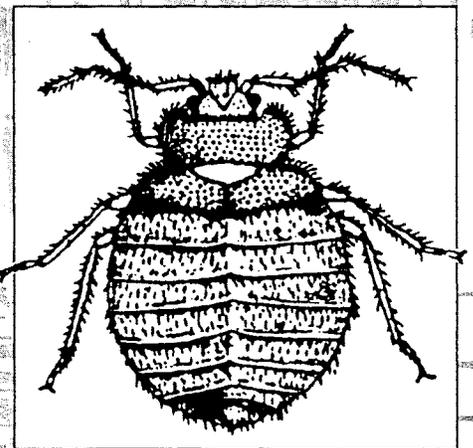
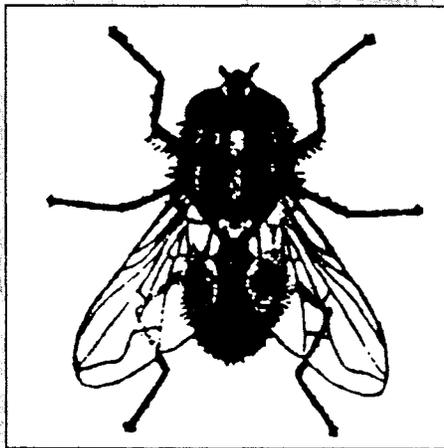
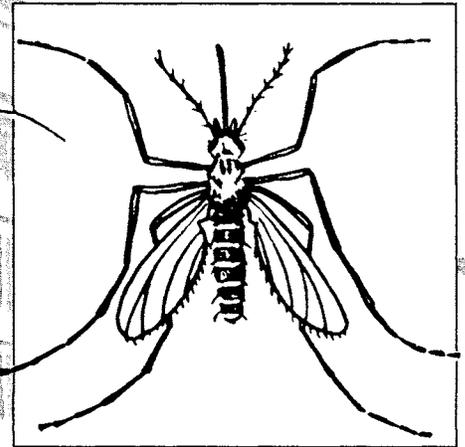
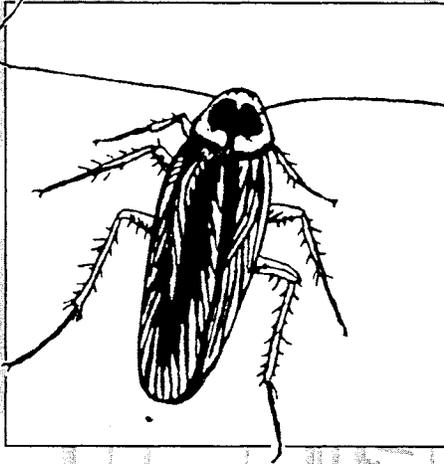


Public Health Pest Control



Directions

For Using

This Manual



his is a self-teaching manual. At the end of each major section is a list of study questions to check your understanding of the subject matter. By each question in parenthesis is the page number on which the answer to that question can be found. This will help you in checking your answers.

These study questions are representative of the type which are on the certification examination. By reading this manual and answering the study questions, you should be able to gain sufficient knowledge to pass the Kansas Commercial Pesticide Applicators Certification and Recertification examination.

Table of Contents

How Insects Affect Humans	2
Cockroaches	4
Sucking Lice	9
Bedbugs	11
Mosquitoes	13
Flies	20
Fleas	25
Ants	27
Stinging Insects	29
Mites	31
Spiders	34
Ticks	39
Skunks	45
Bats	48
Rodents	50
Birds	56

How Insects Affect Humans

Insects occur in the air, on and under soil, and in fresh or brackish water. They eat the leaves and roots of plants and bore into vegetation. Some insects live on other animals, as parasites or predators. Despite their small size, the combined bulk of insects may equal that of all other land animals.

More than 750,000 species of true insects have already been described. Mites, ticks and other close relatives of insects also total in the hundreds of thousands.

For centuries people have fought insects as pests, carriers of disease, and destroyers of food. This combat will continue, for humans have never eradicated a single species. Today, a number of the most important species are showing increasingly significant resistance to insecticides so that other methods of control, either alone or in combination with insecticides, are necessary.

Insects have a long history through many geological periods. They appeared in the world long before humans; yet insect fossils from coal, amber and limestone deposits differ little from their present-day descendants of 250 million years. As humans appeared on earth and changed, their parasites and pests evolved with them.

Insects are often thought of as human's most formidable competitors. Not only do they damage crops, but such insects as flies, fleas, lice and mosquitoes attack humans and domesticated animals directly as pests. Others attack indirectly by transmitting dangerous diseases to people and animals.

Transmission of Human Diseases

Although insect bites or stings occasionally cause severe illness or are fatal to humans and animals, their disease-laden saliva or contaminated bodies are responsible for many illnesses or deaths over the world.

Mechanical or passive transmission of disease occurs, for example, when the housefly merely transports organisms such as dysentery bacteria on its feet, body hairs and other surfaces, from filth to humans. Other examples include cockroaches and vinegar gnats that visit sewers and liquid excrement and then move to human habitations.

Biological transmission of disease occurs when an insect, mite or tick is essential for the completion of the life cycle of the disease or parasite. Certain *Anopheles* mosquitoes, for example, are essential carriers and spreaders of the malaria parasite. This parasite undergoes a portion of its life cycle in the *Anopheles* carrier and another portion in the human host.

Disease is also transmitted through the **host-vector relationship**. Such transmission is often further complicated by more than just the direct carrier of the disease from one host to another. Some other hosts called reservoirs are not affected by the disease but are able to perpetuate the disease organism by providing safe harborage for the disease organism. Some birds, for example, are reservoirs of mosquito-borne encephalitis (sometimes called "sleeping sickness"). The birds are apparently unharmed by the encephalitis virus, but when the mosquito sucks blood from the bird and then bites man or horses, the virus may produce serious or fatal results.

Insects generally cannot transmit diseases unless they have already bitten a diseased host. For example, an *Anopheles* mosquito cannot transmit malaria unless it has first bitten a person with the malaria parasite. (In

How Insects

Affect Humans

addition, there is often an "incubation period," a period between when the disease is picked up by the insect and the time when it is able to transmit the disease.) Some ticks and mites, however, are able to transmit disease-causing organisms, such as the rickettsiae causing Rocky Mountain spotted fever, directly to their offspring through the egg.

Myiasis is the infestation of humans or animals by living larvae (maggots) of flies. Maggots mostly infest dead tissue. An example of the other type is the "true screwworm," which attacks the living tissue of livestock, and rarely humans. The maggots of some flies, including the rat-tailed maggots of flower flies, may be accidentally swallowed, causing intestinal upsets.

Poison, Irritation and Allergy

Many insects and some spiders, scorpions, and centipedes, have developed poisoning mechanisms for self-defense or for paralyzing their prey. Stings and bites may be intensely irritating to humans but seldom cause death in Kansas.

Probably the most dangerous are the bites of the black widow spider, *Latrodectus mactans*, and the sting of a small scorpion, *Centruoides sculpturatus* found in the Southwest. The brown recluse spider, *Loxosceles*

reclusa, is common in Kansas and may inflict a serious bite, often resulting in so much dead tissue that skin-grafting is needed. Even the stings of bees and wasps may be serious, or even fatal to persons highly allergic to their venoms.

Some insects, such as the puss caterpillar, io moth, and saddle back, have "urticating hairs" rather like those of stinging nettles. Cantharidin, present in the blood of certain beetles such as the blister beetles, causes painful blistering of the skin when the insect is crushed. Mosquitoes, fleas, chiggers and other pestiferous creatures have done much to affect peace of mind.

Entomophobia

Entomophobia means excessive fear of insects. Many household pests do little or no actual harm but arouse intense feelings of revulsion in susceptible people. Persons with feelings of repugnance and imaginary "bites" and other feelings must be handled with care by the sanitarian.

Reasoning and proof of pest problems seldom satisfy persons affected by entomophobia. These people are sincere in their belief and should be handled with respect. Medical attention is often necessary. Some definite control efforts should be taken to eliminate any role that insects and related arthropods may play.

Cockroaches



Cockroaches are some of the oldest insects, as indicated by fossil remains dating to 200 million years ago. This ability to survive the many changing environments through time illustrates the capability of these insects to adapt to wide ranges of habitats and living conditions.

Although cockroaches have not been incriminated as direct carriers of diseases, they do contaminate food and kitchen utensils with excrement and salivary secretions and leave an unpleasant odor. Cockroaches sometimes produce allergic reactions in humans. The allergy is due to roach parts (proteins), not the odor.

Biology and Behavior

Cockroaches develop by gradual metamorphosis through three life stages: egg, nymph and adult. Adult females produce small, bean-like capsules or oothecae which contain the eggs. These capsules usually are dropped or glued to some surface by the female soon after they are formed. (The female German cockroach carries the capsule protruding from her body until the eggs are ready to hatch.)

Nymphs which hatch from the eggs and emerge from the oothecae resemble adult roaches, except that they are smaller and do not have fully developed wings. Their flattened bodies and long, spiny legs enable them to run rapidly and to squeeze into crevices and other hiding places.

Nymphs molt several times, and finally mature males and females appear. As indicated in Table 1, the time required to complete the life cycle varies from about 2 months to nearly 3 years, depending on the species and environmental conditions.

Most cockroaches are tropical or sub-tropical and generally live outdoors. However, some species have become well-adapted to living with man. Though it is true that dirt, filth and grime are what they like best,

Table 1. Life-History of Four Common Cockroaches in Kansas

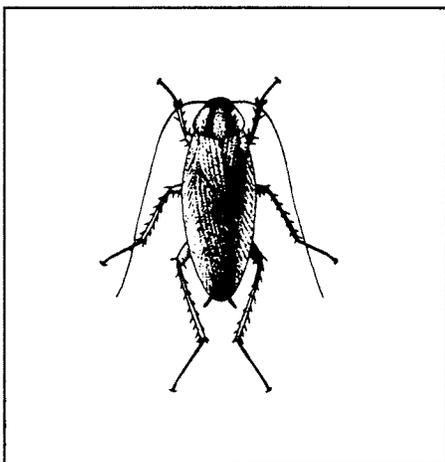
	Average number of eggs per capsule	Average number of capsules produced per female	Length of Life cycle (days)	Average longevity of adults (days)	Approximate number offspring possible per year beginning with one female
German	37	7	60-250	140	35,300
American	15	58	320-1070	440	810
Brownbanded	16	10	140-380	110	680
Oriental	14	14	210-990	100	200

roaches at times infest even the most sanitary and well organized homes and buildings.

Cockroaches can enter buildings in infested boxes, grocery bags, beverage cartons, furniture and dried pet foods. They also can enter around loose-fitting doors and windows, where electrical lines or water and steam pipes pass through walls, in seasoned firewood, and through sewer lines.

Most roaches are nocturnal and appear during daylight only when disturbed or where there is a large population. They prefer warm, dark, humid shelters and often are found around the kitchen sink or drainboard; in cracks around, under or inside cupboards and cabinets; where pipes or electrical wiring pass along or through a wall; behind window or door frames, loose baseboards or molding strips; on undersides of tables and chairs; in upholstered furniture; in bathrooms; in radio and TV cabinets; and in motor compartments of refrigerators, washing machines and other appliances.

Cockroaches feed on a variety of plant and animal products, including meat and grease, starchy foods, sweets, baked goods and other unprotected kitchen goods. They also feed on materials such as leather, wallpaper paste, book binding and sizing.



German Cockroach
(*Blattella germanica*)

Cockroaches

Common Species

There are about 55 species of cockroaches in the United States, but only five species are routine problems in buildings. Most of the other species live outdoors and therefore escape notice. If brought into the building, they either leave or die. Unfortunately, the remaining five species of cockroaches favor the buildings of humans as a home—reflecting the close relationship humans have had with cockroaches since they moved into their first cave. (See appendix pages 69 and 70.)

German Cockroach (*Blattella germanica*)

The adult German cockroach is light brown and $\frac{1}{2}$ to $\frac{5}{8}$ -inch long. The head shield is marked with two dark stripes that run lengthwise on the shield. Adults are fully winged but rarely fly. Nymphal German roaches are smaller and darker than adults and are wingless.

The German cockroach is the most prevalent roach in Kansas and is more active than other domestic species. As indicated in Table 1, the German cockroach produces more eggs per capsule than other species and has a developmental period as short as 2 months. Thus, troublesome infestations can develop rapidly after the introduction of a few individuals.

The German cockroach is the only domestic species in which adult females carry egg capsules protruding from their abdomen until the eggs are ready to hatch. In fact, few eggs will hatch if the capsules are detached from the female more than a day or two before hatching takes place.

These roaches thrive in all types of buildings but are found most often in homes and commercial food establishments. They usually enter tightly constructed homes with bottled drinks, potatoes, onions, dried pet foods, grocery sacks, corrugated cartons and even furniture. German roaches usually seek dark shelters

near moisture and food in kitchens and bathrooms. However, when populations become large and food is scarce, they can be found in bedrooms and other less likely places.

American Cockroach (*Periplaneta americana*)

The American cockroach is the largest of the common species, growing to a length of $1\frac{1}{2}$ to 2 inches. It is reddish brown with a light yellow band around the edge of the head shield. Adults of both sexes have well developed wings but seldom fly. However, they are capable of gliding flights. Nymphal roaches are smaller than adults, grayish brown and not fully winged.

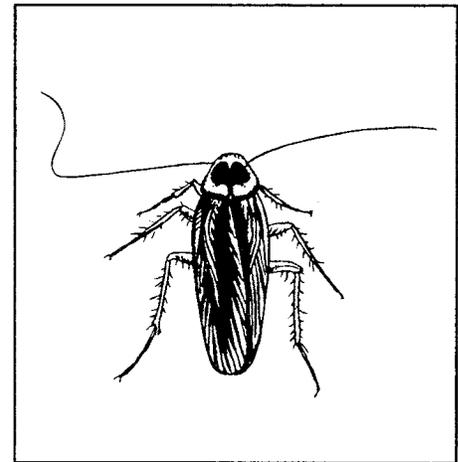
The adult female usually drops her egg capsule within a day after it is formed. The capsule often is dropped near a food source or in locations where it can be covered with miscellaneous debris. Occasionally, the capsule is glued to some surface with secretions from the female's mouth.

American cockroaches thrive in homes, commercial establishments and other buildings that provide favorable shelter and an ample food supply. They live mainly in dark, moist sites in kitchens, bathrooms, basements, steam tunnels and sewers.

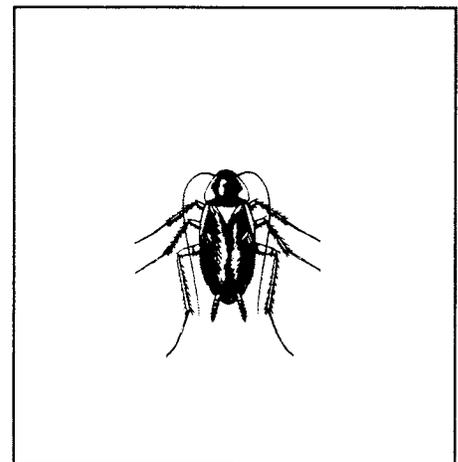
Brownbanded Cockroach (*Supella longipalpa*)

The brownbanded cockroach is light gold to glossy dark brown, and $\frac{1}{2}$ - to $\frac{3}{8}$ -inch long, with transverse yellow bands across the base of the wings and across the abdomen. The wings of adult males cover the abdomen, while the female's wings are shorter. The yellow bands across the back are more pronounced on nymphs than on adults.

These roaches are quite active and the adults fly readily when disturbed. Both adults and nymphs may jump when attempting to escape danger. The adult female carries her egg capsule for only a day or two before gluing it to protected surfaces such as



American Cockroach
(*Periplaneta americana*)



Brownbanded Cockroach
(*Supella longipalpa*)

Cockroaches

the undersides of tables and furniture, inside upholstered furniture and closets, and sometimes to ceilings in darkened rooms.

Brownbanded roaches are more apt to be found in homes, apartments, hotels, motels, nursing homes and hospitals than in restaurants, grocery stores and other commercial establishments. They prefer starchy foods and appear to have lower water requirements than other roaches, so they can occupy many different locations within a building. Consequently, nymphs and adults frequently are found on ceilings in dark or dimly lighted rooms, behind picture frames, in light switches, in upper walls of cabinets and closets, on undersides of furniture, and inside upholstered furniture.

Because brownbanded cockroaches do not confine their activities to well-defined areas in the home or building, control may be difficult.

Oriental Cockroach (*Blatta orientalis*)

Adult oriental cockroaches are glossy dark brown to black. Females are nearly 1¼ inches long and males are 1 inch long. The male has wings that cover most of the body, while the female has rudimentary wings that are reduced to mere lobes. Neither sex can fly. In fact, these roaches are rather sluggish and do not move very fast even when disturbed. Nymphal roaches are smaller than adults, dark brown to black, and have wings stubs that lack a definite venation.

The adult female oriental cockroach usually carries her egg capsule for about a day then it is dropped or attached to a protected surface near a food supply. These roaches appear to have a seasonal cycle in their development. Adults are more abundant in the spring; hence, mating is most frequent at this time. Natural mortality usually reduces the number of adults in the population during the summer, fall and winter.

Nymphs and adults usually are found near decaying organic matter. During warm, humid weather they inhabit lawns, compost piles, flower

beds and dumps. However, in periods of drought or with the approach of cool weather, there is a mass movement into homes and other buildings. In buildings, these roaches inhabit high moisture areas such as sewers, drains and dark, damp basements. Their activities are somewhat restricted to the ground or below ground levels in buildings.

Pennsylvania wood roach

(*Parcoblatta pennsylvanica*)

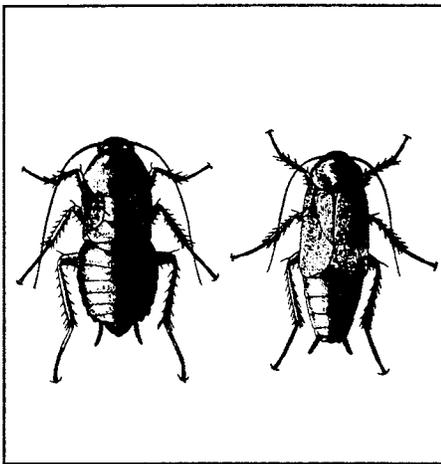
These insects are not a normal home-dwelling species, but the males are attracted to lights or will invade rural or suburban homes in the spring. Although they usually do not nest inside, they enjoy the warmth of the home and the crumbs in the kitchen. In some areas, particularly wooded areas, the Pennsylvania wood roach is a definite, but seasonal, problem.

