KANSAS MASTER NATURALIST PROGRAM

ENTOMOLOGY

CHAPTER GOALS

AFTER COMPLETING THIS CHAPTER, VOLUNTEERS SHOULD BE ABLE TO:

- Describe what entomology is.
- Understand why insects are biologically diverse, why this diversity is threatened, and why the conservation of insect biodiversity is important.
- Discuss basic principles of insect behavior and ecology, and relate these to environmental adaptations.
- Demonstrate knowledge about the general characteristics of the major groups of insects.
- Demonstrate familiarity with the insect fauna of Kansas.
- Understand the role that insects play in local ecosystems and various other ecosystems in Kansas.

A. Introduction

It would be impossible to approach the goal of becoming a Master Naturalist without considerable knowledge of insects. In this chapter, all you may expect is the briefest of introductions to the incredibly broad subject of entomology. We have time and space here to provide you a starting point, some principles, a few basic techniques, and, hopefully, inspiration.

This chapter of the curriculum is broad by necessity. It seeks to relate insects to the natural history of all regions of Kansas. It is meant to be used statewide, and this may seem at first to be a hindrance to your progress. If you can reasonably expect to find 5,000 insect species in your closest natural area, then how can you afford the brainpower to learn about other areas? But remember, knowing a lot of names does not make you a naturalist. A Master Naturalist is able to make connections. Many times a little knowledge about some other region will trigger you to connect things going on at home. You might find yourself wishing that you had a naturalist book exclusively devoted to your little area. It is possible to think about this in another way, though. Knowledge of other regions will equip you to know what is remarkable in your own. It will allow you to make connections.

B. What is Entomology?

Entomology is both a basic and an applied science that deals with the study of insects and their relatives.

Entomologists are at the cutting edge of scientific research in such areas as biotechnology, systematic genetics, physiology, biological control, and integrated pest management. Applied entomology helps further develop and transfer the knowledge and understanding gained through basic research to those who can benefit directly. Employers include universities, government agencies, and private industry. There are ample opportunities to work with people.

No matter what your interests, skills, and background, there's a place for you in entomology. Because of its diversity, entomology provides many choices and opportunities for those interested in nature and sciences. Some entomologists work in the field, others work in the laboratory or classroom, still others find a niche in regulatory entomology or international activities.

C. Why Study Insects

Naturalists are interested in making discoveries. As a Master Naturalist, you will make a long string of discoveries in nature. Often things that you learn will be new to you, but not to other people. However, some things that you discover will be known only to you. It is often difficult to know which is which.

Often it takes years of study to reach a point where you can recognize new discoveries. How could you ever get the critical mass of knowledge necessary to know that some fact is new, or to begin to relate things? Birds are much friendlier in this respect. With checklists and identification guides, you can quickly reach the point of recognizing a rare bird, or even a new state record.

Now comes an important point, perhaps the most important of this chapter. A major trend in biology is working to make information about what is known more easily available than ever before. The trend is called **bioinformatics**, and it makes this the beginning of a period when it will be most possible for you to reach a level of expertise in some aspect of natural history.

Knowing what is new information is what makes an expert and, as you read this, insect collectors across the country including Kansas Natural History Survey personnel are entering the data from their specimens into databases that are or will be available online. Some automatically generate distribution maps with county records and regional checklists. Identification guides with keys and pictures will be more accessible than ever.

Recognize now that if you like insects — from dragonflies to dung beetles to ants — then you will be able to use the Internet to find lists of the species known from Kansas. You might locate high quality pictures of identified specimens and county level distribution maps. You can collect your own specimens and more rapidly than ever make lists for your own area, identify new county records, or even state records. You will email the professionals, who often don't have the time to go out and collect the most basic information on behavior, lifecycles, or distribution. They will be happy to hear your news. If enough naturalists recognize this opportunity, now will be the beginning of a renaissance of the contributing amateur entomologist.

When you are able to sit at your home computer and see that the dragonfly you caught over a nearby pond is not pictured in the list of Kansas species, then a simple and powerful change will have occurred.

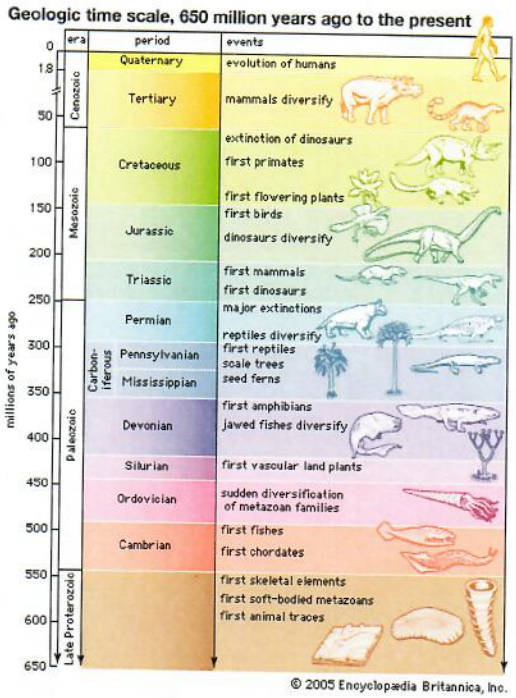
D. Why Are Insects So Diverse?

The word "diversity" is used a lot these days. What does it mean? It may refer to the number of different taxa (species, genera, families, etc.). It may refer to many forms, or the variety of habitats and foods utilized. Some may have used it to refer to large numbers of individuals, even though this seems like an entomological stretch. Usually when diversity is referred to, what is really being discussed is richness, or the number of different species.

They are the group of organisms with the most species. Four out of five animals are insects. Their physical forms vary from the most reduced parasites to specialized castes in social colonies. They are found in almost every non-polar terrestrial and fresh water habitat. Some water striders even inhabit the ocean surface. There is an insect adapted to feed upon almost every natural concentration of organic matter. There are insects specialized to feed upon hair and horn (keratin), dung, fungus, carrion, petroleum, wood, blood, pollen, nectar, bones, seeds, even wax.

Insect species richness can be attributed to many qualities. These include:

1. Ancient origin
2. Ability to adapt to change
3. Small size
4. High rate of reproduction
5. Powers of dispersal
6. Ability to aestivate or diapause
7. Metamorphosis.



