	R	A	W	L	E	R
S	I	G	N	A	L	R

CLIMBER
CRAWLER
DIGGER
JUMPER
HOLDER
RUNNER
SIGNAL
SWIMMER
WALKER

Page 29: Find the trail through the maze.



Did you find another path?

Out

Special thanks
to my mother,
Eunice Taylor

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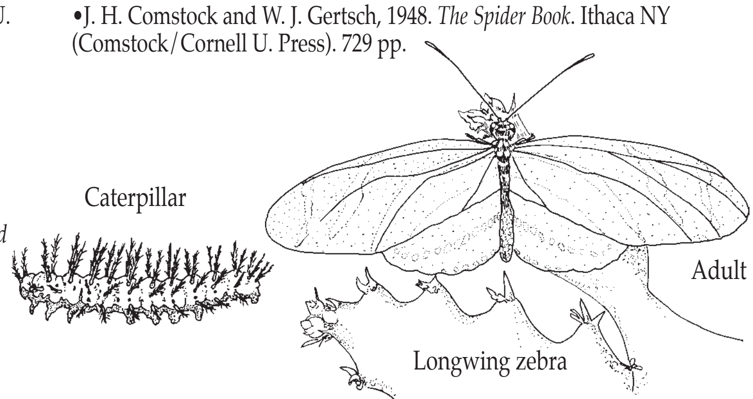

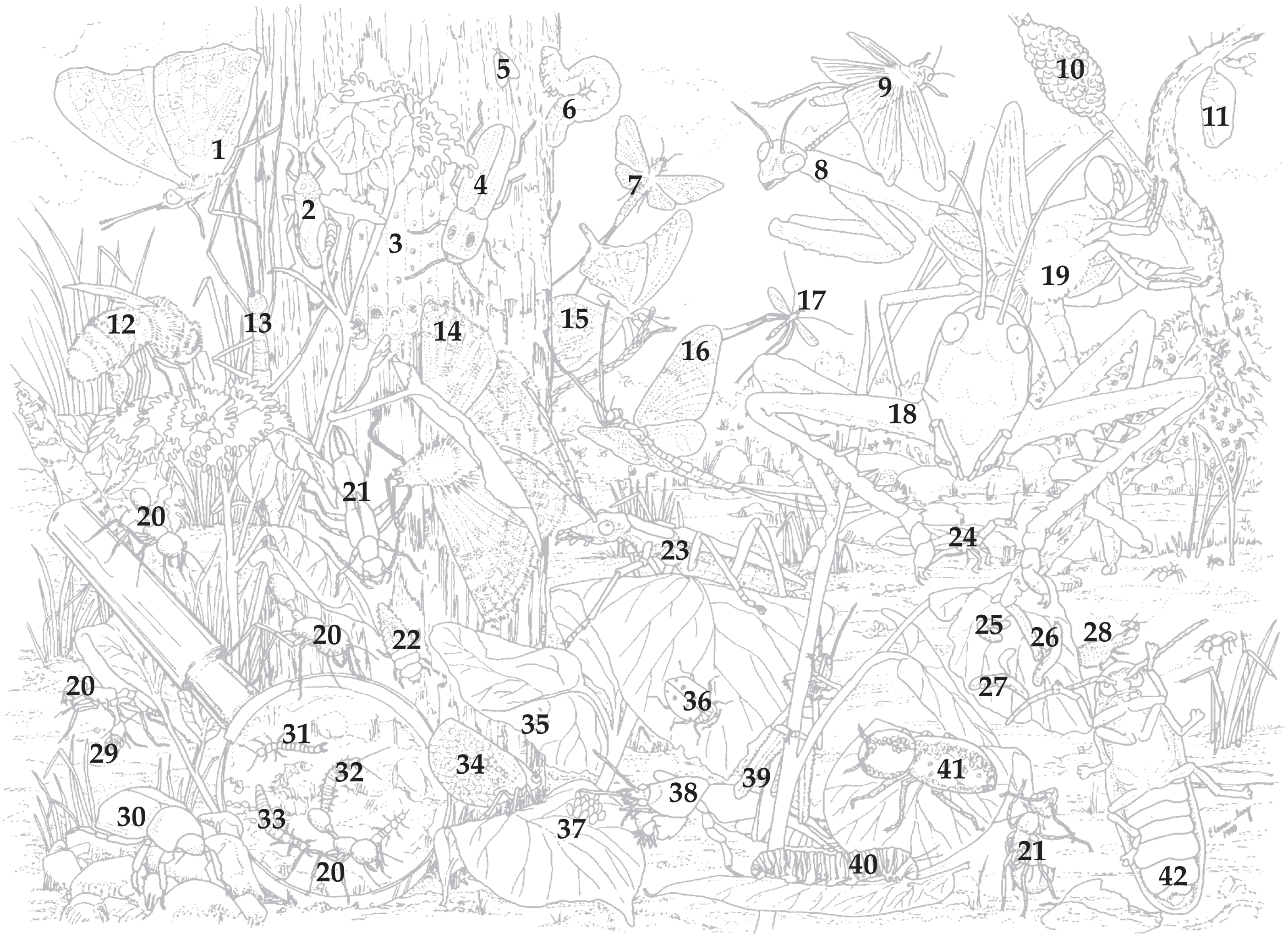

1. Tawny emperor butterfly
2. Conenose bloodsucker
3. Mud-dauber nest
4. Eyed elater
5. Elena's favorite insect
6. Looper caterpillar
7. Large mayfly
8. Praying mantis
9. American bird locust
10. Spittlebug
11. Monarch chrysalis
12. Bumblebee
13. Giant walking stick
14. Checkered skipper
15. Giant swallowtail
16. Mayfly
17. Cranefly
18. Grasshopper
19. Dragonfly
20. Fire ant
21. Texas agricultral ant
22. Ladybird beetle larva
23. Longhorn beetle
24. Snakefly (Chris's favorite insect)
25. Moth caterpillars
26. Morning cloak caterpillar
27. Sawfly larvae
28. Clouded ant lion
29. Prairie-ant cricket
30. Scarab beetle (Georg's favorite insect)
31. False earwig
32. Garden symphylan
33. Telsontail
34. Broadwing leafhopper
35. Whiteflies
36. Ladybird beetle
37. Insect eggs
38. Mole cricket
39. Grasshopper
40. Monarch caterpillar
41. Ironclad beetle
42. Firefly

Key to Cover

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