Control

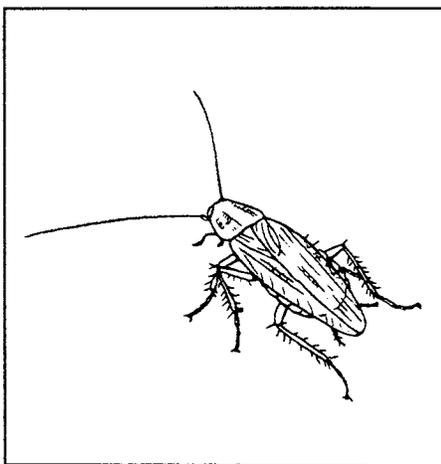
The control of cockroaches requires much care and planning. Taking precautions to prevent the invasion of cockroaches into a home or building works better than applying insecticides to control an established population.

Cleanliness in the home and elimination of favorable breeding sites will lessen greatly the possibility of cockroach infestation, but these practices will not always prevent infestation from outside. Cockroaches can survive in even the most sanitary environment once an infestation is established.

Because various combinations of cockroaches can occur in the same building, it is essential to accurately identify the species present. This will permit use of control measures that take advantage of behavioral patterns and life requirements of the particular species. For instance, for control of the widely dispersed brown-banded cockroach, chemicals must be applied over greater areas of a home or building than for control of the more restricted Oriental or American roaches.



Oriental Cockroach
(*Blatta orientalis*)



Pennsylvania Wood Roach
(*Parcoblatta pennsylvanica*)

Non-Chemical Control

Non-chemical measures include:

- Keeping tight-fitting windows and doors; caulking cracks in outside walls, sills and foundations.
- Sealing all openings where electrical lines or water, steam and cooling pipes pass through walls and floors to slow the movement of roaches into a home or building.
- Inspecting beverage cartons, boxes, dried pet foods, potatoes, onions and firewood to avoid bringing roaches into the home.
- Repairing plumbing leaks and sealing other moisture sources.
- Keeping the premises clean by removing all food crumbs, garbage, etc. to containers with tightly fitting lids.

Chemical Control

To effectively control cockroaches with insecticides, it is necessary to inspect closely for their shelters and treat these locations thoroughly. Regardless of the insecticide or formulation chosen, chemicals placed in or near regular hiding places will provide much better control than those placed where roaches move only occasionally.

Present methods of insecticidal control generally provide temporary control within treated structures. Since some roach species invade homes and buildings from outside, reinfestation can occur once the insecticide has dissipated. To solve this problem, outdoor populations also must be controlled. For example, when wood roaches become numerous in the home, use of chemicals inside will provide short-term control. Locating, treating or removing outside shelters can provide effective long-term control.

To eliminate an established infestation from a home or building, first remove all routes of reinfestation, then thoroughly clean the home and apply an approved chemical. The type of chemical selected and the application method used will depend

on the location and nature of the infestation. No one chemical is best suited for handling all roach problems, but the various types available present a combination that is effective.

Each cockroach problem must be studied and control measures used in accordance with the location, extent and nature of the infestation. With a range of chemicals, formulations and application techniques available, it is important to select the appropriate combination to provide the desired control.

Residual Sprays. Residual sprays are formulated as oil-base or water-base emulsions or as water-base suspensions (wetable powders). Oil-base sprays may stain floor tiles and painted surfaces, deform carpet and other rubber pads and become fire hazards near open flames. Water-base emulsions are easy to mix, but may stain wallpaper, light-colored carpets and certain other surfaces. Furthermore, they can short-out electrical circuits and are inferior to oil-base sprays on impervious surfaces such as glass and metal. Wettable powders need near-constant agitation in the spray tank, but they leave the most active residues, especially on porous surfaces.

Residual sprays are easy and fast to apply and should be used in cockroach shelters with attention to cracks and crevices. Usually, exposed surfaces are not treated with sprays, although it may be necessary to treat surfaces over which roaches crawl. Apply sprays just to the point of runoff to minimize chances of staining and reduce pesticide waste.

Dusts. Dusts sometimes can be used as the total treatment for cockroaches, but are most often used as a supplemental treatment. Dusts generally have longer residual action than sprays, but are ineffective if they become damp. Usually, dusts are less hazardous to people than sprays because they are not absorbed through the skin as easily.

Cockroaches

Dusts are useful in roach control because they can be placed deep into cracks, crevices and wall voids; under refrigerators and furniture; around pipes, tunnels and conduits; on very smooth or very rough surfaces; and in other places not treatable with other formulations. Do not use for treating large surfaces because they leave unsightly deposits. Also, heavy deposits are repellent to cockroaches; they will not walk through thick layers of the material. Use light pressure on the application device to minimize dust particles in living areas.

Baits. The least important part of a bait is the insecticide. If roaches will not feed on the bait, the insecticide will have no effect. Thus, it is important not to contaminate stored bait with organic solvents, other insecticides, fungicides, fertilizers, etc.

Baits are usually long lasting and often can be applied to areas that cannot be effectively sprayed or dusted. In many situations, baits seem to be most useful when used in conjunction with a residual spray or dust. Baits provide best results in buildings where there is no other food supply.

Aerosols. Aerosols are most useful for identifying the location and extent of cockroach infestations. They have no residual effect, so must be used in conjunction with residual sprays or dusts. Squirting small amounts of aerosols into hidden areas and shelters will force roaches to evacuate. This helps determine the areas of infestation and also forces roaches to move across previously treated surfaces.

STUDY QUESTIONS *for pages 2-8*

Introduction and Cockroaches

- (2) Close relatives of insects are:
 - mites
 - ticks
 - spiders
 - all the above
- (3) Spider, scorpion and centipede bites on humans in Kansas, _____ cause death.
 - never
 - seldom
 - usually
 - always
- (4) Immature cockroaches are called:
 - maggots
 - nymphs
 - larvae
 - pupae
- (4) Cockroaches can enter buildings in:
 - boxes, bags, furniture
 - loose fitting doors, windows
 - firewood, sewer lines
 - all the above
- (5) The _____ cockroach is the only one which carries the egg capsule protruding from the abdomen.
 - German
 - American
 - Brownbanded
 - Oriental
- (5) The adult female American cockroach usually drops the egg capsule within _____ after its is formed.
 - one day
 - three days
 - five days
 - seven days
- (6) Adult oriental cockroaches are most abundant in the _____.
 - spring
 - summer
 - fall
 - winter
- (6) Home cleanliness and elimination of breeding sites _____ cockroach infestations.
 - increases
 - lessens
 - has no affect on
 - none of the above
- (6) Chemicals must be applied over the greatest area of the home to control the:
 - American cockroach
 - German cockroach
 - Brownbanded cockroach
 - Pennsylvania wood roach
- (7) Residual sprays for cockroach control are formulated as:
 - oil-base sprays
 - water-base emulsions
 - wettable powders
 - all the above
- (7) Dusts generally have a _____ residual action for cockroach control than sprays.
 - shorter
 - equal
 - longer
 - are not used in roach control
- (8) The least important part of the bait for cockroach control is the:
 - attractant
 - insecticide
 - placement
 - roach species

Sucking Lice

There are two "orders" of lice: the "sucking lice" (*Order Anoplura*) that suck blood and to which the three species of lice attacking humans belong; and the "chewing lice" (*Order Mallophaga*), which feed on skin, scales, scabs, dried blood, feathers, etc., most living on birds. They affect humans rarely, only in such cases as when they crawl on hands while handling chickens. Both orders are wingless and undergo gradual metamorphosis: egg hatches into a nymph; sheds its skin three times, each time getting larger; and finally attains adulthood. The remaining discussion pertains to the three species of sucking lice that attack humans.

Sucking lice have been intimately associated with humankind for centuries. Some infestations occur even today despite better health practices, including frequent bathing and clothes washing. Public health agencies are called upon, particularly if infestations include or expose large groups of people, especially those in public institutions such as schools, jails and certain hospitals or homes for the aged.

The three sucking lice that attack people are (1) the body louse, *Pediculus humanus humanus* (the "grayback" of the Civil War, the "cootie" of WW I, not named in WW II because it was not common due to greater sanitation and use of insecticides); (2) the head louse, *Pediculus humanus capitus*; (3) and the crab louse, *Phthirus pubis* (also known as the "crotch cricket"). Sometimes the two subspecies of *Pediculus* are considered to be separate species.

The body louse is involved in epidemics of louse-borne typhus, trench fever and a type of relapsing fever.

All three species cause "pediculosis," characterized by irritation and evidence of louse feeding, sometimes leading to scratching, secondary infection, and scarred, hardened and pigmented skin. In many countries

pediculosis is associated with tramps and migrants and is known as "hobo's disease."

An outbreak of any or all of the three kinds of lice may originate with people who wear the same clothing too long, fail to bathe regularly, or do not wash and groom their hair, and then it may spread to the general population through contact in schools or society.

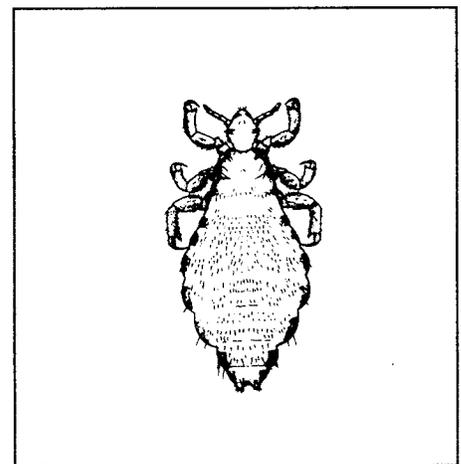
The head bears a pair of eyes, mouthparts, and a pair of short, four-segmented antennae. The mouth is encircled by six pairs of hooks, which the louse uses to attach into the skin during feeding. There is also a retractable, soft haustellum with piercing stylets to open the wound and a salivary duct. There is a claw and an opposing "thumb" on each of the three pairs of legs, for grasping the host's hair or clothing.

The egg has a distinct cap through which the young louse emerges during hatching. When the eggs are glued to hairs, they are called "nits." Most nymphs differ from adults by being smaller, having fewer body hairs and fewer hardened plates. Females are usually larger than males and the tip of the abdomen is notched or bilobed. Males have the tip of the abdomen rounded with a somewhat cigar-shaped genitalia often visible through the body wall.

When ready to feed, the louse anchors its mouth to the skin, stabs an opening through the skin, pours saliva into the wound through the duct and sucks blood into its digestive system. Human lice feed only on human blood. They suck blood for long periods, but do not ordinarily become noticeably engorged. Some individuals feed too avidly, causing rupture of their digestive system that leads to death. During feeding, dark red feces may be deposited on the skin.

Head lice are confined to the head hairs and scalp, and the eggs are fastened to the hairs.

Body lice are found on hairy parts of the body below the neck, with



Body and Head Louse

Sucking Lice

adult and young lice and eggs frequently on clothing, especially along the seam of the inner surfaces.

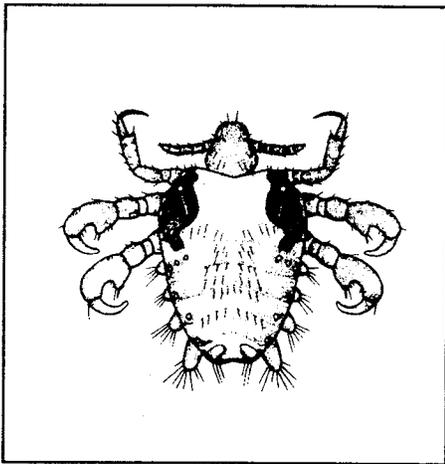
Crab lice are found in the pubic and anal regions and occasionally in the armpits, on eyebrows or in beards.

Lice are transmitted from an infested person to another by direct contact, and indirectly by contact with personal belongings, especially combs, clothing, head gear and bedding. Animal lice normally do not infest people.

Body Lice

Most body lice are on the inner surface of the clothing, next to the skin. Females tend to congregate along seams for egg laying. Some adults migrate from the skin to the outer garments, hence to other persons. Head and body lice can move fairly rapidly and will pass from host to host or from one host to bedding by simple contact.

It is difficult to find human lice and crab lice except on, or closely associated with humans. Beds occupied every night by unsanitary individuals have more chance of being lousy. If unoccupied for several nights, they tend to be free of lice. Hairs with eggs attached may be blown about. Lice tend to leave a feverish human and seek another human.



Crab Louse

Head Lice

Adult and young head lice are seen less frequently than the eggs which are fastened to the hairs, particularly those behind the ears. Foreign material in the hair and "hair casts" have been mistaken for eggs. A hair cast is the inner hair root sheath which has slid along the hair shaft.

A number of cases of "pseudopediculosis" (false pediculosis) have

been reported in which solidified globules of hair spray were confused for eggs. The louse egg seen through a microscope is easily distinguished from other objects by distinct characteristics: the ring at the base of the egg by which it is fastened securely to the hair, the egg itself, frequently with an embryo visible inside, and the cap (operculum) with definite pores.

Crab Lice

The crab louse, *Pthirus pubis*, is often incorrectly spelled *Phthirus pubis* or *Phthirius pubis*. Relatively few details of its biology are known because crab lice are difficult and unpleasant to rear in the laboratory.

The life cycle of the crab louse is similar to that of head and body lice. The eggs are glued to hairs but are smaller and have a more convex cap than do *Pediculus*. There are three nymphal stages. All stages move less than those of head or body lice. They tend to settle down at one spot, grasping hairs with the legs of both sides of the body. They differ from the other two species by having the first pair of legs relatively small. They insert the mouthparts, sucking blood intermittently for many hours at a time.

Crab lice are spread chiefly by sexual contact, but may be acquired by other means such as infested toilet seats and beds and by close personal contact. There appears to be a resurgence in the number of cases of infestations, related to the present worldwide climate of cultural permissiveness. Small children may become infested with crab lice on their eyebrows or eyelashes from their mothers or nurses or through contact with adults with facial infestations.

Bedbugs

The bedbug, *Cimex lectularius*, has been prevalent in Europe for centuries and in this country since early colonial days, although apparently unknown to the American Indian. The adult is reddish brown, 1/8-inch long and 1/4-inch wide. The flattened oval body is adapted for hiding in narrow crevices.

The head bears a pair of four-segmented antennae and piercing-sucking mouth parts which, when not in use, fold to lie between the first pair of legs. The wings are represented by mere pads. The body becomes greatly enlarged and blood-red during a blood meal. The eggs are cemented to bedding or in cracks. Development from the egg through a series of nymphs to the adult takes 18 to 56 days. Adults normally live 6 months to a year. The female may live nearly a year without food and can endure freezing temperatures for considerable time.

Bedbugs are found on clothing and possessions of infested humans. They commonly hide in such places as seams of mattresses, cracks in beds and inside coils of coil-spring mattresses. They also occur on poultry and may be abundant in farmers' markets. A heavily infested house has a distinctive odor.

Some people are very sensitive to bedbug bites, while others are hardly aware of them. Immediately after feeding the bedbug defecates, passing out a semisolid, sticky remains of the last meal. These resulting spots provide a good clue to their presence. As yet, the bedbug has not been incriminated in the transmission of any com-

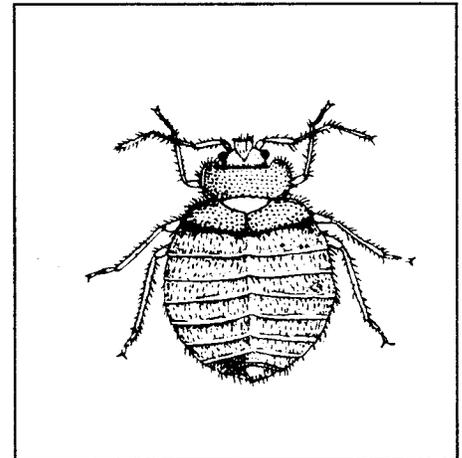
municable disease. Bedbugs may cause nervous disorders in sensitive people and may otherwise contribute to ill health. Humans are the preferred host but bedbugs will feed readily on poultry, mice, rats and other animals.

Control

To control bedbugs, caulk or otherwise eliminate all possible cracks and spaces behind baseboards, paneling, loose wall paper and other hiding areas in infested rooms. Baseboards, closets, wood paneling and other places that harbor bedbugs but cannot be eliminated should be thoroughly sprayed with an insecticide registered for bedbug control. Apply a heavy film of insecticide into cracks but a lighter film to exposed surfaces. Avoid spray run-off. Ventilate the room while spraying and during drying. Follow the directions for use and precautions on the label of the insecticide container.

Children should not play in rooms with treated baseboards and other exposed surfaces for several days.

Treat the frame, slats and springs of beds. Apply a light mist to seams, tufts and folds of mattresses, but not to the entire mattress surface. Allow 4 hours for the spray to dry before covering it with sheets. Upholstered furniture should be sprayed or dusted lightly, only along the edges and seams of cushions, and the inside (hidden) framework. Sit-on or arm rest areas do not need treatment. Do not use treated furniture until thoroughly dry; or, preferably, vacuum it thoroughly to remove loose and excessive amounts of chemical before the furniture is used.