1. Ancient Origin

The earliest fossils of insects have been around for perhaps 400 million years (Devonian Period). They have survived many of the major extinction events of the past. However, the extinction event at the end of the Permian Period, about 250 million years ago, knocked out many ancient orders. The rise of flowering plants, in and at the end of the Cretaceous Period, influenced the rise of some groups.

2. Ability to Adapt to Change

Having small body size allows for more individuals to co-exist in a habitat, and abundant offspring allow for more variation in the population. Combine this with excellent powers of dispersal, and you have a good recipe for adaptation. Whenever some drastic change occurs in the environment, then a species with many individuals that have varying traits will have some individuals that survive and pass on their successful genes.

3. Small Size

Small size reduces the requirements for life, and generally allows for more individuals to live in one area, thus allowing a more varied genetic pool to exist. Natural selection may proceed more rapidly in such a situation. Also, there are more possible adaptive niches for small animals. It would not be unusual to find an insect species adapted to feed upon the seeds of just one particular species of plant. It would be much more difficult for a large vertebrate to survive that way. The smaller you are, the larger your potential resources are.

4. High Rate of Reproduction

Ecologists have described two strategies for reproduction. They are labeled R-strategy and K-strategy. K-strategists have few young, and take good care of them. Human are an example of K-strategists. R-strategists mass produce offspring and hope that a few will make it. Most insects are R-strategists, and this is one of the major reasons for their success. R-strategy is especially successful in insects because of their small size, rapid maturation, and wide dispersal.

5. Powers of Dispersal (Flight)

Small size and the power of flight combine to make insects excellent dispersers. They may accidentally travel distances great enough to colonize oceanic islands like Hawaii. By colonizing new habitats in this way, some insects have been able to undergo speciation. Aquatic insects are typically good dispersers because they must get around between relatively small, isolated habitats. Some insects use their powers of dispersal to

migrate long distances, such as the Monarch butterfly. People on the Gulf Coast have probably observed migrations of dragonflies in the fall. Weather radar has been used to track migrating masses of moths and aphids.

6. Ability to Aestivate or Diapause

Aestivation in insects is the equivalent of hibernation in vertebrates. Metabolism slows down along with activity and food use. Insects may aestivate over unfavorable periods of cold, heat, or drought. Boll weevils aestivate over the winter as adults in field stubble, so one control for them is to disc or plow winter field stubble.

Diapause is another form of waiting out unfavorable conditions. Diapause is a resting period of suspended animation. Eggs, larvae, pupae, or adults may diapause. This ability allows specialized use of intermittent resources such as flower nectar.

7. Metamorphosis

There are two different types of metamorphosis (= "many appearances"): 1. **Complete metamorphosis** and, 2. **Incomplete metamorphosis**.

Complete metamorphosis = egg, larva, pupa, and adult life stages. The majority of insects undergo complete metamorphosis (Figure 1). This pattern of development allows different life stages to use different food sources and avoid competition with each other. A caterpillar eating leaves is not in competition with the adult that feeds upon nectar. Additional advantage is conferred by the egg and pupal stages that are well adapted for surviving unfavorable times like winter or drought. The ability to use seasonal food sources expands the possibilities for specialization. Avoiding competition for resources between adults and larvae allows for greater population numbers.

Incomplete metamorphosis = egg, nymph stages, adult. The offspring look like miniature versions of the adult and all versions feed on the same food. This type of development is seen in grasshoppers and crickets.

E. Characteristics of Insecta

Insects = arthropods that have three body regions, six legs, and external mouthparts.

Insect Body Regions

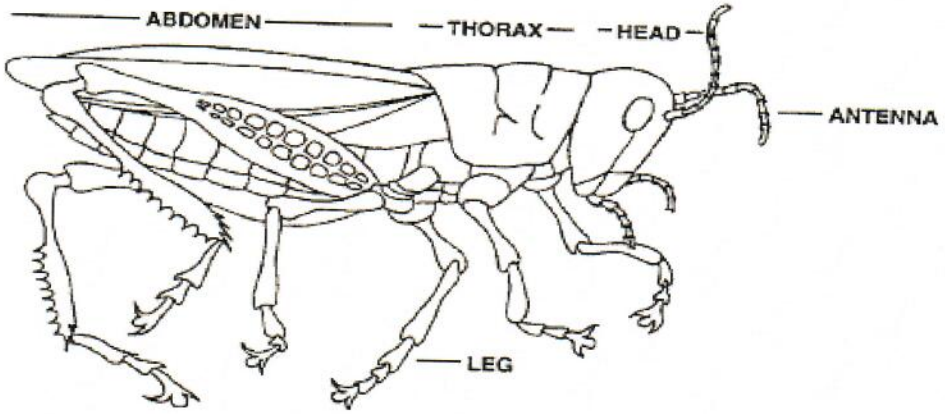


Table 1. Characteristics of Insecta

	Antennae	Body Regions	Legs
Hexapoda	2	3	6
Crustacea	4	2	10+
Arachnida	0	2	8
Chilopoda (centipede)	2	2	Many
Diplopoda (millipede)	2	2	Many

Selected Taxonomic Orders of Insects:


Springtail

1. **Collembola:** Springtails are tiny, widespread, less common as habitats dry, present by and on water, in moist soil, and sometimes in vegetation. They jump by means of a ventral appendage.


Bristletail

2. **Microcoryphia:** Bristletails are 10-12 mm, elongate with three tails, cylindrical, jumping, uncommon in collections. Not uncommon in moist woodlands. Some inhabit dry areas, living in crevices and under rocks.


Silverfish

3. **Thysanura:** Silverfish and firebrats are 2-20 mm, elongate with three tails, flattened or convex, not cylindrical, not jumping. Common in soil, leaf litter, under bark, occasional household pest of pantries and barns.


Mayfly adult

4. **Ephemeroptera:** Mayfly nymphs are aquatic predators and detritivores. Adults emerge and fly. Look for them on vegetation near water. Some burrow in riverbanks. Many people study Ephemeroptera because of their value as indicators of water quality.

5. **Odonata:** Dragonfly and damselfly nymphs are aquatic predators. Adult dragonflies hunt insect prey over water, or sometimes in fields and fence rows far from water. Damselflies are smaller Odonates that fly weakly by the side of ponds and streams.

6. **Plecoptera:** Stonefly nymphs are aquatic predators or detritivores. Plecoptera generally require cool, clean waters. Summer stoneflies emerge as adults in the summer, and are the more common kinds. They are mostly predators. Winter stoneflies emerge in early spring, but this can be delayed by water temperature in places like cold springs. Winter stoneflies often fill the detritivore niche of ephemeropterans in some streams.

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right)

7. **Phasmida:** Walkingsticks are 10-100 mm,stick-like herbivorous insects that clamber in vegetation. Phasmids are semi-tropical insects that are more common in the South. Collect them by beating trees, or sweeping vegetation.

Walkingstick

8. **Orthoptera:** A large and diverse order including crickets, grasshoppers, katydids, lubbers, cave crickets, and mole crickets. Orthoptera may be found in many other habitats besides grassy meadows. Some families of crickets are adapted for semi-aquatic life. Camel crickets inhabit caves and burrows. Katydids are difficult to get out of the canopy of forests, but other species are common on prairie vegetation. Mole crickets tunnel through moist soil.

Cricket adult

9. **Mantodea:** Only one family (Mantidae) occurs in North America. Mantids are familiar predators of other insects in gardens and yards.

Mantid adult

10. **Blattodea:** Many cockroach species that inhabit leaf litter, soil, rotten logs, or animal nests are never pests. Some species are important components of forest ecosystems.

11. **Isoptera:** This Order includes termites. Termites use bacteria housed within their gut to digest the cellulose ingested from wood. Different castes include workers, soldiers, and reproductives called alates. Often mass emergences of alates in spring will fill the air, and provide great feasts for wildlife.

Termite worker and winged reproductive

12. **Anoplura:** Sucking lice all take blood meals, and only live on mammalian hosts. Two species are associated with humans.

13. **Hemiptera:** True bugs have piercing sucking mouthparts and two textured wings held flat over the back. Most terrestrial kinds pierce plants and drink juices. A large number are predators though. Aquatic forms are mostly predators.

True bug nymph and adult

14. **Homoptera:** Homopera have wings of a uniform texture that are generally held roof-like over the abdomen. Loud cicadas of summer are the homopterans most familiar to people.

Cicada adult

15. **Coleoptera:** About 40% of the insects are beetles. One of every four animals is a beetle. The largest family, the weevils, is larger than most orders. It is difficult to convey the spread of beetles through the environment in a few paragraphs. Wood, bone, hair, fungus, insects, carrion, manure, algae, and or humus serves as food for some beetle. Even parasitic forms live in pelts of beavers. Beetles are present in every habitat type except the marine and coldest polar regions.


Click beetle larva (lower) and pupa (upper)


Click beetle adult

18. **Trichoptera:** Caddisflies are small moth-like flying insects who have case-building, aquatic larvae. Any book on aquatic insects will devote a portion to the larvae. They are often identifiable to family based on the structure of the case. Cases are built of sand, gravel, vegetation, or other detritus joined together by silk. They are often used as indicator species for water quality.


Caddis fly adult

19. **Lepidoptera:** Moths, skippers, and butterflies comprise perhaps the most popular order of insects. It is ironic that moths make up the majority of the Lepidoptera, and receive less attention from collectors. Most people are familiar with the leaf-eating larvae of many butterflies. Less well-known are those larvae that bore into stems, mine the inside of leaves, tunnel into fruits and nuts, eat submerged aquatic plants, dried grain, wax, fungi, lichens, or wool. Some lepidopteran larvae parasitize or prey on insects, eat dried meat and cheese, or take blood meals.


Red admiral butterfly larva, pupa, adult

20. **Diptera:** Although the name "fly" is attached to many other orders of insects like dragonflies and butterflies, the true flies belong only to order Diptera. The order of true flies is characterized by having only two wings. Dipterans have their names separated, such as "horn fly". Like the beetles, Dipterans are spread throughout the environment and occupy almost every imaginable niche.

21. **Siphonaptera:** Fleas are all parasitic blood feeders. Caterpillar-like larvae live in the nests of animals, and feed on dandruff and dried blood. Most are associated with mammals. A few are bird parasites. The greatest variety may be found on various rodents. Always exercise caution with fleas and rodents. If you are exposed to any flea, rodent, or rodent nest, and develop the slightest illness or cold, rush to the doctor and tell them what you have been up to. Several cases of Bubonic Plague are reported each year. These originate commonly from exposure to prairie dogs and their fleas.


Flea adult

22. **Hymenoptera:** This is another of the gigantic orders, like Coleoptera and Diptera. Collectors and scientists divvy it up into more workable groups including ants, bees, sawflies, stinging wasps, gall wasps, and parasitic wasps.


Wasp adult

F. Roles insects play in ecosystems

A list of roles insects play in the ecosystem include: pollination, carrion removal, dung removal, disease transmission, erosion, predation, parasitism, herbivory, and phoresy (movement of organisms on other organisms – hitching a ride). Insects affect the composition of the atmosphere, build the soil, influence the vertebrate communities, and affect what our woods and prairies look like.

Seed-eating insects, like seed weevils and some stink bugs, affect the composition of every plant community by their seed preferences. Termites remove dead wood, return nutrients to the soil, and affect the composition of the atmosphere with the gases they release. Populations of vertebrates are fed by insects, and kept in check partly by transmission of diseases by insects. Every species of mammal and bird is susceptible to louse parasites.

G. Insects of Interest in Kansas

Native Pollinators and Honey Bees

Most plants with showy flowers are pollinated by insects. Bees and most other insects see the same color spectrum as humans except that it is shifted. Most insects cannot see red, but can see ultraviolet which we cannot see. The dark color patterns that we see on pansies are actually ultraviolet colored markings that serve as nectar guides to insects. Placing the blooms of black-eyed Susans, asters, sunflower, and other flowers that appear all yellow or white to us under a black light will reveal the ultraviolet patterns that insects see. Even some red flowers, such as hibiscus and rose of Sharon, will reveal an ultraviolet pattern. Other red flowers such as columbine, trumpet creeper, and fuchsia evolved to be pollinated by hummingbirds and are not very attractive to insects. White, night blooming flowers probably evolved to be pollinated by bats and moths.