Bedbug

Bedbugs

STUDY QUESTIONS *for pages 9–11*

Sucking Lice and Bedbugs

1. (9) There are _____ species of sucking lice that attack humans.
 - a. 1
 - b. 2
 - c. 3
 - d. 4
2. (9) An outbreak of _____ lice may originate with people who wear the same clothing, fail to bathe, or do not groom their hair.
 - a. body
 - b. head
 - c. pubic
 - d. all the above
3. (9) Human lice feed only on:
 - a. blood
 - b. hair
 - c. skin flakes
 - d. ear wax
4. (10) Most body lice are found:
 - a. on the person's head
 - b. on the inner surface of clothing
 - c. along clothing seams
 - d. b and c above
5. (10) Head lice eggs can be distinguished from other objects by their:
 - a. ring at the base of the egg
 - b. embryo visible inside
 - c. cap with definite pores
 - d. all the above
6. (10) Crab lice are spread primarily by:
 - a. toilet seats
 - b. bedding
 - c. sexual contact
 - d. close personal contact (non-sexual)
7. (11) The adult bedbug is _____ in color.
 - a. orange
 - b. reddish brown
 - c. gray
 - d. transparent
8. (11) Adult female bedbugs can live nearly _____ with out food.
 - a. a year
 - b. 9 months
 - c. 6 months
 - d. 3 months
9. (11) While humans are the preferred hosts of bedbugs, they will also feed on:
 - a. poultry
 - b. mice
 - c. rats
 - d. all the above
10. (11) When spraying an insecticide for bedbug control on beds, you should spray the:
 - a. frame
 - b. slats
 - c. springs
 - d. all the above



Mosquitoes are mainly blood-sucking pests, but also transmit certain diseases when the disease-causing organism is present.

There are about 50 species of mosquitoes in Kansas—1,600 to 2,500 species in the world. There are more species in the tropics, but the greatest numbers of mosquitoes occur in the Arctic.

Habits and habitats vary widely among species. Only the females suck blood. The males feed mainly on the nectar of flowers. Females of most species suck the blood of warm-blooded animals and humans, although a few feed on cold-blooded animals. Females of some species feed on nectar of flowers.

Mosquitoes belong to the family *Culicidae*, a family within the order *Diptera* or two-winged flies. Thus, mosquitoes are “flies” but this name is usually used for more highly developed or specialized *Diptera* such as house flies, blow flies and horse flies.

The mosquito family is divided into genera (singular is genus) and species (which can mean either singular or plural and hence species can refer to one, two or more kinds of mosquitoes). The scientific name of a species is composed of a genus name, which has the first letter capitalized, and the species name which does not have the first letter capitalized. Scientific names are underlined or are in italic letters. For example, the scientific names of three important species are:

- *genus and species*
- *Culex tarsalis*
- *Aedes vexans*
- *Anopheles quadrimaculatus*

Species of mosquitoes are designated by their scientific name (genus and species). Common names are seldom used.

The mosquito family may also be divided into “Anophelines” which includes only the genus *Anopheles* in the United States, and “Culicines” which includes all other genera.

Sometimes the habitats and habits of species within a genus are so similar that only the genus name is used.

Biology

Mosquitoes have four stages to complete their life cycle: (1) eggs, (2) larvae or “wrigglers,” (3) pupae or “tumbler,” and (4) the winged adults.

The main differences between Anophelines and Culicines are illustrated on page 71, using the genus *Anopheles* to illustrate Anophelines and the genera *Aedes* and *Culex* to illustrate Culicines. It is usually not necessary to use these two categories except in large-scale control programs, particularly during outbreaks of pest mosquitoes (*Culex*, *Aedes*, etc.) or when disease transmission is involved. *Anopheles* seldom is numerous enough to be a pest but transmits malaria. In either case, identification to genus and species by a specialist is usually required.

Eggs. The adult female lays several dozen or several hundred eggs. *Anopheles* and *Culex* species lay their eggs on the water surface, while eggs of *Aedes* and *Psorophora* are usually laid on damp mud or dry soil which will eventually be flooded. Eggs may be laid in “rafts,” which consist of numerous eggs glued together, standing on end (example *Culex*), or singly (examples *Anopheles*, *Aedes*, *Psorophora*).

Eggs may hatch in as little as 2 or 3 days, or may remain dormant for weeks or months until they come in contact with water. The surfaces of eggs of various species are different in appearance but the differences are slight and eggs are difficult to find in the field.

Larvae. Larvae shed their skins four times, each successive stage becoming larger. They are called first, second, third and fourth instars. Usually only fourth instars can be used to identify species, and then only with a microscope.

Mosquitoes

Larvae have a distinct head, a widened thorax, and a more slender abdomen. There are no legs. The color may vary from almost clear to some light shade of brown; from gray or green to nearly black.

Most genera (except *Coquillettidia*) obtain air through an air tube or "siphon," which breaks the water surface. All genera except *Anopheles* hang, head downward, at an angle from the water surface. *Anopheles* have no distinct air tubes but lie horizontally just under the water surface and obtain air through two openings or "spiracles" near the end of the abdomen.

Culicines "wiggle" when disturbed or when feeding, going downward part way or all the way to the bottom. Anophelines more often wiggle rapidly just under the water surface, but they, too, can dive.

The food consists of particles of organic matter, algae, bacteria and other small parts of animals or plants. Anophelines turn their heads around 180 degrees, and by moving their mouth brushes, cause a surface current containing food to pass to their mouths. The Culicines dive downward to feed, usually along the bottom, also using mouth brushes.

Under favorable conditions, many pass through all four instars in 5 to 10 days. A few species living in shallow, temporary water may take only 4 days.

Pupae. The larvae transform into pupae. The individuals gradually change from larvae to adults inside the pupae. Pupae do not feed. They are "comma-shaped" and obtain air through a pair of air tubes on the back. They dive rapidly when disturbed, hence the name "tumblers," propelling themselves by "tail paddles." The adults emerge through a split down the back of the pupae.

It ordinarily takes 2 or 3 days in the pupal stage. The older the pupae, the darker their color. Pupae can be identified to genus and sometimes to species but identification is difficult and usually impractical because of their short life.

Adults. Adults emerge from pupae by pulling themselves upward and outward from the floating pupal skins, on which they perch until their wings are dry and they are ready to fly.

Adults are small, soft-bodied and slender, with distinct head, thorax and abdomen. Their legs are long and slender. Other closely related families are also mosquito-shaped (midges, crane flies, fungus gnats, etc.), but mosquitoes can be recognized by numerous scales on the veins of the wings (which can be seen only by a hand magnifying lens or microscope). The antennae of the males are feather-like, while those of the females have whorls of hairs seen by magnifying lens or microscope. The proboscis or beak is long, extending forward and downward. All but the Anophelines have a pair of short palps on either side of the proboscis.

Adult species vary considerably in size and markings. Markings are the result of arrangements of scales on the body and wings (white to gray to black); hence any rubbing off of these scales makes them more difficult to identify.

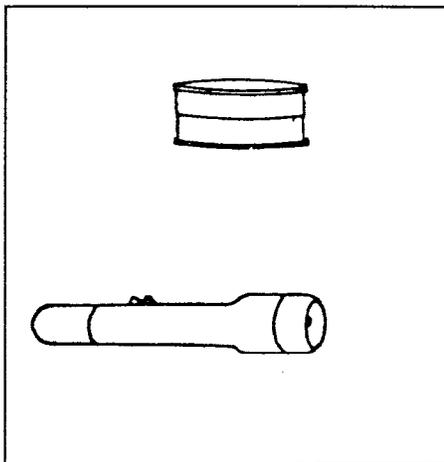
Males have a relatively short life span, often no more than a week. Females may live from 2 to 4 weeks, particularly if the humidity is high. (Species which over-winter as adults, of course, live several months).

Adults have a wide range of habits among the species. Some bite at night and on cloudy days, most commonly between twilight and sunrise; others during bright days, particularly in the shade. Some bite without warning while others are heard flying before they bite.

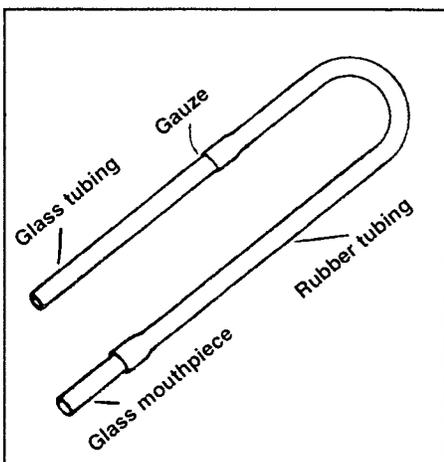
Adults have a wide range of flight from where they emerged from the water, varying from a few feet to several miles. Most mosquitoes do not fly far from where they emerged.

Seasonal Cycles

During the intermittent rainfall conditions, some species may undergo two to six generations a year.



Equipment for mosquito surveys. Top: pillbox. Bottom: Flashlight for collecting adults.



Survey equipment. Aspirator for collecting adults.

Mosquitoes

Some females overwinter as adults, in basements, caves, brush and debris, animal burrows and other protected places, flying and laying their eggs in the spring and then dying (examples: *Anopheles*, *Culex*). Others such as *Aedes* and *Psorophora* pass the winter in the egg stage.

Habitats

Larvae. Knowledge of the habitats of larvae is the principal basis for the most efficient control because the larvae are still confined to water. Favorite habitats are standing water with no wave action (often called stagnant), emergent vegetation or floatage of vegetation and other organic materials along edges of ponds. Shallow water is generally preferred.

Larvae do not live in open areas of ponds, lakes or flowing streams although flight from nearby water where they develop leaves this impression.

Impoundments, roadside ditches, seepage from irrigation ditches, tail-water pits from irrigation, low areas in irrigated fields, and animal troughs are common sources of larvae. Areas may be dry most of the time but sometimes maintain water after rains long enough to permit the completion of a life cycle.

Other examples of the more temporary types include tire ruts, water-filled hoof prints, depressions with the bottom containing leaves, grass or debris, and small, temporary water following recession of rivers and streams after flooding. These may have little or no vegetation.

Tree holes resulting from rotting of stumps or limbs when filled with water are a source of some species. Containers such as tin cans, rain barrels, fire barrels, old tires, automobile junkyards, clogged roof troughs and bird baths, especially in the shade, are major sources for some species. Water accumulation in storm sewer catch basins under manhole covers are heavy sources when there are insufficient rains to flush them down the sewer. Cesspools, septic tanks,

poorly-managed, overloaded sewage disposal plants, cisterns and flat top roofs are some further sources.

Pupae. Their habitats are the same as those of the larvae.

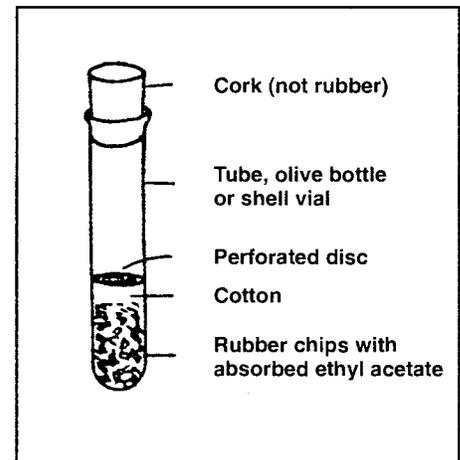
Adults. Adults rest in a variety of places already mentioned. Usually these places are cool and damp and free from wind. Spraying of these resting places is usually not practical because they represent only a small fraction of the population; they are used to measure population density during surveys.

Surveys. The location of larvae and pupae is generally determined by using a dipper along the surface of the water, except in small tree holes and other difficult-to-reach places. The dipper is white enameled with a hollow handle in which a wooden dowel stick is thrust to elongate the handle. See pages 14-17 for equipment needed.

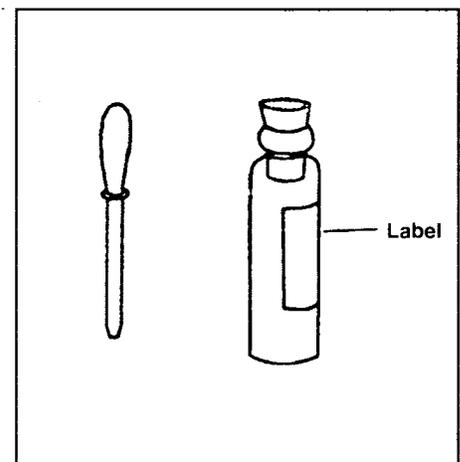
The dips should be made close to the water surface. Skimming the top will capture more larvae and pupae per dipper, but this technique makes it more difficult to compare population sizes on a "per dip" basis. Initially, all water areas should be sampled; after some experience it will become obvious that open ponds with waves and certain other areas described previously, need not be sampled.

The larvae and pupae may be removed from the dipper in the field, but it is faster and more efficient to pour the contents of the dipper into a labeled jar, and the individuals taken to the laboratory and poured into shallow white enamel pans, using a wide-mouthed pipette or medicine dropper to collect them for identification, or for counting numbers per dip.

Adult surveys during the day are made by searching for their most likely resting places, already mentioned. Adults may be captured by holding the mouth of a killing jar around them while perched, or they may be captured with an aspirator.



Survey Equipment. Killing bottle for adults.



Survey Equipment. Left: wide mouth pipette for picking up larvae and pupae. Right: Vial with cork for stowing larvae and pupae.

Mosquitoes

Adults resting in brush, shrubbery or grass and weeds may best be captured with a sweeping net. Light traps, which attract the adults to a light where they drop or are sucked into a container with or without poison, are used commonly for surveys. Such traps are of little or no value as control measures; they probably attract into the area as many as they kill.

Control

Larvae and Pupae. Draining or filling of mosquito-producing marshes and other aquatic habitats with soil or rock is permanent control but these procedures are relatively expensive. Removing vegetation along the edges is a temporary alternative. Drainage ditches and sewage lagoons should have steep banks.

Manipulation of habitats or environmental control in water that may support wildlife should first be discussed with appropriate wildlife specialists. It is unlikely that fish-inhabited water is a source of mosquitoes, unless vegetation is so dense that the larvae and pupae are protected.

Water in cans, old tires, bottles, buckets and other water-catching receptacles, particularly in the shade, should be emptied and permanently removed; if this is impossible they can be sprayed. One tin can or one grassy pool can produce hundreds of mosquitoes.

Insecticides are the most rapid means of control but they are toxic to man, wildlife and fish unless applied carefully and with good judgment. Generally, insecticide effectiveness on water will last 10 to 14 days but need for a second spray should be confirmed by sampling with a dipper to determine whether there is need.

Adults—Indoors

Small enclosures such as houses, tents, trailers, barns and bins may be treated with space sprays, using either aerosol cans or ULV sprays. Space sprays are applied as fine

droplets and have little or no residual effect and hence must be repeated each time a new batch flies in. The label on the container tells how long the enclosure should be left closed in order to become effective.

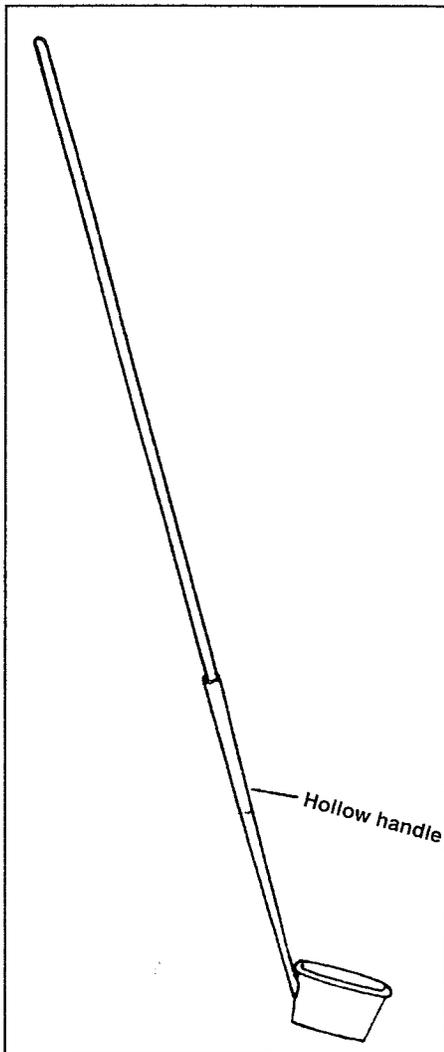
When frequent re-entry is a problem or when there is a potential or actual threat of disease transmission, a residual spray is also used. These involve coarser droplets and remain effective longer because an invisible residue is deposited on surfaces so that the adult mosquitoes come in contact while walking over or perched on the sprayed surface.

Adults—Outdoors

When adults are inactive, most species generally rest on vegetation or in other protected areas previously discussed.

Repellents for mosquitoes are sold in stores under various trade names, alone and in various combinations. They are sprayed on the outer clothing and on exposed parts of the body but care must be taken to keep them out of sores, eyes, nostrils and lips. Repellents are effective about 1 to 5 hours, depending upon the amount applied to sprayed surfaces, sweating, and number of mosquitoes. Pressurized aerosol cans are more likely to cover more of the surface vulnerable to attack than the rub-on types.

Fogging involves dispersion of the insecticide as fine particles, appearing as fine smoke. Fogging must be done when the air is still, applied by a mounted vehicle moving no more than 5 to 7 miles per hour. Fogging, at best, is only a temporary adult killer. Adults from nearby can fly in or be brought in by the wind. When properly applied, fogging does not leave a dangerous or unsightly deposit and is more effective when the mosquitoes are flying than when they are resting. The fog should remain close to the ground. This occurs when there is a thermal inversion which usually occurs between twilight and sunrise when the lower air is cooler than that above.



Survey equipment. Dipper to sample larvae and pupae.

Mosquitoes

Mist blowing involves applying insecticides in larger droplets, which results in some residue deposits. It can be done at higher wind velocities. Currently available residual insecticides usually will not persist long enough to provide good control, particularly when exposed to dew or rain. The mist droplets that hit the mosquitoes are more effective than the droplets that form residues on surfaces.

Mist blowing is used in less dense residential areas and does not penetrate vegetation as much as fogging. Furthermore, green vegetation may be burned by the oil-carrier in the insecticide, and objectionable residues may remain on automobiles, windows and laundry. Exterior residual sprays have limited value in protecting single residences when applied around foundations, under buildings, on tree trunks, between logs and the under surfaces of leaves. Larger areas, such as picnic sites, should have applications extended 100 feet or more from the site to be protected. Avoid misting of fish ponds.

Other control methods are largely in the experimental stage. *Gambusia*, the mosquito fishes, provide some control. Predators, parasites and disease do reduce mosquito populations but do not control mosquitoes sufficiently to prevent mosquito outbreaks.

Organized mosquito control efforts are obviously more successful than those by isolated individuals. If a community-wide program is anticipated, it is recommended that the Kansas Department of Health and Environment, Division of Prevention and Control, and the Kansas State Board of Agriculture, Plant Health Division, Topeka, be contacted.

In most cases it is an advantage to have the specimens identified to species, particularly if potential transmission of disease is involved. In rare instances the species may not bite

man or animals. Usually there are only a few important species in one locality. Control efforts should be based upon a knowledge of each species and its respective habitats.

Larvae and adults for identification may be sent to:

Insect Diagnostic Laboratory
Department of Entomology
Kansas State University
Manhattan, Kansas 66506

Up-to-date information on legal and effective insecticides can also be obtained at the above address.

Mosquitoes and Human Welfare

Mosquito bites are well known but people differ in the amount of irritation produced. The actual pain and itching is not because of piercing of the skin but rather the mosquito's saliva injected into the wound.

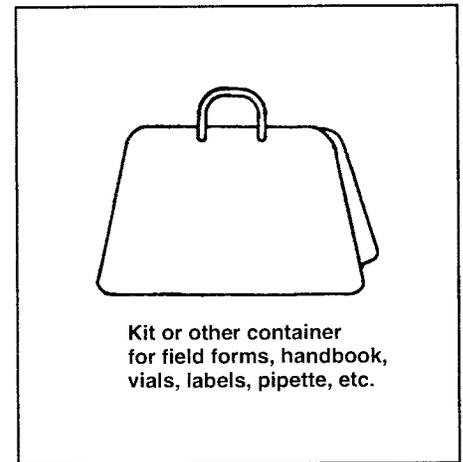
Mosquitoes transmit several diseases **but only if the disease organism is present for them to transmit.** Malaria is transmitted by certain *Anopheles* but malaria organisms are virtually missing in Kansas and the United States, except when people from certain other countries come home with the disease.

Western Equine Encephalitis, St. Louis encephalitis and possibly other related viruses are transmitted in Kansas primarily by *Culex tarsalis* and *Culex pipiens*.

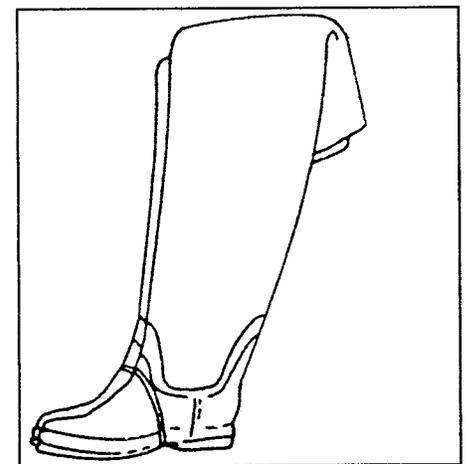
The normal reservoirs of the viruses are certain birds: the mosquito bites an infected bird and then a person. Cases of mosquito-transmitted encephalitis have been reported in Kansas, so precautionary control measures are justified.

Yellow fever is transmitted by *Aedes aegypti*, a mosquito found rarely in southeastern Kansas. Yellow fever was devastating decades ago in some United States cities but no cases have been reported for several decades.

Heartworm in dogs is transmitted by certain mosquitoes.



Survey equipment.



Survey equipment. Rubber boots.

Mosquitoes

Threat from an Exotic Species

An exotic mosquito species, *Aedes albopictus*, the "Asian tiger mosquito," deserves mention here. First discovered in the U.S. in 1985 in a tire dump near Houston, Texas, these mosquitoes have become established in many locations from Texas to Illinois and eastward. Specimens were collected in Kansas City, Missouri, in 1986 but were believed to be eradicated. In 1992, populations were discovered in tire piles at Oklahoma City and Tulsa and at two sites in eastern Nebraska, but had not yet been found in Kansas.

Aedes albopictus is an aggressive biter. With its arrival came at least the possibility of contracting an agonizing viral disease, called dengue, that was hitherto unknown in the U.S. This species can also transmit yellow fever and just about every kind of viral encephalitis that is already present in our native mosquitoes.

The females lay eggs in small bodies of water such as tree holes, tin cans, old tires, rain gutters, even in rainwater collected in sagging areas of tarps covering tire piles to keep them from collecting water.

Suspected populations of *Aedes albopictus* should be reported to the Kansas Board of Agriculture. The adults are distinctively marked. They are dark gray to black with a white stripe running from the top of the head back to more than midway along the thorax. The underneath side of the abdomen has a white spot on each segment. There are several small, irregular-shaped spots on the sides of the head and thorax, and two white spots on each side of each abdominal segment. There are some white markings on the legs, also, but several well-known native species have these.

STUDY QUESTIONS for pages 13–18

Mosquitoes

- (13) Mosquitoes have _____ wings.
 - 2
 - 4
 - 6
 - 8
- (13) Mosquitoes have _____ life stages.
 - 1
 - 2
 - 3
 - 4
- (13) _____ lay their eggs in "rafts."
 - Aedes*
 - Culex*
 - Anopheles*
 - Psorophora*
- (13) Mosquito larvae have _____ instars.
 - 1
 - 2
 - 3
 - 4
- (14) In mosquito development, the stage following the larva is called the:
 - nymph
 - egg
 - pupa
 - adult
- (14) Adult mosquitoes can be distinguished from closely related families by the:
 - length of their legs
 - numerous scales on the wing veins
 - shape of their antennae
 - number of white bands on the legs

continued on page 19

STUDY QUESTIONS for pages 13–18 continued from page 18

Mosquitoes

7. (15) An example of a mosquito that over winters in the adult stage is:
 - a. *Aedes*
 - b. *Psorophora*
 - c. *Culex*
 - d. *Coquillettidia*
8. (15) Mosquito larvae do NOT live in:
 - a. roadside ditches
 - b. seepage from irrigation ditches
 - c. animal drinking troughs
 - d. open areas of lakes and ponds
9. (15) Mosquito pupae habitats are the same as the:
 - a. eggs
 - b. larvae
 - c. adults
 - d. none of the above
10. (16) The most permanent method of mosquito control is:
 - a. spraying to control the adults
 - b. spraying to control the larvae
 - c. draining or filling mosquito breeding areas with soil or rocks
 - d. use fish to feed on the larvae
11. (16) Adult mosquitoes can be controlled in small enclosures, e.g. houses, tents, barns, etc., using _____.
 - a. ULV sprays
 - b. aerosols
 - c. residual sprays
 - d. all the above
12. (17) Large areas, like picnic sites, should have applications extend _____ feet beyond for adult mosquito control.
 - a. 25
 - b. 50
 - c. 75
 - d. 100 or more
13. (17) In most cases of adult mosquito control, it is best to identify them to the _____ level.
 - a. order
 - b. family
 - c. genus
 - d. species
14. (17) The pain and itching from mosquito bites is caused by:
 - a. the mouth parts piercing the skin
 - b. the mosquito's saliva
 - c. a toxin injected by the mosquito
 - d. the mosquito's feet
15. (18) _____ is an exotic mosquito also known as the "Asian tiger mosquito."
 - a. *Culex pipiens*
 - b. *Aedes aegypti*
 - c. *Culex tarsalis*
 - d. *Aedes albopictus*
16. (18) The new disease in the U.S. transmitted by the Asian tiger mosquito is _____.
 - a. Yellow fever
 - b. encephalitis
 - c. dengue
 - d. malaria

Flies



Biting Flies

Black Flies

Black flies are sometimes called "buffalo gnats." They are small black, gray or silverish-gray flies with stout, humpback bodies; short, broad wings; and short legs. In Kansas they are rarely pests of humans. They fly around the head causing annoyance, but only a few bite.

Even if the black fly is not seen while biting, its bite is recognized. There is little or no pain while the fly punctures the skin and feeds, but the site of the puncture is usually marked by a small trickle of blood after feeding. Within an hour, the area around the bite swells and an intense itching begins that may last for several days. Some individuals are sensitized to the bites, suffering pain and severe swelling in the area of the bite. Eyes may become almost swollen shut. There may be additional reactions or extreme swelling requiring hospitalization.

Unlike most mosquitoes, black flies bite only during the day, most commonly just before a storm. When feeding on animals, they crawl through the hair or feathers to the skin or enter the ears and nostrils to bite. On people they usually feed on exposed skin but may crawl through openings in the clothing to bite covered parts of the body.

Black flies generally lay their eggs in masses on stones, sticks, vegetation and other objects located in shallow, running water or where continually wetted by splashing. Hatched larvae attach themselves to these objects in the stream, using a small suction disc and fine silken threads. The larvae transform to pupae, which are firmly attached within silk pupal cases spun by the larvae just before pupation. Duration of the aquatic stages varies from 2 to 3 weeks to several months, depending upon species, temperature and other conditions.

Upon emerging from the pupal skins, the flies take flight immediately and may live from a few days to several weeks. Some species have one generation each year, others two or more.

Because the larvae and pupae live in flowing streams, insecticide control as well as stream alterations are seldom practical. Outdoor space sprays recommended for adult control offer some local relief. Bites are the most effectively reduced by insect repellents on exposed skin and by keeping clothing tightly fastened.

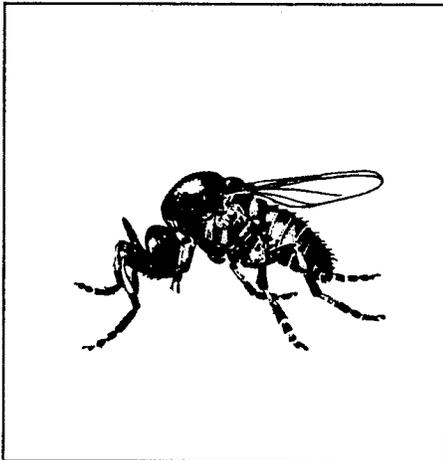
Stable Flies (*Stomoxys calcitrans*)

These flies are often called "biting house flies" because of their close resemblance to house flies and because they may bite people, especially during stormy or cloudy days. They are also sometimes called the "cattle flies" because they are most commonly seen biting cattle.

The major difference in appearance between the two is the sharp "beaks" of the stable flies which are used to pierce the skin and suck blood. Their beaks point forward when not feeding, whereas the house fly's does not penetrate the skin and its mouth parts are blunt on the end and retracted into the head when not feeding. Unlike most other biting flies, both male and female stable flies feed on blood.

Females lay eggs in piles of moist, rotting organic matter, such as lawn clippings, straw and grain, particularly when mixed with wastes of livestock.

Development from egg to adult may occur as early as 2 weeks during hottest days, but 3 to 4 weeks is more common. Adults live 60 days or more and take blood meals once or twice daily. They usually remain outdoors, perched on barn walls and vegetation, waiting for the animals to come out. Nevertheless, they will enter animal quarters, houses and cabins, especially during cloudy and stormy summer weather.



Black Flies



Stable Flies
(*Stomoxys calcitrans*)

Flies

The most effective method for controlling stable flies, like most other biting insects, is removal of favorable breeding sites. This involves removal primarily and drying (by spreading thinly) the accumulations of rotting vegetation, including that mixed with manure. Simply piling in another distant location may reduce the number of pests locally, but their long flight range makes it difficult to completely eliminate them. Furthermore, repiling in another location may produce the same problem in another area.

Spraying these piles is ineffective. Indoor space sprays or aerosols, such as those used against mosquitoes, may reduce stable flies that enter animal shelters or human habitations. Skin or clothing applications of insect repellents for biting flies or mosquitoes provide some protection. Known insecticide control measures seldom are practical for large area treatments.

Horse Flies and Deer Flies (Family Tabanidae)

Several species of horse and deer flies occur in Kansas, particularly southeast Kansas. Nevertheless, they are seldom as much of a pest as they are in the states with more low, moist, forested areas.

The larger species of this family are commonly called horse flies. Most smaller species have mottled or speckled wings and are called "deer flies." They are a much greater biting pest of humans. Both horse flies and deer flies are strong fliers and commonly have large, brilliantly colored eyes that are banded, spotted or striped with green or purple.

Only the females suck blood. Adults are most active on warm, sunny days; although some are active through dusk until darkness. They initiate biting by making a stabbing wound and then sponge up the resulting blood. All this occurs rapidly so they are on the host only a short time, making contact poisoning by insecticides less effective.

Eggs are laid in compact masses of several hundred on the leaves of aquatic plants, vegetation or overhanging bridges, bordering pools, swamps or other bodies of water. Eggs hatch in about 1 week, and the hatched larvae drop into water or damp soil where they spend 1 to 3 years completing development to the pupal stage. Adults emerge from the pupal case in 2 to 3 weeks.

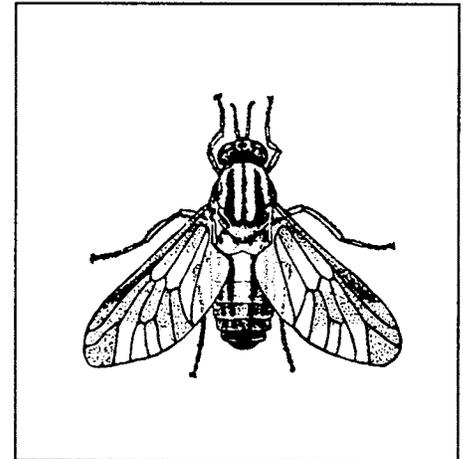
No satisfactory control has yet been developed. The extensive and diverse areas where the larvae and pupae develop in the soil and mud make it impractical to use chemical insecticides. Drainage of these areas is also generally impractical. Suitable clothing and an application of insect repellent such as that for mosquitoes to areas of exposed skin and hair will provide some protection from their rapid bites.

Biting Midges

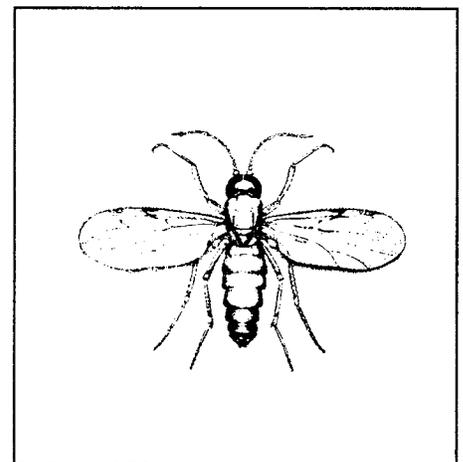
Common names for these very tiny flies include "punkies," "sand flies" and "no-see-ums." Those that feed on humans, bite mainly in the evening and early morning. The burning and irritation they cause is far greater than would be expected from an insect this small. Attacks often involve so many individuals that, at a glance, it appears pepper has been shaken onto the skin.

The minute size of the larvae makes location of their habitat very difficult. They are severe pests in such northern states as the northern part of New England, New York and Minnesota where they are known to develop in and along the bottom or edges of streams, lakes, marshes and other wet soils. The small size and diversity of habitats makes larval and pupal control impractical. In Kansas, they have been found to develop in soaked soil overflow of septic tanks and sinks, in seep areas of pastures, and along the edges of livestock waste lagoons.

In addition to out-of-doors biting, they are attracted to lights. Their tiny size enables them to enter tents, cab-



Horse Flies and Deer Flies
(Family Tabanidae)



Biting Midges

Flies

ins and cottages through average mesh screen. Indoors, an aerosol is effective. Fortunately, their weak flying ability restricts their nuisance to relatively limited and localized areas.

Nonbiting Flies

Several species of nonbiting flies may affect health, cause discomfort and annoy humans. Although they differ in appearance, all are in the order Diptera and have complete metamorphosis (egg, larval, pupal and adult stages).

House Fly (*Musca domestica*)

The house fly is known in all areas of the world and is the most widely distributed insect of importance to human kind. In some areas, it may constitute 98 percent of all flies entering houses. As a matter of necessity, a large part of any pest control program will be directed against house flies.

In general, the house fly is gray in color. The gray thorax is marked with four equally broad dark stripes running longitudinally. The mouth parts are pad-like and are adapted for taking up liquified foods. They may be partly withdrawn into the head when not in use. Eggs are laid and larvae develop in animal and vegetable refuse. Garbage, contents of pit privies, animal manure, spilled animal feed, and soil contaminated with organic matter such as from washings of any of these items are favorite breeding places.

House flies are very prolific, each female laying several masses of many eggs. Under favorable conditions the eggs hatch in 24 hours or less. The headless maggots, pointed at the front end, creamy white and about one-half inch long when mature, move about in the breeding medium to secure optimum temperature and moisture conditions. Larval stages last 3 to 24 days; the usual time in warm weather is 4 to 7 days.

Full grown larvae move to dry parts of the breeding medium or move out into the soil or sheltered

areas under debris to pupate. The pupal case is red. The pupal stage usually lasts 4 to 5 days; under very warm conditions only 3 days may be required. In cold weather, flies may remain in the pupal case for several weeks. When this stage is completed, the adult pushes open the end of the pupal case, works its way to the surface of the ground, and after drying and hardening, flies away to feed. Mating may take place a day or two following emergence from the pupal case.

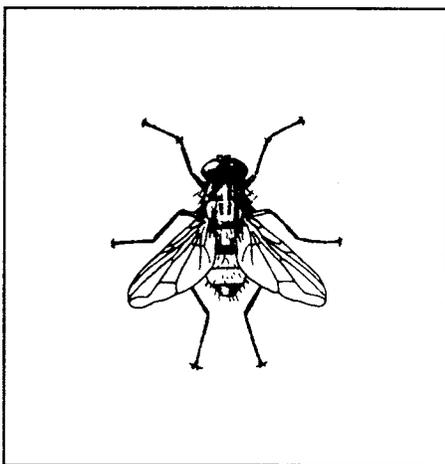
Many of the intestinal diseases of man are transmitted by house flies, such as the dysenteries, cholera and typhoid fever. The fly simply transports the organisms causing these diseases from man's feces to his food.

Sometimes these organisms are carried on the flies' feet or body hairs, and frequently they regurgitate onto the food when the fly attempts to liquify it for ingestion. The house fly has a wide flight range and varied food tastes. The female is naturally attracted to collections of filth in which to lay her eggs.