Leafcutter bees

Native bees that are important pollinators include bumble bees, carpenter bees, sweat bees, leaf cutter bees, mason bees, alkali bees, ground bees, and other solitary bees. Except for the bumble bees and carpenter bees, most of these are black, blue, or gray and black banded insects that are about one quarter inch long. Some flies, beetles, butterflies, moths, and other insects may be important pollinators for some plants.

Honey bees have been managed by people for thousands of years, both for their pollination services and their production of honey and beeswax. Practices have recently been developed to manage some of the native bees, particularly mason bees, leaf cutter bees, alkali bees, and bumble bees.

Honey bees (*Apis mellifera*) are not native to the Americas, but European honey bees were brought to North America by early settlers in the early- to mid-1600s. Honey bees have become an important part of human dominated ecosystems, with the need for the pollination of large, monoculture crops.

African honey bees (*Apis mellifera scutellata*) were brought to Brazil in 1956 in the hopes of developing a hybrid more suitable for honey production in tropical and subtropical climates. Africanized honey bees, hybrids between European and African bees, quickly became established in the local, feral population, rapidly spreading through South and Central America and Mexico, and reaching the U.S. (Texas) in 1990.

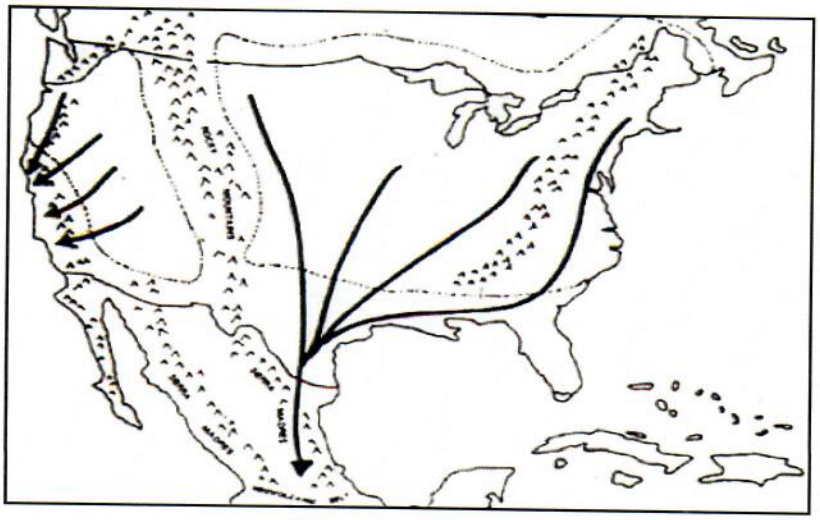
Monarch butterfiles

MONARCHS

Monarch butterflies are perhaps the best example of a well-known and loved arthropod. We have studied monarch migration, biological adaptations, and their relatedness to other butterflies. Through monarchs, millions of schoolchildren have learned about metamorphosis, migration, and mimicry. Search for the terms "monarch," "Danaidae" or "Danaus plexippus" and you will find a wealth of information.

Yet despite their popularity, the destination of migrating monarchs remained a mystery until the recent date of 1976. That year, the winter roosting grounds of the monarch were located in the mountains of Central Mexico. Many other important questions remain. How do the butterflies navigate? What are the migration routes, and what affects them? What are the origins of the migration phenomenon? Monarch Watch is an organization formed in 1991 to study monarchs, and promote conservation. See their address below.

Every fall, the shortening days trigger emergence of a generation of monarchs that postpone mating and reproduction in response to an urge to fly south. Monarchs from all over the eastern United States make a remarkable trip south to a few mountain refuges in central Mexico, where they spend the winter. Populations living on the western side of the Rocky Mountains have winter roosting sites in California. They spend the winter in clumps on trees, and then spread north depositing eggs on milkweed plants in spring. Migrating monarchs can fly up to 3000 miles. Migrations can go wrong sometimes. Groups have arrived in Britain in the fall of 1876, 1933, 1968, 1981, 1983 and 1995. It is possible to determine that trans-Atlantic monarchs originated in North America by analysis of the cardenolid chemicals that they accumulated while feeding on toxic milkweed plants as larvae. Different species of milkweed have slightly different cardenolides.



Monarch migration

Monarchs have long been known to be distasteful to predators because of these chemicals that are accumulated in their bodies. Their bright red and black colors serve in part to advertise distastefulness. The viceroy butterfly is another species that closely resembles the monarch. For many years the viceroy was cited as an example of batesian mimicry, in which one tasty butterfly takes advantage of another's acrid defenses by mimicking it. It has since been determined that the viceroy, too, has distasteful defense, and both species reinforce each other's reputations by sharing warning colors. This is known as mullerian mimicry.

Threats to monarch populations include deforestation of roosts in Mexico and California. Pollen from corn engineered to contain the insect toxin from the bacterium *Bacillus thuringiensis* has been shown to be toxic to monarch larvae. However, many people think it unlikely that corn pollen can be blown over distances to milkweed plants in sufficient quantities to harm the larvae. Some butterfly gardeners have reported paper-nest building wasps to be preying on their pet monarch larvae. Predation by wasps will certainly be augmented by our construction of favorable wasp habitats like sheds, porches, and eaves. Even a protozoan parasite of monarchs has been discovered. In 1966, *Ophryocystis elektroscirrha* were found to infest monarchs. Spores on leaves are eaten by larvae. The parasite may kill larvae, and disrupt adult emergence or vitality.

To contact Monarch Watch go to: http:// www.monarchwatch.org.
An informative site on monarch biogeography can be found at:
http://bss.sfsu.edu/holzman/courses/Fall99Projects/Monarch/monarch.htm
Other migrating danaids are mentioned at:
http://www.hku.hk/ecology/porcupine/por17/butterf.htm#index6

DRAGONFLIES

Dragonflies have begun to give the butterflies some competition for the attention of amateur naturalists. They are well adapted to do this because of their species diversity, colorful beauty, and abundance. They are even useful tools for rapid bio-assessment of aquatic habitats.

Dragonfly adult

Dragonflies and their kin, the damselflies, are placed in the order Odonata. They have aquatic larvae called naiads. The naiads are typically predators on other aquatic invertebrates. Consequently, dragonflies will be commonly found around bodies of water.