House Fly Control. Sanitation—

There is no substitute for sanitation in house fly control. Basically, this means destroying their breeding place. Because house flies have developed resistance to many insecticides, proper sanitation is even more essential. Place all garbage in cans with tight-fitting lids. Keep cans on racks and wash them frequently. Exercise care where repeated washing of cans occurs not to let the water run onto the same ground or graveled areas.

Pick up garbage at least twice weekly and dispose of it in properly operated sanitary landfills. Chemical treatment of breeding areas hastens development of resistance to insecticides more than does chemical control measures for adults. Therefore, emphasis should be placed on sanitation. Supplemental larviciding is generally only an emergency and ineffective measure.



House Fly
(*Musca domestica*)

Screens and doors—To keep flies out of buildings, screen all doors and windows with 16- or 18-mesh screen. Use automatic closers on all outside doors and keep them properly adjusted.

Chemicals—The application of insecticides for the control of adult flies indoors usually includes the use of aerosols. Application of insecticides with some residual action may also be effective if applied around windows or other areas visited by flies. Vapors with insecticidal action emitted by impregnated resin strips may offer some control of adult flies but care must be taken not to place these strips in areas prohibited by the label.

For control of adult flies out of doors, aerosols applied by mist, fog or ultra-low volume equipment is of some value. Fly baits may offer some control in certain situations, particularly where no other food is in competition. Residual sprays may be used around areas of high fly concentration such as garbage cans. Resin strips impregnated with insecticide are effective if placed inside garbage cans or bulk solid waste containers.

Blow Flies

Blow flies may be identified by their relatively large size and shiny blue (*Calliphora*), green or copper (*Phaenicia*), or black (*Phormia*) abdomens. They are also called blue and green bottle flies, depending on the color. They are larger and more robust than house flies and fly with a buzzing sound.

Various species breed in animal carcasses, meat scraps and decaying vegetable matter. Adults are strong fliers and are attracted to oviposition sites from long distances. The life cycle is similar to that of the house fly.

While these flies have essentially the same potential for mechanically transmitting disease organisms as do house flies, they have fewer opportunities because they are less inclined to enter buildings. The immature stages have been found in wounds of

humans and other animals, and many of the flies in this group may cause myiasis —infestation of the organs and tissues of man or animals by maggots.

Occasionally blow flies cause annoyance indoors in much the same way as do house flies.

Blow fly maggots (larvae) develop in protein-type materials such as cheese, eggs, meat, fish, dead animals and droppings of dogs and other animals. Different types of organic matter often encourage the presence of different species of flies. In certain neighborhoods it is not uncommon to find blow flies associated with dog manure.

Normally blow flies originate outdoors but infestations can arise from dead rodents and birds inside houses. They might also arise from maggot breeding places in birds' nests, in eave troughs or above windows, and sometimes in soiled carpets and rugs.

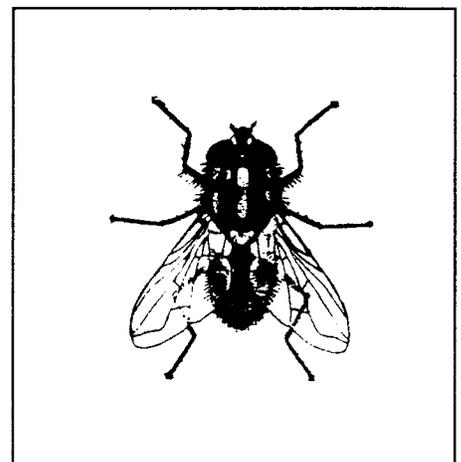
Destroy all sources of maggot infestation. Bury excrement of dogs each week and spray pens with a suitable insecticide.

The control measures recommended for house flies are, in general, effective against blow flies.

Face Fly (*Musca autumnalis*)

Few insects give people the creeps as much as the sluggish flies appearing in buildings on warm days during late autumn, winter and early spring. These flies make irritating buzzing noises, actively spin around in circles, move sluggishly and make a greasy spot when crushed. They collect in large numbers, especially at windows and in rooms not frequently used.

Actually, face flies do not damage home furnishings or bite humans, but they are a nuisance just by their presence. Even after the flies are cleaned up from a room, within a few days the same room may need to be cleaned of flies again. It is the continuous appearance of these pests in a room that is most frustrating. They are commonly called "attic flies" because they enter attics.



Face Fly
(*Musca autumnalis*)

Flies

In Kansas, the most common attic fly is the face fly. The "cluster fly" may also occur in homes during cold weather, but is usually more of a problem in Northern and Eastern states. Attic flies overwinter as adults in homes and other buildings. They enter the home during the autumn months by forcing themselves through small cracks and openings. They hibernate between walls, in window casings, in dark corners, in closet clothing, beneath curtains, behind furniture, in hats, etc.

Just as the flies are a nuisance in the fall while seeking hibernating quarters, they are again troublesome in the spring, trying to get outdoors. As the warm spring weather induces fly activity, many appear inside the home from wall voids and accumulate around the windows.

The face fly is similar in appearance to the house fly but is darker in color and often slightly larger. The large eyes of the male face fly nearly touch on top of the head while those of the house fly are far apart. Female face flies are difficult to separate from female house flies. However, the face fly female has a silvery stripe around the eyes, whereas the stripe around the eyes of the house fly is golden in sheen. The middle section of the body of the face fly is slate-gray.

Face flies are very annoying on faces of cattle where they lap exudation from the eyes, nostrils and

mouth. Face fly females deposit eggs in manure during the spring and summer. The maggot stage lasts 3 to 10 days; egg to adult takes about 14 to 18 days.

Face Fly Control. *Non-chemical*—Control of face flies or "attic flies" cannot be permanent until the openings are closed through which they enter the home. When flies are prevented from entering a building, they will not become a nuisance nor require control.

Use caulking compound or other suitable material to fill all cracks and openings near windows, doors, vents and other possible fly entry sites. Seal holes, cracks and splits in the siding. Maintaining the house in good physical condition greatly reduces infestations. Use tight-fitting screens, especially on the upstairs and attic windows, screen ventilators, louvers, air conditioner openings, etc.

Chemical—Kill flies inside with a space spray. Residual sprays may be used when flies congregate. Any tightly enclosed room with little air movement, such as attics and storage rooms, can be treated by hanging insecticide impregnated strips.

No practical means has been found for directing chemical control measures against face fly breeding sites.

See page 72 in the appendix for a pictorial key to flies.

Fleas

Most flea infestations are associated with pet dogs or cats but may sometimes originate from rodents or rodent nests located in or near human habitations.

Fleas lay their eggs among the hairs of their animal host or in the host's sleeping places. The eggs drop or are shaken off and tiny, cylindrical, legless larvae hatch and feed on various animal and plant substances that have accumulated both inside and outside. When mature, the larvae spin small silken cocoons and develop into the pupal stage, emerging later as adult fleas that feed upon blood. Full development from egg to adult may require several weeks or several months, depending upon the environment.

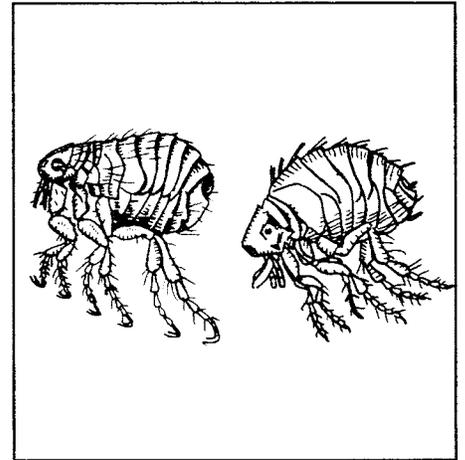
To be effective, control efforts must be directed against both the adult fleas on the animal and the adult and immature stages located throughout the area frequented by the dog, cat or rodent host. Frequent and thorough cleaning will help prevent outbreaks of flea infestations in buildings. This should include vacuuming floors, carpets, rugs and upholstered furniture often, and careful cleaning of cracks and crevices in the floor, around furniture cushions, and sleeping areas used by cats and dogs.

Rodent nests in or near buildings occupied by humans or pets should be removed and burned. Before removing rodent nests, treat the nest and surrounding area thoroughly with insecticides to kill any fleas that may be present.

Flea infestations on pet dogs or cats can be eliminated by applying an insecticide to the animal. This normally is accomplished by the owner or a veterinarian. If pets run freely outdoors, treatment may be repeated as often as necessary.

Infested sites within the occupied building should also be sprayed with a suitable insecticide at the time or immediately after the animal is treated. Apply the insecticide to the floors of infested rooms (including the basement), rugs, mats, sleeping quarters of pets, and their bedding. Yard or outside infestations can be controlled by treatment with a residual spray or dust. Pay particular attention to treating shaded areas and favored pet resting sites.

Most insecticides do not kill flea eggs so the materials selected for control should have residual activity. If non-residual materials are used, reapplications will be necessary.



Fleas

STUDY QUESTIONS *for pages 20–25*

Flies and Fleas

1. (20) Black flies are sometimes called _____.
 - a. buffalo gnats
 - b. midges
 - c. no-see-ums
 - d. humpback flies
2. (20) Black flies generally lay their eggs in masses:
 - a. in warm, dry sandy areas
 - b. on stones, sticks, etc. in shallow water
 - c. on foliage overhanging water
 - d. in tin cans and old tires
3. (20) When not feeding, stable fly mouth parts:
 - a. point forward
 - b. point straight down
 - c. point backwards
 - d. are withdrawn into the head
4. (21) Horse flies and deer flies are most common and abundant in _____ Kansas.
 - a. northwest
 - b. southwest
 - c. southeast
 - d. northeast
5. (21) Horse flies and deer flies feed by:
 - a. crawling around slowly to select the spot
 - b. landing softly and slowly piercing the skin
 - c. flying around the ears then quickly biting only on the rump.
 - d. making a stabbing wound and sponging up the blood.
6. (21) Control of horse flies and deer flies:
 - a. no satisfactory control has been developed
 - b. is done by spraying ponds and lakes
 - c. is done by spraying livestock manure
 - d. is done by spraying decaying organic matter
7. (21) In Kansas, biting midges have been found to develop in:
 - a. soaked soil overflow of septic tanks
 - b. seep areas of pastures
 - c. along the edges of livestock waste lagoons
 - d. all the above
8. (22) All nonbiting flies are in the order:
 - a. Hymenoptera
 - b. Diptera
 - c. Coleoptera
 - d. Orthoptera
9. (22) The mobile, immature stage of the house fly is called a:
 - a. maggot
 - b. nymph
 - c. naiad
 - d. caterpillar
10. (22) The primary control measure for house flies is:
 - a. spraying for the adults
 - b. spraying the maggots
 - c. flocks of chickens to eat the maggots
 - d. sanitation
11. (23) Chemicals to control house flies indoors are usually applied as:
 - a. wettable powders
 - b. dusts
 - c. aerosols
 - d. fumigations
12. (23) Blue and green bottle flies are also called:
 - a. house flies
 - b. blow flies
 - c. horn flies
 - d. stable flies
13. (23) Blow fly maggots develop in:
 - a. decaying lawn clippings
 - b. fresh cow manure
 - c. protein-type materials
 - d. the stems of aquatic plants
14. (24) Attic flies over winter as _____ in Kansas.
 - a. eggs
 - b. larvae
 - c. pupae
 - d. adults
15. (24) The only permanent control of face flies in buildings is:
 - a. spraying the outside walls
 - b. caulking all cracks and other openings
 - c. screening windows and doors
 - d. chemical treatment of breeding sites
16. (25) Flea eggs are:
 - a. deposited among the host animal's hairs
 - b. attached to the animal's hairs
 - c. deposited in the seams of chairs
 - d. deposited in open areas on the floor
17. (25) A help in preventing flea outbreaks in buildings is:
 - a. removal of all pets
 - b. the use of insecticide impregnated strips
 - c. frequent and thorough cleanings
 - d. release of predators
18. (25) In addition to treating the pet animal for flea control, it is necessary to treat:
 - a. floors, rugs and mats
 - b. pet sleeping quarters and bedding
 - c. yard and outside areas
 - d. all the above



Ants feed upon every food consumed by man and are troublesome household pests. Some ants feed predominately on sweets whereas others prefer meat and grease. All ants bite and some ants also sting. Reaction to an ant bite or sting can be severe in sensitive individuals. Ants also act as scavengers and predators of many harmful insects.

Ants are distinguished from other insects by having the first one or two abdominal segments reduced into a knobbed stalk located between the thorax and the abdomen proper, and by their elbowed antennae. (Termites have a broad connection between the thorax and abdomen and straight, beadlike antennae.) The forewings of ants are larger than the hindwings and have comparatively few veins (whereas the two pairs of wings of termites are similar in size and appearance and have many indistinct veins). Ants have chewing mouthparts. Their heavy mandibles are suitable for biting, piercing, cutting and gnawing.

The smallest ant is less than $\frac{1}{16}$ -inch long and the largest ant attains $1\frac{1}{2}$ inches. They are among the most abundant of living creatures infesting the home.

Ant colonies may last many years. The colony is established when the newly mated female discards her wings, digs a nest and produces eggs for a new brood. After nourishing her young through the larval stage, her labors are over as the larvae pupate and the young workers emerge and take over the work. The worker ants feed the queen, fight off enemies, construct a maze of tunnels, and care for the young. When the colony has become strong, a special brood of males and females is reared to establish new colonies. These winged adults emerge for their marital flight in vast numbers in order to mate and seek new harborage. Ants have a highly developed social system.

Common Species

Carpenter Ants (*Camponotus spp.*)

These very large ($\frac{1}{4}$ to $\frac{1}{2}$ inch) ants are black or dark brown. They nest principally in wood, which they hollow out into extensive systems of galleries. They do not eat the wood, but feed on honeydew and are predaceous on other insects. They do not sting but will bite readily.

Several species of carpenter ants are widely distributed throughout most of the United States. While these ants can damage trees by removing the supporting wood, they enter old scars and do not normally penetrate the bark and healthy cambium. In limited areas, they can cause severe damage to buildings by nesting in supporting structural timbers.

Thief Ant (*Solenopsis molesta*)

This yellowish ant is one of the smallest. It is named the thief ant because it often nests near other ants and raids their galleries for food. Its own galleries are very small, and it cannot be followed by the ants whose nests it raids. It does not typically forage for food above ground. It feeds on a wide variety of available plant and animal materials. It is predaceous on insects and other small animals. It can sting but rarely does.

This ant readily invades buildings and is a common household ant. Because of its size, it can nest in very small cracks. In buildings it will forage widely for sweet, starch and protein foods, but prefers greasy materials.

Pharaoh Ant (*Monomorium pharaonis*)

This small ant (about $\frac{1}{16}$ -inch) varies in color from yellow to red. It can be distinguished from the thief ant because it has three segments in the antennal club whereas the thief ant has only two. It will nest almost anywhere—in cracks and crevices, under stones and boards, and around foundations.

This ant feeds on sweets, greases and proteins, and is predaceous on many insects. It is an important and

Ants

persistent pest in buildings where it will forage for food and for moisture. This ant cannot sting but will bite readily. It may be a serious pest in hospitals where it sometimes invades nurseries, feeds on wounds, and gets under plaster casts.

Ant Control. *Indoors*—Some ant control techniques can be used in buildings. Others are suitable for use only outdoors. The control of some ants requires techniques developed for the particular species rather than normally used for other ants.

Inside buildings, sanitation carried out by building occupants is an important aspect of ant control. Crumbs, grease, food scraps and foods in open or partly open containers are readily found by foraging workers and can attract large numbers of ants. Heavy infestations in buildings are rarely found where good sanitation is practiced.

Insecticide dusts are tracked into the nest by the workers. Dusts are usually more effective than sprays. Dusts are blown directly into the nests or are applied in all cracks and crevices several feet each side of the points of entry.

Sprays can reduce ant populations indoors, even if ants enter buildings from outdoor nests. Nevertheless, sprays are not effective in eliminating colonies. Treat all points of entry as well as the areas several feet on each side. Foraging areas, other than food preparation surfaces, should also be treated.

Poisoned baits can be used effectively if they are more attractive to the species present than other available foods. Baits are taken into the nests and are fed to the larvae, the reproductives and the soldiers. However, the poisons must be slow acting to provide control. Fast-acting poisons kill the workers before the bait is distributed. Follow the manufacturer's recommendations for bait use

and take necessary precautions to avoid possible food contamination and contact by children and pets.

Outdoors—On the outside, dusts may be blown directly into nests, followed by clean air to distribute the dust within the galleries. Dusts are also used for barrier treatments in which bands 4- to 6-inches wide are used to ring the nests. A clean area several inches wide should be left between the ring and nest entrance. Several applications may be required in wet or windy weather. Mound-building ants often enter and leave nests through tunnels at a distance from the mound and control may require treatment of areas 10 feet or more in radius.

Sprays are used to saturate nests after the mounds are opened with a hoe. Oil-based solutions should not be used in vegetated areas. Emulsions must be used with care as they can burn some foliage. Water suspensions or wettable powders are the safest sprays to use outdoors. They are effective for area control where there are many small nests or where nests are hidden but the foraging areas are known. The area should be wet down thoroughly. After the water has dried, the residual dust is tracked into the nests by the worker ants. Poisoned baits can be used for the control of some ants.

Carpenter ants are best controlled by treatment of the nest. Only dusts should be used. Oil solutions can soak through wood to stain walls, and the water in emulsions and suspensions can cause swelling and warping of wood and can lead to decay. Dust should be introduced into the top of the nest if it can be found by tapping and by drilling. Where the nests cannot be located, area control is required. Emulsions or suspensions are effective for use around foundations, in attic spaces, and in other areas where ants are seen.

Stinging Insects

Ants, bees and wasps are all members of the order *Hymenoptera*. Most are membrane-winged though some have wings. Ants have wings only in the reproductive forms—workers are wingless. Females of multilid wasps (velvet ants) are all wingless; most males have wings.

Many *Hymenoptera* live solitary lives. Yet this order contains most of the “social insects” that have caste systems with workers, soldiers and reproductive forms—all living in single nests or hives. This system is best developed in ants, some of which have several types of workers and soldiers.

Bumble bees, honey bees and wasps have workers in addition to reproductive castes. Mud-dauber wasps have no worker caste. Many hymenopterous insects are beneficial to man because they parasitize or prey upon injurious insects.

The various sting mechanisms are modified ovipositors (egg laying apparatus). The venom produces lethal or narcotic effects in the arthropods intended as food for adults or larvae. The stings of many also are well suited for defense. While truly unprovoked stinging of large animals is considered quite rare, very little provocation is needed to incite some wasps and ants to attack intruders near their nests. The *Hymenoptera* kill more people in the United States each year than do snakes and spiders combined.

Wasps

Wasps, compared to bees, are more elongated and their body is not hairy. In contrast to honey bees, they do not lose their stinger during the first sting; hence they may sting repeatedly.

The *Vespid*s are the most dangerous because of their social nesting habits, aggressiveness and abundance. The yellow jackets and hornets are mostly black with white, red or yellow markings. Their nests are globular, con-

structed of a paper-like material formed by chewing wood fiber into pulp. There are several layers of cells within the globe. Most nests are above ground.

The *Polistes* wasps are more slender than hornets or yellow jackets. Their paper-like nests consist of one layer of cells, opened vertically, umbrella or saucer-shaped. Most wasps feed on insects and other arthropods.

Most species of mud-dauber wasps are a dark, shiny color, often purple, with an elongated waist. Their nests are made of several clay cells, almost always in or on man-made structures. Several paralyzed spiders are placed in each cell and one egg is deposited. The cell is capped. The female then abandons the nest.

Control is directed toward treatment of nests and surrounding areas. Insecticides may be used as dusts, wettable powders, solutions or emulsions.

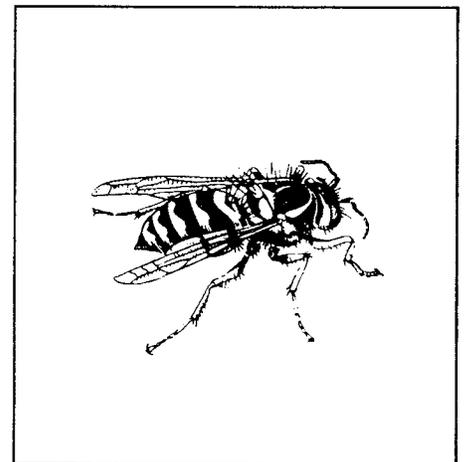
Use oil-based solutions with care around vegetation to avoid damage. Most wasps will be at their nests at evening or night and are the least active then.

Dusts may be applied to some hornets' and yellow jackets' nests whether above or below ground. Insert the extension tube on a hand duster into the nest opening. Two or three strong puffs of dust will filter through the nest and usually will kill the colony within 24 hours.

Solutions and emulsions may be sprayed into and onto the nests. The more nearly saturated the nest, the quicker the kill. A cylindrical pressured sprayer can have the nozzle adjusted to send a jet spray to 40 feet from the nest.

Rapid garbage disposal will reduce the numbers of some species that congregate around garbage. Spraying garbage containers once a week, particularly around the tops, will control these wasps.

Residual sprays are effective for control of wasps in buildings. Treat the screens, window frames, door frames and other places where wasps generally crawl.



Wasps

Stinging

Insects

Bees

Like the wasps, bumble bees overwinter only as fertilized queens. In the spring, a new queen finds a nesting site, partially fills it with a mass of dry grass or moss, adds a ball of "bee bread," a mixture of pollen and nectar, then adds eggs. She stays to care for this first brood until the new workers take over all of her duties other than egg laying.

The life cycle of the honey bee is different. After the mating flight of new queens, the old queen will leave with a number of workers called a swarm to start a new hive. A single queen may lay 1,500,000 eggs in her 3- to 5-year life, and may have as many as 100,000 offspring at one time.

Of the many types of bees, those most commonly responsible for stinging humans are the bumble bees and honey bees. Bumble bees are large, furry, black and yellow or black and sometimes reddish-haired bees. In flight they make a loud buzzing noise. Their nests are located in cavities in the soil, often in abandoned nests of field mice or in a bird house. A single nest in late summer will have the original queen, workers representing several broods, and a number of functional males and females.

Honey bees are typified by their moderate size, hairy bodies and the ability of the workers to sting only once, by pollen baskets on hind legs of workers, and by the strict caste system in which the queen performs no duties other than egg laying. She is without the pollen basket on the hind legs.

The nests of honey bees are predominantly in man-made hives. Some escape domestication and establish hives in such places as hollow trees, attics and wall spaces of buildings.

To control bees, a jet stream of insecticide, preferably on a cool evening, can be directed into and around the area where the bees are active. This operation may have to be repeated in about 2 weeks to kill the bees that were in the larval stage in the comb during the first spraying. Swarms hanging on supports such as tree limbs will disperse in a few hours. Beekeepers are reluctant to have these swarms, because there is insufficient time for the colony to lay up enough storage to survive the winter.

See page 73 in the appendix, "Stinging Hymenoptera, Pictorial Key to Some Common United States Families."



Bees

Mites



Chicken Mites

These mites are on the birds only when they are feeding. Otherwise, in the daytime they hide in cracks and crevices in the vicinity of the roost. Their red bodies are tightly packed in these spaces. They also feed on other birds.

When mites attack someone it causes a mild dermatitis and itching. Infestations have been traced to pet canaries, pigeons and nests of other wild birds. Mites may leave the nest and crawl to a human. Death of a bird host sometimes results in mites crawling in large numbers to humans. These mites can live for several months without food, so control even in the absence of birds is necessary.

Northern Fowl Mite

This mite is a much more serious pest of chickens. It lives among the feathers of the host bird and may complete development without leaving the host. It may leave the host, however, and go to nests or roosts and in surrounding cracks and crevices. It can survive for 2 or 3 weeks away from the host.

This mite may bite people, causing some annoyance. Dermatitis is not as frequent as with the chicken mite. This mite is a general parasite of birds, found on domestic fowl, sparrows, swallows and many other species. Annoyance is frequently associated with the death or departure of the normal host bird leaving an infestation of mites behind in the nest area without a convenient source of food.

Tropical Rat Mite

The tropical rat mite is associated with rats and will feed on humans and many other warm-blooded animals. The bite is painful, causing intense itching and a skin irritation known as "rat-mite dermatitis." The

mite has not been proved to be a transmitter of typhus or other diseases.

The attack is almost always associated with rats in buildings, such as warehouses, stores, theaters and apartments. Killing rats drives the mites off the host and may intensify their attack on a person, but this mite will bite a person even where there is an abundance of rats. The mites drop from their host after each feeding and occur on a variety of surfaces near rat-infested areas. They can survive for several days without a blood meal.

Mouse Mite

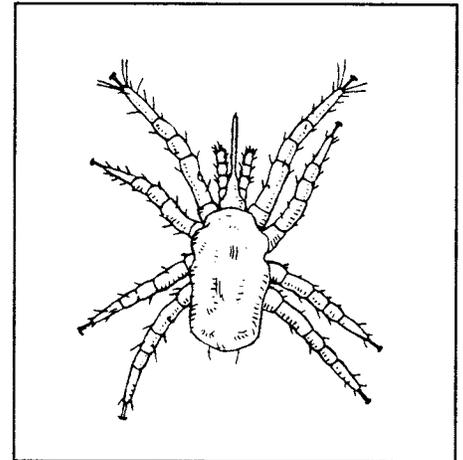
The mouse mite in the United States is primarily a parasite of mice. It tends to leave its rodent host to wander throughout buildings and bite people. Its major importance is that it has been identified as the vector of rickettsial pox, a mild and non-fatal disease of man.

Grain Mite

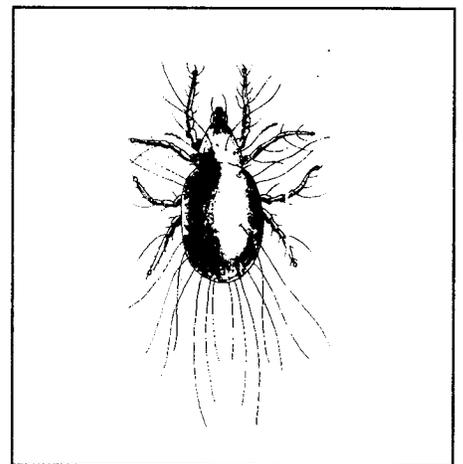
Grain mites may infest all types of grain flour. They also may be found on other stored foods, being one of the mites reported from cheese. The grain mite prefers a moist location and under favorable conditions develops rapidly and in great numbers.

The second nymphal form may be replaced by a special stage known as the "hypopus." This stage is highly resistant to unfavorable conditions, insecticides and fumigation. The hypopus may exist for several months without feeding. It does not move much under its own power, but is transported by clinging to small animals such as insects or mice. Under favorable conditions it sheds its skin and resumes normal growth and development. The peculiar adaptation through the hypopus stage makes it very difficult to eradicate.

The grain mite and relatives may cause mild dermatitis in man, known under various names as "grocers' itch," "vanillism" (from infestations



Chicken Mite



Grain Mite

Mites

on vanilla beans), and "copra itch," where products infested with the mites are handled by people. These mites are not bloodsucking and thus are the cause of only mild irritations.

Mushroom Mites

This mite is a common pest of mushroom beds. It also may be found in huge numbers on such materials as cheese, dried meats, cereals and many other materials in homes or food storage. It does not suck blood and any dermatitis from it is superficial irritation. This mite reproduces in enormous numbers so may quickly overrun an area surrounding its source of food.

Straw Itch Mite

This mite normally lives on other insects. Common hosts are the larvae of several insects such as the wheat jointworm; the wheat strawworm; the Angoumois grain moth; the rice, granary, bean and pea weevils; and the pink boll worm. It reproduces rapidly. Its development involves the eggs hatching within the body of the female and the young maturing within the body of the mother. They are born as sexually mature adults. They reproduce rapidly.

Workers engaged in threshing straw, handling grains, grass seed or other material infested with the insect hosts often are overrun by these mites. Their bites produce a rash-like dermatitis which may cover large areas of the body, first appearing about 12 hours after the attack. It is accompanied by a severe itching. The attack is often of such intensity as to induce vomiting, headache, sweating and fever.

Attack on people was common when it was the custom to sleep on straw mattresses.

Chiggers

Chiggers are by far the worst mite that attacks humans in Kansas. The species commonly encountered is *Eutrombicula alfreddugesi*.

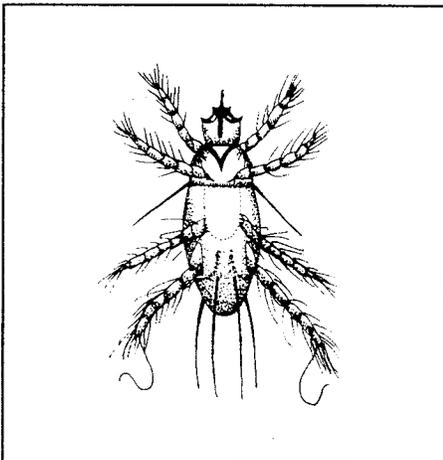
The eight-legged adult overwinters in the soil. This stage does not attack humans but feeds on insect eggs and immature soil insects. In the spring the adult emerges from the soil and lays eggs. These hatch into a tiny oval, orange-colored, six-legged "larvae," which attacks people. Normally these larvae live on snakes, turtles, rabbits, squirrels, birds and other wildlife. They also feed on humans and domestic animals.

The larvae can barely, if at all, be seen with the naked eye. They are very active and crawl about rapidly in search of a place to feed. When a person comes in contact with vegetation infested with the larvae, they swarm over his or her body. Sitting or lying in the grass results in more bites than walking. It may be several hours before they settle down to feed or they may attack immediately. Their attack is more concentrated at points where the clothing is pressed against the skin, as under belts or garters or in skin folds.

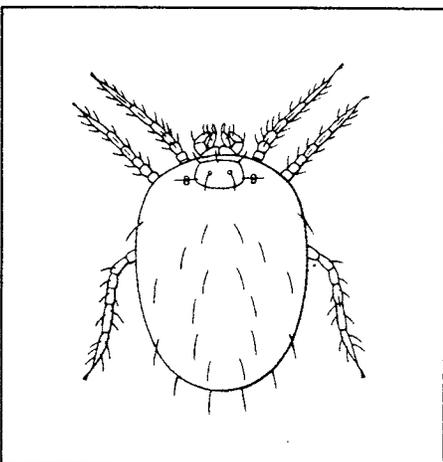
Chiggers attach themselves by their mouthparts, frequently near a hair follicle. In feeding, the mite injects a fluid into the host which liquifies the immediately adjacent tissues. The liquified tissues are ingested by the mite. The surrounding tissues become hardened, and, as feeding progresses, form a tiny tube through which further liquified tissue may be withdrawn. The larvae become fully fed in 4 to 6 days when they drop off the host, leaving behind the tube which was developed from its feeding.

The digestive fluid of the mite causes a severe itching about 8 hours after feeding starts. Scratching may lead to a secondary infection. The itching may last for a week or more. This mite is not associated with disease transmission in the United States.

After leaving the host the larvae transform to an eight-legged nymph and later to the adult. Neither of these forms attack people or animals, but are predators on other mites, small insects, and the eggs of such creatures.



Straw Itch Mite



Chigger

Mites

Control of chiggers consists of both pre- and post-exposure. Spray repellents particularly around ankles and seams of clothing. Remove clothing after exposure and shower, preferably with a strong soap containing sulfur. Control in special areas such as picnic grounds involves use of sprays.

Itch Mite

This mite causes scabies or itch in humans. There are several closely related forms on animals which may sometimes transfer to people, but usually close contact is required and the problem is not one where the pest control industry is usually consulted or can offer any assistance of value.

Clover Mite

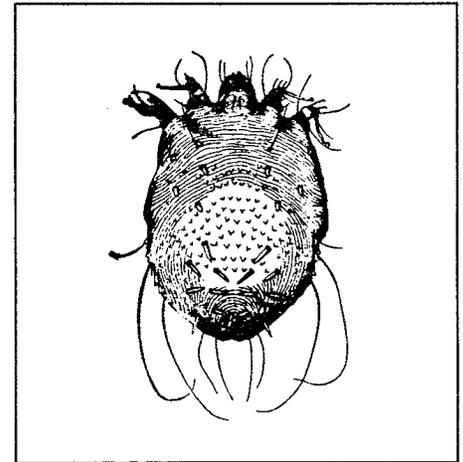
Clover mites often invade homes during the fall, winter or spring where they are a nuisance and may cause stains when crushed. Clover mites do not attack people, but suck the juices of grasses, clover and a variety of other plants outdoors. It is reddish brown, eight-legged, and the

young are redder. The front pair of legs is much longer than the other three pairs, and extend forward.

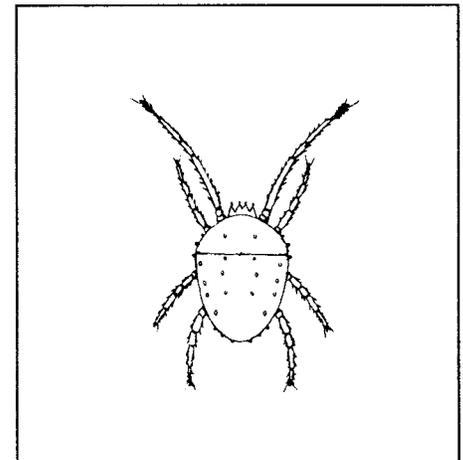
The bright eggs are laid singly or in masses in cracks and crevices in building walls and beneath bark on trees. Most hatching and mite activity occurs during the fall and spring. The eggs remain dormant and do not hatch above 86° F.

Clover mites feed by puncturing the plant tissue and sucking out the juices. Feeding usually occurs between 50° and 70° F. The time of day feeding occurs varies with the season and temperature. Late fall and early spring feeding occurs on grass, etc., growing in sheltered spots near foundations or other protected spots warmed by the sun. Tufts of plants should be observed in such sheltered spots for indications of clover mite problems.

See pages 74-76 in the appendix for more illustrations of "Household and Stored Food Pests: Key to Common Adults." Page 77 also shows health pests.



Itch Mite



Clover Mite

Spiders



Many people fear spiders because of myths that surround them or the publicity given to the very rare fatal poisonings by a few species. Others object to them because of their annoying habit of building webs in corners, on furniture, or across doorways and in other places. Under some conditions spiders are considered beneficial because they feed on insects.

Spiders have a characteristic appearance recognized by most people. Spiders lack wings and antennae. Their bodies have two regions—a cephalothorax (fused head and thorax) and an abdomen. Males are usually smaller than females of the same species. The eight legs of a spider are attached to the cephalothorax which also bears the eyes and mouth parts.

Most spiders have eight eyes, but some species have only six, and a few have fewer or none. All spiders have a pair of jawlike structures chelicerae at the end of which is a hollow, clawlike fang. Each fang has a small opening in the end through which venom can be ejected.

The abdomen of spiders contains their reproduction system, largest part of their respiratory system and the spinnerets. The latter are the silk spinning glands and are located at the tip of the abdomen.

Spiders are seldom aggressive towards humans and usually bite only when injured or trapped. Only large spiders are capable of breaking the tough skin of humans. The smaller ones usually can inflict only superficial scratches.

Nearly all spiders have venom glands, but almost all of the United States species have a venom so feeble that their bites are insignificant.

The severity of a person's reaction to the bite of a spider is influenced by a number of factors. The species of spider and the area of the body where the bite occurs are of great importance, but the amount of venom injected and the depth of bite also play a role. The signs and symptoms

are caused by the mechanical action of the bite, and/or by the venom. In some cases there is no reaction at all.

Life cycle

After being impregnated by the male, the female spider begins to lay eggs. The eggs are laid in dark retreats or in silk cocoons called egg sacs. The females of some species guard the eggs, others carry the egg sac with them. Depending upon the species, a female may produce as few as two or as many as 3,000 eggs. They are usually laid over a period of time in several sacs.

In warm weather, the young may hatch within 3 weeks. They tend to remain together for several days before scattering. Cannibalism often occurs during this period. Most common species mature within one year, going through a series of molts as do insects. Some species require up to 2 years to reach maturity.