However, many will leave the water's edge and hunt insect prey in fields and fencerows. You will find that differences in habitat are important determinators of dragonfly species. Rivers will have different species than ponds and lakes. Some rare species will only be found in micro-habitats like boggy seeps, or clean sandy woodland streams. A wide variety of habitat requirements and tolerance levels for pollution or disturbance also make the Odonata useful as bio-indicators.

Some dragonflies, like the large colorful *Anax Jjunius*, migrate in masses from and through Kansas each fall to the Texas coast of the Gulf of Mexico. Recently, several excellent field guides have been developed for dragonflies and damselflies.

PERIODICAL CICADA

Nymphs that hatch from eggs inserted into stems drop to the ground, burrow into the soil, and find a root to feed upon. The nymphs suck sap from the roots until the last year of their life cycle, when they emerge from the soil in the late spring, climb a tree, and

emerge as adults. The adults are black, about 1-1/4 inches long, and have red eyes. They have clear wings with orange veins. The adults do little feeding, spending most of the daylight hours involved in reproductive activities. Male cicadas sing during the day to attract females. Mated females select twigs and branches up to one inch or more in diameter and insert their eggs into slits made with their ovipositors. Very little egg-laying occurs in the first ten days after emergence. Eggs are laid mostly during the last ten days of the female cicada's adult life.

Periodical cicadas are a threat to small trees with trunk diameters of two inches and smaller. Their egg- laying may cause trunks and branches to snap off in windy conditions. These insects do not fly very far from where they emerge. That fact, combined with their long generation times, means that the spread of periodical cicadas is very slow.

H. Overview of other Arthropods

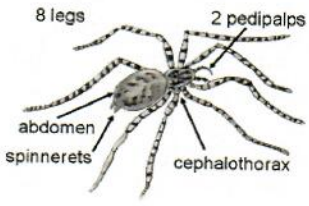
Arthropods — Phylum Arthropoda

The phylum Arthropoda, also known as the arthropods, includes the insects, crayfish and sowbugs, scorpions, pseudoscorpions, harvestmen, spiders, ticks and mites, horseshoe crabs, millipedes, and centipedes. The term Arthropoda literally means jointed foot; these are all animals with segmented legs. They also all have exoskeletons: the skeleton comprises the outside of the body and contains the organs and other flesh. It is estimated that of the over 1.1 million described species of animals in the world, 850 thousand are insects and another 75 thousand are non-insect arthropods. In Kansas there are approximately 15,000-20,000 species of insects.

Class Chelicerata

Spiders — Order Araneae

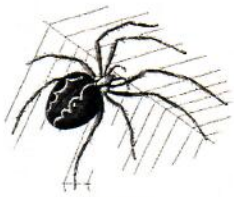
Spiders have eight legs, two leg-like pedipalps near the mouth, and two chelicerae (fangs) very close to the mouth. Their body is composed of an abdomen and a cephalothorax. The cephalothorax contains both the head and thorax fused together. It contains the legs, pedipalps, and chelicerae, as well as the sucking mouthparts and typically eight eyes. Spiders do not have antennae. The abdomen has openings on the underside for the book lungs (stacks of alternating air pockets and hemolymph-filled tissue give spider lungs the appearance of a "folded" book) towards the front and spinnerets near the posterior. The reproductive openings are also on the underside of the abdomen. Spiders have several spinnerets which together are capable of producing several kinds of silk. Some silk is sticky for prey capture, other is non-sticky and strong for web structure, still other kinds are used for retreat and burrow linings, draglines, and egg masses.



Spider anatomy

All spiders are predators on insects and other small animals. They have ducts in their chelicerae that release toxin produced by poison glands into their prey when they bite it with their chelicerae. They hold and manipulate their prey with their pedipalps while mashing it with their chelicerae. During this time, enzymes are regurgitated which break down the prey's tissues into liquid that is sucked up by the spider. The large muscles for these sucking mouthparts are attached to the anterior dorsal side of the cephalothorax. The exoskeleton is thickened in this area to provide a strong base for muscle attachment. This thickened area is usually a darker color and is frequently striped in many spiders.

Orb-weavers – Family Araneidae



Orb weaver

The orb-weaving spiders are characterized by a round web with the spider sitting in the middle of it. The web contains thick, non-sticky silk used for bracing to the web attachment points as well as the radiating spokes in the web. These are the strands that the spider walks on while gripping the silk with three claws on the end of each leg. The spider spins a spiral of sticky silk over this web structure that serves to catch and hold prey that flies or crawls into the web until the spider can run to it and subdue it. Prey that is captured by the web but is too large for the spider to subdue is ignored by the spider until it works its way out of the web. The web is eaten every few days by the spider and rebuilt during the night.

The third pair of legs of orb-weavers is shorter than the other legs. They tend to have poor eyesight. They use the movement of their web to determine the location, size, and identity of their prey. Adult females are very large in comparison to males. Females and their webs are typically what are noticed by most people. Males also build webs when immature, but roam about in search of females when they mature. It is common to see the tiny male spider near the edge of the female's web.

The argiopes, also called garden spiders, are common in prairies where the two-foot diameter orb web is frequently spun between large prairie plants such big bluestem, Indiangrass, and compass plant. There is a thick, obvious, zig-zag of webbing near the center where the two-inch leg span female sits. There are two common species in Kansas. The yellow and black argiope, *Argiope aurantia,* is commonly called the banana spider in northeastern Kansas. The dorsum of the abdomen is black with a series of about six yellow banana-shaped markings on each side. The banded argiope, *Argiope trifasciata,* has dorsal thin black bands across a yellow to whitish abdomen. These spiders commonly spin their webs between tomato plants and other large plants in residential areas.

There are several other large orb-weavers that are about one-half inch long with about a one inch leg span. They have large, rounded abdomens and spin one to two-foot diameter webs across doorways, sidewalks, and spaces between large plants. Many are named for the markings on the upper side of the abdomen, including the cross, shamrock, marbled, furrow, and lattice spiders. The marbled spider also occurs in a yellow-orange to reddish-orange form that is commonly called the Halloween spider. These spiders are common in prairies and in forests, particularly in forest edge habitats.