Mating and egg-laying occur any time of year, depending upon the species. Some species, after overwintering as half-grown individuals, mature and lay eggs in the summer. Others overwinter as eggs, hatch in the spring and mature and lay eggs in the fall.

Habits

Spiders cannot fly, therefore, they use other means of dispersing in addition to walking. Some, such as the brown recluse, find many objects transported by man suitable retreats and can be moved great distances in this manner.

The most interesting method of travel is "ballooning," which is practiced primarily by the young of some species. To accomplish ballooning, the spider climbs to the top of an object such as a plant or fence post and releases a strand of silk. If a wind is blowing, the spider sends out silk until there is enough windborne to lift the spider from its perch. Spiders reach great heights by this method and have been carried 60 miles.

Some spiders build simple webs and others build very complex ones. Webs usually consist of strong, non-sticky strands of silk which form the framework. These strands are united with a series of silk strands having sticky globules on them. Spiders are just as susceptible as insects to being stuck in the sticky globules, but spiders are adept at avoiding them. Some types of spiders do not spin webs, but use their silk only for building egg sacs or retreats.

Spiders can be separated into two groups based on the way they capture prey:

1. The web-spinning spiders make webs to catch insects and live all the time in the web or in a nest near it. The species that commonly live indoors are web-spinning spiders.

2. The hunting and ambush spiders run on the ground or on plants, catching insects wherever they find them, or waiting among leaves and flowers until insects come within their reach.

Spiders eat live prey, usually consisting of insects and their relatives. Victims are killed by the venom injected through its fangs. Spiders have food preferences but a hungry spider will tackle most anything not too large. Some, if not all species, can go for long periods without food. The brown recluse, for example, has survived for 6 months without food or water.

Although all spiders require water for survival, some species require very little and can live in dry environments. However, many species can live only in humid places and need a regular source of drinking water. Most species are attracted to water sources if available. For this reason, first look around water pipes, floor drains and air-conditioners to determine the source of an infestation indoors.

Habitats

Because many spiders are associated with moisture, they are found in basements, crawl spaces and other damp parts of buildings. Others live in warm, dry places and can be found

in subfloor air vents, upper corners of rooms and attics. Most species found indoors hide either in cracks, darkened areas or retreats.

Outdoors, spiders live in a variety of places depending upon the species. Some hide in flowers waiting for prey. Others live on tree trunks, under stones or leaves, or in and under eaves. Most of the outdoor living species do not adapt to indoor conditions.

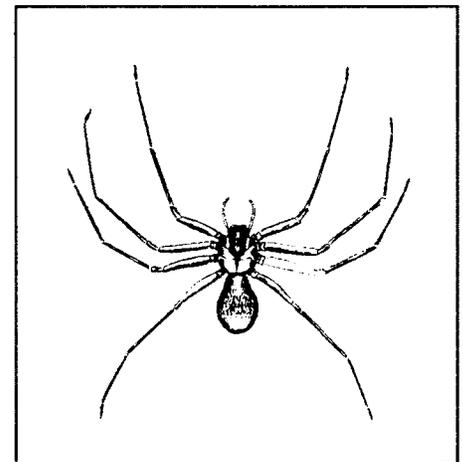
Common Poisonous Species

There are two poisonous spiders with which every Kansas resident should be familiar: the black widow and the brown recluse. They are the two most poisonous spiders in the United States and both occur in Kansas. Learn to recognize them, how their bites affect humans, what to do when bitten, and how to control spiders in and about dwellings.

Brown Recluse Spider (*Loxosceles reclusa*)

The brown recluse spider is found throughout Kansas—usually indoors in all types of buildings. It constructs a loose, irregular web in undisturbed areas, such as under shelves or boxes in basement storage areas or in clothes or boots stored undisturbed for long periods of time. Unlike the black widow, this spider is a hunter and leaves its web in search of prey.

How to Recognize the Brown Recluse. Males and females are similar in appearance and their bites are equally toxic. They range from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, excluding legs. The most distinguishing characteristics are: (1) six eyes (most spiders have eight), arranged as three pairs in a semicircle, and (2) a brown guitar- or violin-shaped marking on the tan cephalothorax, the first body region which bears the legs. This latter characteristic has resulted in the common name “fiddleback” or “violin” spider. Their legs are quite long and somewhat darker than the off-white to yellow or tan body.



Brown Recluse Spider
(*Loxosceles reclusa*)

Spiders

Bite and Symptoms. The brown recluse is shy and avoids danger in undisturbed places. Bites usually occur when a person is putting on clothes or shoes, such as winter coats or hunting boots which have been stored, in which the spider is hiding. As the spider is a nocturnal hunter, some bites also occur when the spider has crawled onto a bed and is squeezed by a person rolling in his/her sleep.

The amount of venom injected by the spider and the sensitivity of the person are both factors in determining the seriousness of the bites. Victims may have no reaction at first or may feel a stinging and painful sensation immediately. Intense pain may last from 2 to 8 hours. A small blister forms at the bite and a large area around the bite becomes red and swollen.

Some victims experience nausea, stomach cramps, stiffness of joints and fever. Tissue in the infected area usually slough away, resulting in an ulcerous area that gradually fills with scar tissue. Wounds heal slowly, sometimes taking 6 to 8 weeks, and a deep round scar may remain permanently.

What to Do. If bitten by a brown recluse or a spider that you think may be one, see a doctor immediately, taking along the captured spider to verify the cause of bite. Injections of corticosteroids may reduce necrotic response and systemic reactions to the bite.

Black Widow Spider (*Latrodectus mactans*)

The black widow spider can be collected throughout the state. It prefers to inhabit in undisturbed situations, often hiding in old stumps and hollow logs, under fallen fence posts, in abandoned animal burrows or in piles of dead tree branches and other debris. It is also sometimes found in or near human dwellings, inhabiting undisturbed corners in garages or basements, outdoor privies, rain gut-

ter downspouts, crawl spaces under trailers and porches, and under piles of wood or rubbish.

How to Recognize the Black Widow. The poisonous female is about ½ inch long, excluding legs, when mature and is shiny black or brownish black. Its spherical abdomen has an orange or red marking resembling an hourglass on the underside. Sometimes this hourglass is divided into two reddish triangles.

The smaller, non-poisonous male is little more than ¼ inch in length, excluding legs. It has several whitish streaks on the sides of the abdomen, but usually lacks red on the underside.

The black widow belongs to a family of spiders called cob web weavers or tangled web weavers. Loose, unsightly webs made by other members of this group are commonly found in cellars, garages and other infrequently cleaned buildings.

The female black widow is usually found hanging upside down in her loose, tangled web. She encloses her eggs in a spherical off-white silken egg sac and guards it until the young hatch. She is normally shy and nocturnal in habit and does not often leave her web voluntarily. She is not at all aggressive and can be subjected to considerable provocation without attempting to bite. However, she may rush out and attack when the web is disturbed or when she is accidentally trapped in clothing or shoes which have been stored unused for some time.

Bite and Symptoms. The bite of the female is slight and may not be felt at the time the neurotoxic venom is injected. It is usually followed by a burning sensation, local swelling and redness. Pain may become intense in 1 to 3 hours and last up to 48 hours. The person may experience cramps in the legs, arms and chest. The abdominal muscles may become rigid.

Other symptoms may include headache, nausea, tremors, speech defect, and a slight rise in body tem-



Black Widow Spider
(*Latrodectus mactans*)

perature. The degree of severity of symptoms depends a great deal on the sensitivity and age of the victim, with small children usually the most severely affected.

What to Do. First aid measures, other than the application of a mild antiseptic (such as iodine or hydrogen peroxide) to the bite, should not be given. Keep the person calm and under observation. If the symptoms begin to appear, take the victim to a doctor or hospital (and take along the captured spider to verify the cause of bite). A doctor may give calcium gluconate to relieve the symptoms. A specific antiserum is also available.

Complete rest for a day or two will usually result in the disappearance of pain and symptoms. Fatalities are extremely rare and the healthy person usually recovers quickly and completely.

Spider Control. Good sanitation is the best method of control. Use vacuum cleaner attachments with strong

suction to collect spiders and webs, then destroy the bag and its contents. Frequent cleaning throughout the entire household will reduce spiders and insects serving as spider food.

Brown recluse spiders are often found in homes where there is an abundance of insects. Rid premises of piles of rubbish and trash to aid in control. Be careful when moving piles of lumber and machinery that has not been used for some time or undisturbed boxes. Examine and shake out clothing that has hung unused in closets or other storage areas before you wear it.

Many spiders may be excluded from homes by caulking or otherwise eliminating cracks and crevices around the foundations and around windows and doors. Outside window shutters, step areas, crawl spaces, and related hard-to-reach places can be washed with a forceful stream of water from a hose.

Residual insecticides can be effective in supplementing sanitation practices. They should be applied where the spiders normally hide.

STUDY QUESTIONS *for pages 27–37*

Ants, Stinging Insects, Mites and Spiders

- (27) Ant colonies may last for:
 - one month
 - many months
 - one year
 - many years
- (27) Carpenter ants:
 - nest principally in wood
 - eat wood
 - normally penetrate bark & healthy cambium
 - are very tiny ants
- (28) The first step in ant control inside buildings is:
 - caulking all cracks and crevices
 - locating the nest
 - applying an aerosol
 - sanitation
- (28) Carpenter ants are best controlled by treatment of:
 - their food sources
 - their galleries
 - their nests
 - their water sources
- (29) Ants, bees and wasps are in the order:
 - Diptera
 - Coleoptera
 - Hymenoptera
 - Homoptera
- (29) Wasps, when compared to bees:
 - are more elongated
 - body is not hairy
 - do not lose stinger during first sting
 - all the above
- (29) _____ are a dark, shiny color, with an elongated waist.
 - Yellow jackets
 - Mud-daubers
 - Hornets
 - Honey bees
- (30) Bumble bee nests may be located in:
 - cavities in the soil
 - old field mice nests
 - bird houses
 - all the above
- (30) The honey bee queen duties include:
 - egg laying
 - feeding the young
 - fanning the hive
 - making "bee bread"

continued on page 38

Spiders

STUDY QUESTIONS *for pages 27–37 continued from page 37*

Ants, Stinging Insects, Mites and Spiders

10. (31) When chicken mites feed on humans, it causes:
 - a. a very large welt to form
 - b. a mild dermatitis and itching
 - c. an open sore lasting several months
 - d. only a mild annoyance
11. (31) When the northern fowl mite bites humans, it causes:
 - a. a mild dermatitis and itching
 - b. a very large welt to form
 - c. some annoyance to the human
 - d. an open sore lasting for several months
12. (31) Rickettsial pox in man is transmitted by the:
 - a. mouse mite
 - b. tropical rat mite
 - c. chicken mite
 - d. northern fowl mite
13. (32) The _____ does not suck blood.
 - a. straw itch mite
 - b. mushroom mite
 - c. chiggers
 - d. tropical rat mite
14. (32) _____ of the chigger causes a severe itching in humans.
 - a. Crawling
 - b. Probing for food
 - c. Poison
 - d. Digestive fluids
15. (33) Scabies in man is caused by the:
 - a. itch mite
 - b. chigger mite
 - c. grain mite
 - d. clover mite
16. (33) Clover mite eggs remain dormant and do not hatch above _____ F°.
 - a. 60
 - b. 69
 - c. 75
 - d. 86
17. (34) Spiders have _____ body regions.
 - a. 1
 - b. 2
 - c. 3
 - d. 4
18. (34) Cannibalism occurs most often in spiders:
 - a. between egg hatch and scattering
 - b. between scattering and 6 months old
 - c. from 6 month old to 12 months old
 - d. from 12 months old to 18 months old
19. (34) The most interesting method of travel used by spiders is:
 - a. walking
 - b. ballooning
 - c. jumping
 - d. flying
20. (35) Spiders eat:
 - a. insects and their relatives
 - b. plant sap
 - c. pollen from flowers
 - d. decomposing organic matter
21. (35) There are _____ poisonous species of spiders in Kansas.
 - a. 1
 - b. 2
 - c. 3
 - d. 4
22. (35) In brown recluse spiders, the bites of the male and female are:
 - a. equal
 - b. female is more toxic
 - c. male is more toxic
 - d. actually, only the female bites
23. (36) Brown recluse bites of some victims may experience:
 - a. nausea, stomach cramps and fever
 - b. the tissue sloughs away
 - c. slow healing taking 6 to 8 weeks
 - d. all the above
24. (36) The black widow spider is found:
 - a. throughout Kansas
 - b. only in northwest Kansas
 - c. only in south central Kansas
 - d. only in eastern Kansas
25. (36) Female black widow spiders are usually found:
 - a. running along base boards
 - b. in dense grassy yard areas
 - c. hanging upside down in her web
 - d. in building corners in a funnel shaped web
26. (37) In case of a black widow spider bite, you should:
 - a. keep the victim calm
 - b. take victim to doctor if/when symptoms begin to appear
 - c. provide for one to two days of complete rest
 - d. all the above
27. (37) Brown recluse spiders are often found in homes where there is:
 - a. an abundance of insects for food
 - b. greasy spatters for food
 - c. fruit and vegetable peels for food
 - d. standing water for breeding sites

Ticks

■

Ticks cause direct distress and spread many debilitating parasitic diseases to man and animals. Ticks belong to the Class Arachnida, Order Acari, with other mites. They have no wings nor antennae. The adults have eight legs. They have no head, as such, but the so-called capitulum includes well developed penetrating and attachment organs, a pair of palps, and a base plate to which these organs are attached. The body is fused, with no distinct division into thorax and abdomen. All ticks are parasites of animals (mammals, birds, reptiles). They do not feed on plant juices, although plants provide shade and protection required by many tick species while they are off the host. Engorgement with blood and dissolved cell matter may require a few hours or several weeks depending on the tick species and stage of growth.

Ticks have three developmental stages: larva, nymph and adult. They feed only once in each life stage and often live months, sometimes years, if unable to find a host. Adult ticks usually mate on the host animal as the female feeds. After engorgement, the females detach from the host and fall to the ground. Those which have also mated digest the blood and lay an egg mass containing 2,000 to more than 10,000 eggs. The egg mass is deposited beneath soil debris. A few weeks later, tiny six-legged larvae hatch from the eggs. They crawl up onto grass blades or other vegetation to await a passing host animal. People who acquire a larval tick are often infested by hundreds of the crawling specks at the same time.

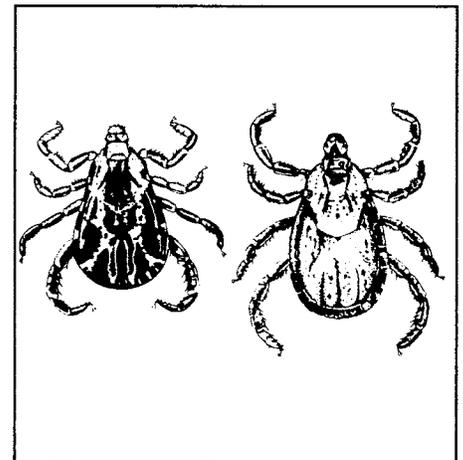
After feeding, the larvae descend into the habitat where they wait as they digest their first meal, molt, and become nymphs. The nymphs have eight legs and are still quite small (small pinhead sized) but in most species they look very much like adult females except for their lack of size, ornatation and a genital pore.

Nymphs seek a host, feed, drop again to the ground, molt and become adults.

Males of the hard tick species, which include all of our most commonly encountered species, are entirely covered with hardened integument skin and, in species with color patterns, are marked different from the female. Juvenile and female hard ticks have hardened plates only on the fore parts of their bodies. Soft ticks have almost no hardened integument and have no color markings. All but the male hard ticks can swell to several times their original size during feeding.

Ticks are categorized as one-host, two-host and three-host species according to the number of times an individual of the species typically uses a different host, whether of the same or different host species, during development and adulthood. Host specificity is a separate concept having to do with tick preference for (or acceptance of) only one, a few, or many host species. There is a tendency in many three-host, non-host-specific species for larvae to parasitize field mice and other small animals, nymphs to parasitize small and medium-sized animals, and adults to parasitize mostly medium-sized and large animals. Except as noted for individual species, ticks typically are active in Kansas from March through mid-October.

There are about 800 species of ticks in the world; about 80 occur in the U.S. and 20 or more in Kansas. The following paragraphs provide information on several species considered to have the greatest implications for human health in Kansas. A study in 1989 showed that only three species, American dog ticks, lone star ticks, and brown dog ticks, comprise 99.5 percent of ticks encountered by Kansas citizens. This simplifies the challenge to pest control applicators as each species has a distinct biology, seasonal progress of growth and population, host and habitat preference, and susceptibility to acaricides and other control measures. Knowing



American Dog Tick
(*Dermacantor variabilis*)
male left, female right

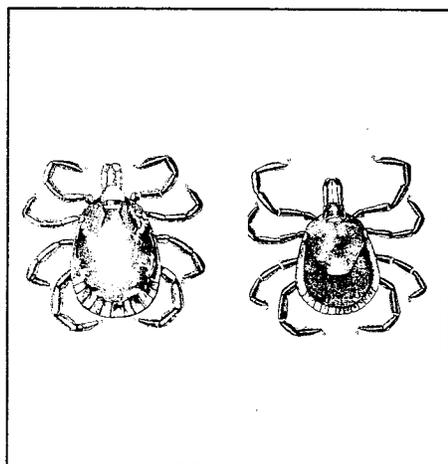
Ticks

such facts for these three species will suffice for most of a commercial pesticide applicator's tick control work; although soft tick infestations may be encountered in association with present or past structural infestation by bats, roof rats, wood rats, or pigeons.