The spined, white, and arrowshaped micrathenas, in the genus *Micrathena,* are small spiders with a one-half inch leg span. Their abdomens are hardened and angularly shaped and colored as evidenced by their common names. They are primarily found in forests where their 1-2 foot webs are spun between tree branches. Many other orb-weaving spiders are common in Kansas. Most are small and build webs that are only a couple of inches across between leaves or small plants.

Funnel Weavers – Family Agelenidae

Funnel weavers are also known as sheet web spiders and grass spiders. They spin a sheet web, typically 3-6 inches across with a funnel-shaped web structure on one side where the spider sits. There are several silk "trip-wires" spun crosswise above the web. These webs are usually spun on grass, shrubs, and in the corner of buildings. When a flying insect hits one of the trip-wires, it falls to the web, and the spider runs out of its funnel-shaped lair

Funnel weaver

to subdue it. The sheet web is not sticky because insects too large for the spider to subdue easily walk off of the web. Most of these spiders have elongated spinnerets that are easily seen protruding from the posterior end of the abdomen.

The aggressive house spider or hobo spider, *Tegenaria agrestis*, has been associated with brown recluse type wounds from its bites. This European spider has established itself in the northwestern U.S. There are other species of *Tegenaria* that are found in Kansas. They are not considered to be poisonous.

Cobweb Weavers – Family Theridiidae

Cobweb weavers are small spiders, typically with a 1/2-3/4 inch leg-span, although widows commonly have a leg-span of about one inch. They have spherical abdomens and typically hang upside-down in their webs. They have three claws on the end of each leg like orb-weavers, but also have a comb of bristles at the end of the fourth leg that is used to throw sheets of silk over their prey. The cobweb is typically 3-6 inches across and consists of silk strands arranged in a haphazard fashion with sticky outside threads to entrap prey. Brown, round, 1/8-1/4 inch diameter egg cases are common in their webs. Their cobwebs are typically spun in rodent burrows, in shrubs, and under leaves, rocks, and loose bark.

Most cobweb weavers are various shades of brown, including their markings. Widow species in Kansas are black with red markings; immature females can have white stripes as well. Kansas species include the black widow, *Latrodectus mactans*, and northern widow, *Latrodectus various*. Both have a red hourglass on the underside of the abdomen, although it is usually broken into two triangular shapes on the northern widow. This red hourglass is easy to see because the spiders hang upsidedown in their webs. Widow spiders seem to prefer areas with higher humidity, being found in Kansas primarily in rodent burrows. Historically, they preferred to live under the seats in outhouses, so be watchful for them in outdoor toilets.

Sheetweb Weavers – Family Linyphiidae

Sheetweb weavers are little spiders, typically with a 1/4-1/2 inch leg-span. Their appearance and habits are similar to cobweb spiders, but their abdomens are more elongate, being oval rather than spherical. They build thin, flat or domed, sheet webs between tall grass and the branches of trees and shrubs. The spider hangs upside down under the web. Prey that land on the web are subdued by the spider biting them through the web. These spiders can be very abundant in natural areas.

Nursery Web Spiders – Family Pisauridae

Nursery web spider

Nursery web spiders are running spiders. Unlike the spiders that build webs to catch their prey, these spiders have excellent vision and run down their prey. They have long legs and elongate oval abdomens. Some species approach two inches in leg-span. They are common in prairies and woodlands, running across the ground and hiding under rocks and dead leaves. Females carry their round egg sac, which is almost as big as them, in their chelicerae until the eggs are ready to hatch. The female then hangs it in vegetation and guards it and the hatching spiders until they disperse about a week after hatching.

Many terrestrial nursery web spiders are brown with black and white markings. Fishing spiders are in this family and are very common in and near ponds, lakes, and streams. Fully grown spiders have about a 2 inch leg-span and are dark brown to black in color

with white markings. These fast-moving spiders run across the water surface, feeding on insects and other small animals that land on the water surface and live in shore vegetation. They also dive under the surface to capture prey.

Wolf Spiders – Family Lycosidae

Wolf spider

Wolf spiders, like nursery web spiders, are also running spiders. They have excellent vision and run down their prey. They are typically brown to gray with white, gray, brown, or black markings. They have oval abdomens and a leg-span of up to two inches, although most species have a leg-span of about 1 inch. A characteristic that helps separate them from other spiders is that they have trichobothria, long individual hairs that stick straight out from their legs. These are thought to be very sensitive to touch, allowing them to quickly detect prey at night. They are fast-moving spiders that are very common on the ground in leaf litter, grass, and similar cover. They rest in burrows in the soil, under rocks, or under other cover. Female wolf spiders carry their large, round egg case on their spinnerets until the eggs hatch. The egg case is commonly half as large as the adult female carrying it. She then carries her newly hatched spiderlings on her back until they disperse.

Ground Spiders – Family Gnaphosidae

Ground spider

Ground spiders are similar in habits to wolf spiders and nursery web spiders. They have excellent vision and quickly run down their prey. They typically have a 1/2-3/4 inch leg-span, reddish-brown cephalothorax, and gray abdomen. They hunt at night and are found during the day under rocks and loose bark.

Brown Spiders – Family Loxoscelidae

Brown recluse spider

Brown spiders are well-known because of the brown recluse spider, *Loxosceles recluse,* which is poisonous to humans. Brown recluse are various shades of brown with no markings except for a violin shape on the cephalothorax. This violin shape may be dark brown and obvious on some or light brown and much less obvious on other individuals. They have longer legs in relation to the body than most spiders, with a leg-span of about 1 ¼ inches. They only have 6 eyes which are arranged in pairs. Although several other families of spiders have only 6 eyes, they tend to be rarely encountered. Brown recluse spiders weave a sheet of sticky silk in which they trap their prey. They also wander at night.

Jumping Spiders – Family Salticidae

Jumping spider

Jumping spiders are small, active spiders that run down their prey. They are covered with long setae which makes them look furry. The middle two eyes on the first row are huge, looking like car headlights under magnification. They have extremely good eyesight, turning to look at any movement, even from several feet away. Most have a 1/4-3/4 inch leg-span. True to their name, they move in short, rapid jumps. If they lose their footing, they catch themselves on a silk dragline. Males frequently have iridescent green chelicerae. Both sexes are roughly the same size.

The zebra spider, *Salticus scenicus,* has about a 1/4 inch leg-span when fully grown. It is common on tree trunks, in ground litter, and on the outside of houses. It is banded black and white. The genus, *Phidippus,* contains several common species. Most are black or

brown and about 1/2 inch long. They commonly have white, yellow, or red markings on the dorsal side of the abdomen. Those with red markings are occasionally thought to be black widows by the public. Of course the rest of the spider is totally different in appearance from a black widow and the red markings are on the upperside of the abdomen rather than the underside. One common *Phidippus* species is very attractive in appearance with a red cephalothorax and abdomen and black legs and other appendages.

Crab Spiders – Family Thomisidae

Crab spiders hunt by lying in wait and ambushing their prey. Their legs are sprawled out to their sides, as those of a crab. They are able to walk forwards, backwards, and sideways. They are small, typically with a 1/4-1/2 inch leg-span. Crab spiders are normally encountered on plants where they sit in crevices of foliage and flowers waiting for prey to arrive. Over time, they are able to change their body color to match the surface where they are lurking. It is common to see them with captured bees, flies, and butterflies. Other species are brown and live in leaf litter and other debris on the ground.

Crab spider

Mites – Order Acari

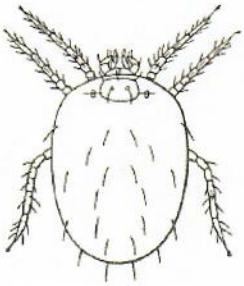
Mites are related to spiders. They have chelicerae and 8 legs as adults. However, the cephalothorax and abdomen are fused together into one body region. Segmentation is not apparent in the body, but the legs are segmented. They tend to be tiny, with many being barely visible to the unaided eye. Many mites are smaller than that, and the ticks are a group of relatively very large mites.Mites hatch from eggs as a 6-legged larva, which later molts into an 8-legged nymph, before molting into an 8-legged adult capable of reproduction. There are other stages that some mites pass through, but these are easily recognizable with magnification.

Predatory mite

Mites are very numerous and occupy a wide range of habitats, being found on plants, in soil, and in bodies of water. Many, such as the spider mites and eriophyid mites, are herbivorous and feed on plants, sucking the juices from cells. Others are predators and feed on herbivorous and other mites, as well as small insects and other small animals. Some of the predatory mites have become parasitic on mammals, birds, and other animals. Parasites include chiggers, human itch or scabies mite, dog scabies mite that causes sarcoptic mange, northern fowl mite, chicken mite, and ticks. A very large number of mites are scavengers, feeding on dead plant and animal material.

Chigger – *Eutrombicula alfreddugesi*

Chiggers, Family Trombiculidae, are parasitic in the 6-legged, red larval stage on amphibians, reptiles, birds, and mammals. As such, they are very tiny and not easily noticed when attacking people. Some people are able to see them crawling on their skin. Chiggers frequent tall grass, bramble, and shrubby areas.



Chigger larva

Long trousers and socks will help protect from chiggers, but do not provide complete protection. Chigger larvae are able to move through socks and similar open-weave fabrics. They rarely move past areas where there are clothing pressure points, commonly stopping there to feed. As a result, chigger bites along the edge of underwear and on ankles are common.

The chigger larva stays on the skin surface, inserting its mouthparts through the skin to feed on lymph fluid and cells digested by saliva that the chigger pumps into the wound. After feeding for 1-2 days, the larva dies. Humans are not the normal host for chiggers, and they are unable to survive. There are chigger species in southeast Asia and islands of the southwestern Pacific that are able to survive after feeding on humans. Even though the chigger dies, humans react to the feeding and saliva of the chigger with a small swollen area that itches. On normal hosts, this swelling and itching does not occur. On those hosts, the larvae feeds for several days, drops off the host, and molts to successive nymph and adult stages that are predators of other mites.

American dog tick – *Dermacentor variabilis*

American dog ticks are commonly called wood ticks. The larvae and nymphs feed on rodents and other small mammals. Adults feed on larger hosts, including people and dogs. Both unengorged males and females are reddish brown and about 3/16 inch long. Males have fine silver lines on the back and do not get much larger after feeding. Females have a large silver-colored area behind the head and will engorge on a blood meal to become ½ inch long.

Female (left) and male (right American dog tick

In Kansas, the adults are most active in May and June. They are especially numerous in brush or areas of tall grass, waiting for passing animals along roads, lanes, and trails. By September, the adults are inactive and are rarely observed. The American dog tick transmits Rocky Mountain Spotted Fever, tularemia, and possibly ehrlichiosis to humans.

Lone Star Tick – *Amblyomma americanum*

The lone star tick is more numerous in the southern half of the state. All 3 active stages, larvae, nymphs, and adults, feed on people and other mammals and also feed on birds. The larva is very tiny. The nymph is larger, being about pinhead sized. The nymph is the most common stage found on people. Adults are about 1/8 inch long and brown. The adult female has a white spot behind the head.

Lone star tick adult female

The 3 stages are active throughout most of the warmer months of the year and prefer wooded areas. Although capable of transmitting Rocky Mountain Spotted Fever, the lone star tick is not as often involved as the American dog tick. It is capable of transmitting tularemia and ehrlichiosis to humans.

Blacklegged Tick (Deer Tick) – *Ixodes scapularis*

Blacklegged tick adult

The blacklegged tick is commonly called the deer tick. All three active stages of the deer tick, particularly the nymph, feed on people. Eggs are laid by the adult female in the spring and the very tiny larva feeds primarily on white footed mice, obtaining a blood meal during the first summer. The following spring, the larvae molt into pinhead sized, brown nymphs that feed on mice and larger animals such as dogs, deer, birds, or people. In the fall, they molt into adults that feed primarily on deer, with the females laying eggs the following spring. Adults are reddish brown and about 1/8 inch long.

These ticks are found in wooded areas along trails. The larvae and nymphs are active in the spring and early summer; adults may be active in both the spring and fall. The blacklegged or deer tick can transmit Lyme disease and possibly ehrlichiosis to humans.

Protecting Yourself from Ticks:
Avoid tick infested areas. When going into tick infested areas, wear long pants with the cuffs tucked into your boots. Apply an insect repellent containing DEET (N,N-diethyl-m-toluamide), to socks, pants, and exposed skin areas. Wear light colored clothing so that ticks are more easily seen and removed. Periodically check each other for ticks on clothing and skin.

Attached ticks should be removed by grasping the tick with tweezers where the head enters the skin. Pull the tick out of your skin with slow, steady pressure. Wash the bite area with soap and water and apply an antiseptic to the site.

Scorpions – Order Scorpiones


Scorpion

Scorpions live under stones on sunny hillsides. They hunt insects at night, subduing them with a stinger located at the end of their long, jointed tail. Scorpions in Kansas are not deadly; their sting is much like that of a bee. Baby scorpions ride on the their mother's back for a length of time before going out on their own.

Harvestmen – Order Opiliones


Harvestman

Harvestmen or daddy-long-legs are common, with 19 species in Kansas. Harvestmen are most recognizable as those with bodies about 1/4 inch long with 8 spindly, thin legs. Many species have a leg-span of 2-3 inches. However, many species have much shorter, thicker legs. They have two eyes, located on a dorsal, raised area towards the front of the body. The cephalothorax is broadly joined to the abdomen, but segmentation is obvious. They have scent glands that release fluid with a disagreeable odor or taste which apparently is their main defense. Their legs also detach easily. Detached legs twitch, keeping a predator occupied while the harvestman makes its escape. Harvestmen are common in leaf litter and are associated with dead and live trees. Most species are predators, but there are scavenger and herbivore species. Harvestmen have small chelae (pincers) at the end of their pedipalps and large chelicerae that they use to subdue their prey; they do not have poison glands and do not produce venom. Unlike spiders, scorpions, mites, and pseudoscorpions, harvestmen can eat solid food.

Pseudoscorpions – Order Pseudoscorpionida


Pseudoscorpion

Like scorpions, pseudoscorpions, have 8 legs and have chelae (pincers) at the end of the pedipalps. They do not have an elongated abdomen with a sting at the end as do scorpions, but they can deliver a toxin through their chelae. They are small animals with most being about 1/8 inch long, but one common species is about 1/4 inch long. Being small, they are not likely to break the skin or deliver enough venom to be dangerous to humans. Pseudoscorpions are predators on mites and other small animals.

Class Myriapoda

Centipedes – Subclass Chilopoda


Centipede

Centipedes are elongate, fast-moving predators with one pair of legs on all of the body segments. Although their name translates to "hundred leggers," species typically have 15-23 pairs of legs, although they can have up to 177 pairs of legs. They have a head that contains one pair of antennae and

frequently simple eyes; some species have no eyes. The body is composed of many leg-bearing segments. The legs on the first body segment are modified into poison claws. The last pair of legs is greatly elongated and trails behind the animal. Centipedes are common under bark, logs, rocks, and leaf litter.

Millipedes – Subclass Diplopoda

Millipedes are elongate, hard-shelled, slow-moving scavengers and herbivores with two pairs of legs on most of their body rings, although some species are short and look similar to sowbugs. Each ring is made up of two segments. Although their name translates to "thousand legger," they typically have about 30 pairs of legs. The head has antennae and eyes. When they are disturbed or die, they curl up into a coil. They defend themselves with their hard shell and glands that emit a foul-smelling substance which contains hydrogen cyanide in some species. Millipedes are common under bark, logs, rocks, and leaf litter. Newly hatched millipedes have only three pairs of legs, but add body segments and legs as they grow and develop.

Millipede

Subphylum Crustacea

Crustaceans are primarily aquatic with most species in the world being marine, living in the oceans and other saltwater habitats. Most Kansas species are aquatic, with many of them belonging to the microcrustacea making up much of freshwater plankton. Water fleas, copepods, and seed shrimp make up 117 species of the 207 Kansas crustacean species. There are another 19 species of scuds, laterally compressed shrimp-like animals that live in the detritus of ponds and streams.

Microcrustaceans

Crustaceans have two pairs of antennae and their appendages are biramous, meaning that the legs appear to branched due to a leg-like structure on the second segment. They have two body regions, a cephalothorax and an abdomen.

Class Malacostraca

Sowbugs and pillbugs – Order Isopoda

Sowbugs and pillbugs feed as scavengers under bark, logs, rocks, and leaf litter, although some feed also on plants. They tend to look like tiny armadillos due to a series of wide, plate-like, segments. Pillbugs have rounded segments; they are capable of curling up into a ball. Sowbugs have flatter segments; they will curl for defense but do not form a ball. Some sowbugs are aquatic, living in the detritus of ponds and streams. Isopods have seven pairs of legs as adults and a very small abdomen.

Sowbug

Crayfish – Order Decapoda

Many of the 11 species of crayfish are aquatic, but several are semi-terrestrial, coming out of streams or burrows at night to feed on land or migrate across it. Crayfish have ten pairs of legs, with the first three pairs having chelae (pincers) on the end. The chelae on the first pair of legs are very large and obvious, with those on the other legs being small. Crayfish have a carapace that encloses much of the cephalothorax and helps protect the gills underneath from physical and drying damage. Adult crayfish are up to 6 inches long.

Crayfish

Web Site Resources

Insect Answers
http://insects.tamu.edu/extension/insctans/
Access a wide variety of printable publications for answers to insect questions.

Digital Dragonflies
http://www.dragonflies.org
Great photos on this site about dragonflies and damselflies and how they relate to water quality issues.

Entomological Society of America
http://www.entsoc.org

Xerces Society
http://www.xerces.org/
international nonprofit organization dedicated to protecting biological diversity through invertebrate conservation

Bugwood Network
http://www.bugwood.org/
Photographs of insects.

Forestry Images
http://www.forestryimages.org/insects.cfm
Photographs of insects associated with trees and forests.

Iowa State University Entomology Image Gallery
http://www.ent.iastate.edu/imagegallery/
Photographs of insects.

Meganeura, Paleontological Webpage
http://www.ub.es/dpep/meganeura/meganeura.htm
Information about fossil insects worldwide.

Ken Gray Image Collection
http://www.ent3.orst.edu/kgphoto/index.cfm
Photographs of insects.

University of Kentucky Entomology for Kids and Teachers
http://www.uky.edu/Agriculture/Entomology/yhfacts/entyouth.htm
Youth entomology resources.