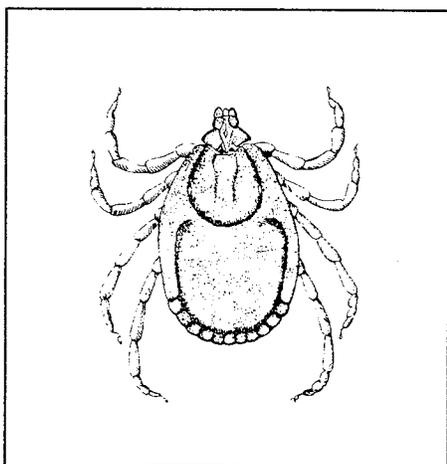
Ticks of Concern in Kansas

American Dog Tick (*Dermacentor variabilis*)

This is the most widely distributed common tick in the U.S. and is abundant throughout most of Kansas. Dog tick is not a good name for this species. Larvae and nymphs feed mostly on mice, moles, cotton rats and rabbits. Adults parasitize many species of wild and domestic animals as well as dogs and humans. Related species found in Kansas include the winter tick (*D. albipictus*), found mostly on large mammals and especially in the fall and winter, and *D. parumapertus* found almost exclusively on jack rabbits.



Lone Star Tick
(*Amblyomma americanum*)
male left, female right



Female Brown Dog Tick
(*Rhipicephalus sanguineus*)

Lone Star Tick (*Amblyomma americanum*)

Lone star ticks in Kansas were long thought to occur only in the southeastern counties. Recent studies have shown them to be currently common throughout the eastern one-third of the state. They are most abundant near brushy and wooded sites. All stages (larvae, nymphs, and adults) parasitize a wide variety of wild and domestic animals, birds, and humans. Their mouth parts are longer than those of the American dog tick, they feed more deeply, and they commonly cause more skin reaction on animals as well as people. The species is named for the single, pale, iridescent spot on the female's back. A related species, the Gulf Coast tick (*A. maculatum*) occurs uncommonly in the Flint Hills and eastward.

Brown Dog Tick (*Rhipicephalus sanguineus*)

The brown dog tick is a native of Africa and is the only exotic tick species that has become well estab-

lished in the U.S. The American strain has a strong host preference for dogs. Brown dog ticks occasionally bite people, usually in a home that has become infested or where people spend time in close contact with infested dogs. These ticks are brought into homes on infested dogs, and unlike other ticks, may become established as indoor pests. This species commonly survives on outdoor dogs only as far north as the southern two or three tiers of Kansas counties, although it occurs in homes and well protected kennels throughout the U.S. Indoor infestations usually are not noticed until winter or early spring when eggs laid indoors in the summer hatch and produce large numbers of ticks. Gravid female ticks usually seek crevices in low sites in which to deposit eggs. Larvae and nymphs tend to crawl upward on walls and across ceilings.

Blacklegged Tick (*Ixodes scapularis*)

This species is present from eastern Texas to eastern Kansas and eastward. It is nearly indistinguishable from the western blacklegged tick. Blacklegged ticks require high humidity and are closely associated with forests, forest edges and dense plant life. The larvae and nymphs feed on many species of small mammals, birds and reptiles. Adults become active in September or October and are found on many animals but are most numerous on deer, cattle and horses. Pets and people are more likely to be bitten by this species during fall and early spring months. Although not abundant in Kansas, this species has been recorded from Chautauqua County through Jefferson County and eastward, with one specimen collected on a deer in Riley County.

Spinose Ear Tick (*Otobius megnini*)

This soft tick is most common in the southwestern states including south central and southwestern Kansas. Larvae and nymphs infest deep within the ear canals, primarily of large, hooved animals but also of

dogs and occasionally humans. The nymphs are covered with spines, making them difficult to dislodge. Their feeding activity may cause great pain and secondary infection. Adults of this species live on the ground and do not feed.

Other Soft Ticks

Ornithodoros turicata and *O. talaje* have no common names. *O. turicata* ordinarily feeds on burrow-dwelling rodents, turtles and rattlesnakes in the dry parts of southern Kansas. This species opportunistically bites humans, causing considerable pain and skin reaction as well as sometimes transmitting relapsing fever. *O. talaje* has been collected in widespread sites within Kansas. This species is more abundant in parts of South and Central America where it has been known to transmit relapsing fever to humans. *O. talaje* feeds principally on rodents but also feeds on many other mammals, including man, and on birds, bats and snakes.

Tick-borne Human Diseases

Several diseases may be contracted from tick bites in Kansas. Contrary to the suggestion in its name, Rocky Mountain spotted fever may be contracted in every state of the U.S. In fact, in recent decades Kansas has had the fifth highest prevalence of this disease—after Oklahoma, North Carolina, Arkansas and Missouri. In Kansas, the causative organism, *Rickettsia rickettsii* is transmitted by American dog ticks, lone star ticks and possibly others. The disease develops rapidly; from 3 percent to 5 percent of cases are fatal; fatalities are usually associated with delay in diagnosis and treatment.

Lyme disease is contracted within Kansas, especially in the eastern one-third of the state. The pathogenic agent, *Borrelia burgdorferi* (a spirochete), is occasionally found in many species of ticks but most species can not transmit it. Circumstantial evidence suggests that Lyme disease

contracted in Kansas may be from the bites of the blacklegged tick and the lone star tick. Blacklegged ticks occur in relatively small numbers in forested areas of eastern Kansas and seldom bite people. Lone star ticks are common to abundant in the eastern one-third of Kansas and they frequently bite people, but several laboratory tests have failed to show this species capable of transmitting Lyme disease. Lyme disease has only rarely been fatal although it sometimes causes severe chronic debilitation.

Tularemia is caused by *Francisella tularensis* bacteria. Most hard ticks, some species of deer flies, and possibly other blood-sucking arthropods are capable of transmitting tularemia. The disease is sometimes contracted through exposure to the blood of infected wild rabbits, squirrels or raccoons, raccoon bites, and cat scratches and bites. About 60 percent of cases are acquired by tick bite. Kansas is considered to be a part of an Arkansas–eastern Oklahoma region of high prevalence for tularemia. Developmental time, prognosis and fatality rates are similar to those for Rocky Mountain spotted fever.

Relapsing fever, caused by the spirochete *Borrelia recurrentis*, is associated with the bite of soft ticks, and historically, from human lice. Few Kansans come in contact with soft ticks. Bites from soft ticks usually occur in relation to working or sleeping in an old building, cabin, bunkhouse or cave that has been infested by rodents or bats.

Q fever is caused by a rickettsia-like microbe, *Coxiella burnetii*. This microorganism is harbored by many species of both hard ticks and soft ticks. People can become infected with Q fever through exposure to filth and dust contaminated by tick excreta and via raw milk of infected cows or goats.

Within recent years another rickettsia-like organism, related to *Ehrlichia canis* that causes ehrlichiosis in dogs, has been shown to cause human disease. Human ehrlichiosis is most common in southeastern and

Ticks

south central states. A few cases have been recognized in Kansas. The brown dog tick is the vector among dogs and, although it bites people infrequently, may be the main vector to humans. Another suspected yet unproven transmitter is the lone star tick.

Tick paralysis is an ascending paralysis caused by the host's immune response to biochemicals in tick saliva. Many species of hard ticks and soft ticks may cause tick paralysis. Onset is most frequently associated with prolonged attachment of ticks, especially along the spine, and most especially near the base of the skull or with simultaneous parasitism by several ticks. Although death may result if paralysis progresses too far, recovery is usually rapid upon timely removal of the ticks.

Tick Control Methods

Tick control is difficult and requires a combination of strategies.

Cultural Prevention

Keeping grassy and weedy areas clipped short throughout the year helps discourage tick infestation and provides less opportunity for ticks that are present to transfer to a host. Most tick species are dependent on rodent hosts such as mice, wood rats, gophers and rabbits during an early life stage. Reduced cover reduces the numbers of these animals, thus reducing tick numbers. Where practical, fencing to exclude deer and cattle from recreation sites also reduces tick populations.

Where appropriate, eliminate shrubs and trees as mixed grassy and woody vegetation provides habitat for both rodents and ticks and affords climbing sites from which ticks can attach to passing people and animals. Twigs and branches should be pruned back from trails so that they do not brush against hikers and afford ticks an opportunity to transfer to them.

Late spring burning of pastures increases grass production and live-stock-carrying capacity while reducing rodent habitat and tick populations. Where feasible, this approach may be used in recreation sites.

Pesticides

Applied to Outdoor Areas.

Insecticides and acaricides are registered for application to specific sites at specific rates for specific pests. Areas where tick control can be implemented include: (1) recreation sites, lawns and non-cropland, and (2) dog kennels. Be sure the specific situation for tick control matches the wording on the label. Do not treat sites that double as pastures, because no chemical tick controls are registered for use on pastures as of this writing. Keep spray or drift from contaminating food crops or grazing areas.

Acaricidal applications are most successful when implemented jointly with as many cultural controls as possible. Tick control requires acaricides with lasting residual activity. In campgrounds and recreation areas, remember that non-target vertebrates and invertebrates are often the primary human attraction to such sites; so concentrate treatment primarily on areas of heavy human activity. This, of course, calls for materials that do not cause imminent danger to human users of the site. Apply treatments when humans are not present and allow reentry only as directed on the label. Do not treat areas likely to shed runoff into streams or lakes when it rains.

Pesticides for Dog Sleeping Quarters and Kennels. Outside tick infestations of various species are often heaviest near the favored resting sites of pets, in dog houses and on or under porches. Gravid female ticks hide in crevices in low sites. Larvae and nymphs tend to crawl upward, so treatment may need to include cracks in and spaces above ceilings of

dog houses, kennels and porches frequented by pets. This is especially likely if brown dog ticks are involved.

Products and specific directions are too numerous to list here and may change without notice. However, tick control compounds registered for use in kennels include some formulations of diazinon, DDVP, carbaryl, malathion, propoxur, pyrethrins and the pyrethroids: allethrin, cyfluthrin, cypermethrin, permethrin and resmethrin.

Pesticides Applied to Indoor Areas The brown dog tick is most often the species that becomes a problem indoors. Treat along baseboards, window and door frames, and any sites where these pests may conceal themselves. Tick eggs may hatch over a period of several months, so more than one treatment may be necessary for control. Most of the products mentioned in the previous paragraph, plus several insecticides commonly used for control of cockroaches and indoor fleas, are registered for brown dog tick control indoors.

Applied to Dogs and Cats. This group constitutes a very long list including one or more formulations of most of the chemicals listed in the previous paragraphs. They include dips, shampoos, dusts and sprays. Such applications are not made by the Commercial Pesticide Applicators with Category 7D and 8 certification, but, as with fleas, if tick control indoors and outdoors is to be effective it must be correlated with treatment of the pets by the pet owner or a veterinarian.

Behavioral Avoidance.

Danger from tick bite and tick-borne diseases can be lowered by avoiding unnecessary forays into tall grass, weeds, and brushy and forested areas—particularly during summer months when the incidence of tick-borne disease is high. Pets can also be restricted from such areas. In tick-infested areas, seek open areas

and trails in preference to dense growths. If you rest, sit on bare ground in a sunlit area.

Clothing as a Barrier.

Long-sleeved shirts with close-fitting cuffs and high necklines, and long trousers make it more difficult for a tick to gain access to bare skin. Once on your outer clothing, ticks tend to climb upward, so upper clothing should be tucked into lower clothing—shirt into trousers, trousers into long stockings or boot tops. For even better protection, tape sock tops over pantlegs with wide tape. Some people apply a second layer of tape with the sticky side out to trap crawling ticks. Light colored clothing helps you see and intercept ticks before they reach skin.

Repellents

Good protection is made better when a person clothed as described above applies a tick repellent to outer clothing and unprotected skin areas such as wrists and hands. Be especially liberal with repellent in the area from the ankles to the knees and where one item of clothing joins another such as at the beltline. A recommended tick repellent is N, N-diethyl-meta-toluamide, often called "Deet." Permethrin-based repellents can be used on clothing and allowed to dry before putting the clothing on. Dusting sulfur is effective but messy, and with perspiration causes an undesirable odor.

Repellents for pets include pyrethrins and some permethrin products.

Personal Inspection

After returning from tick infested areas, remove your clothes and inspect yourself for ticks. Children, especially, will need help searching themselves for ticks. Larval and nymphal ticks may be mistaken for freckles or small scabs, so look carefully. Even ticks that are attached are unlikely to have transmitted disease if they are removed within a few hours.

Ticks

Also inspect the clothing or wash it immediately so ticks can't crawl out of it into furniture, carpets or other clothing. Leave camping gear and bedrolls outside until well inspected.

Tick repellents and tick-killing collars seldom do a complete job. Daily hand-picking of ticks from your pet or working dog is important if the animal frequents infested environments. Primary tick attachment sites on cats include the head, neck and back. Favored sites on dogs vary with the dog's conformation, hair coat and age. Keeping ticks from becoming engorged on pets reduces the number of ticks close to home the following season.

Tick Removal

To remove an embedded tick, place fine-tipped tweezers close to the skin and grasp its "head," then pull gently and patiently directly away from the skin surface. Never twist or pull side-

ways. Do not try to make the tick back out with heat, vaseline, lighter fluid, alcohol, etc. Such methods only work when the tick is not securely attached. If the tick is deeply attached, such methods may cause it to regurgitate, which increases the likelihood of both disease transmission and secondary infection. Do not squeeze the tick's body as you may squeeze its gut contents into the skin, causing infection.

Disinfect the tick bite. Save ticks removed from humans in alcohol with the date and the victim's name on the container for future reference. Do not put ticks from different people or from different occasions into the same container. Be especially watchful for the first 10 to 14 days after tick bites for flu-like illness, headache, lack of balance, nausea, extreme fatigue, skin rashes or fever. If such symptoms develop, see a physician and take the ticks you saved.

STUDY QUESTIONS for pages 39–44

Ticks

1. (39) Ticks have ____ pairs of wings and antennae.
 - a. 0 (none)
 - b. 1
 - c. 2
 - d. 3
2. (39) Ticks deposit their eggs _____.
 - a. on grass stems
 - b. beneath soil debris
 - c. on tree trunks
 - d. on the host animal
3. (39) There are ____ species of ticks in Kansas.
 - a. 800
 - b. 80
 - c. 20
 - d. 3
4. (40) The most widely distributed tick in the U.S. and is abundant in most of Kansas is the:
 - a. lone star tick
 - b. American dog tick
 - c. blacklegged tick
 - d. brown dog tick
5. (40) Lone star ticks are most abundant:
 - a. in corn and sorghum fields
 - b. in native grass meadows
 - c. near brushy and wooded areas
 - d. in and around dairy barns
6. (40) This tick requires high humidity and is closely associated with forests and other dense plant life.
 - a. blacklegged tick
 - b. brown dog tick
 - c. spinose ear tick
 - d. sheep tick
7. (41) In recent decades, Kansas has ranked _____ highest prevalence in Rocky Mountain spotted fever.
 - a. first
 - b. third
 - c. fifth
 - d. seventh
8. (41) About ____ percent of the cases of tularemia are acquired from tick bites.
 - a. 20
 - b. 40
 - c. 60
 - d. 80
9. (42) Tick paralysis is caused by the host's response to:
 - a. the tick puncturing the skin
 - b. a toxin specific to humans
 - c. the tick crawling around
 - d. biochemicals in the saliva
10. (42) Apply tick control chemicals to recreational areas only when humans are not present and allow reentry:
 - a. according to label directions
 - b. immediately
 - c. always after 6 hours
 - d. always after 12 hours
11. (43) The tick that most often becomes a pest indoors is the:
 - a. American dog tick
 - b. lone star tick
 - c. brown dog tick
 - d. spinose ear tick
12. (43) When used as a tick repellent on people and clothing, _____ is messy and stinks.
 - a. Deet
 - b. sulfur
 - c. permethrin
 - d. lime
13. (44) Primary attachment sites for ticks on cats include:
 - a. feet and lower legs
 - b. head, neck and back
 - c. ears and tail
 - d. face, chest and belly
14. (44) Human victims of tick bites should be especially watchful for disease symptoms for the first _____ days after the bite.
 - a. 10 to 14
 - b. 15 to 20
 - c. 21 to 25
 - d. 26 to 31

Skunks



More than 50 percent of the confirmed rabies cases in Kansas are from skunks. The odor given off by skunks can cause many problems for homeowners. The digging habits of skunks can damage house foundations and lawns.

Rabies

Rabies remains enzootic in the striped skunk population of Kansas making up more than 80 percent of the animals confirmed rabid each year. On a yearly basis skunk rabies usually peaks between the months of April and July. This peak is directly related to the breeding season. Skunks breed during February and March at which time rabies virus may be spread from an infected to an uninfected skunk. Once infected, the incubation period may last from 2 weeks to 18 months before the skunk develops clinical rabies. Skunks have been documented to shed virus in their saliva up to 9 days before clinical signs are evident. It is therefore imperative that all skunks be considered potentially rabid and treated with extreme caution when being removed from premise.

Since 1969, three peaks of skunk rabies have occurred in Kansas. Each peak has occurred approximately 10 years apart and has progressively increased in intensity. Increased incidence of skunk rabies is related to areas of denser human and skunk populations, warmer yearly temperatures, and higher amounts of rainfall. The majority of skunks confirmed rabid in Kansas were located around human dwellings during the daylight hours.

A rabid skunk will generally exhibit central nervous system disorders, i.e. walking in circles, falling down, disorientation, staggering and in some cases aggression. However, the spray from a skunk does not constitute an exposure because the virus is not present in the musk or the musk glands. In local areas or in

years where enzootic skunk rabies develops into an epizootic, a "spill-over" effect occurs causing a simultaneous increase in the number of rabid domestic animals thus increasing the danger of rabies exposure to humans. (By Debra Briggs, Veterinary Medicine, Kansas State University)

Biology

There are two species of skunks in Kansas. The *striped skunk* is about the size of a large house cat, generally black in color with two white stripes running from the base of the skull to the large bushy tail. Solid black individuals are known to occur but only rarely. The *spotted skunk* is a smaller mammal about the size of a half-grown house cat. The spotted skunk is now rarely found in Kansas and is fully protected by state regulations. The season on the striped skunk is open all year.

The striped skunk is most often found close to old buildings and stream banks. It is generally more tolerant of humans and is more abundant than the spotted skunk. In rural areas the striped skunk will frequently den beneath barns and sheds. Its daily range is about one-half to one mile.

Skunks are among the least popular of all our wild animals because of the disagreeable scent they discharge. Yet they are very beneficial, as over 1,600 stomach analyses indicate. Nearly half of their natural diet is insects: one-fifth fruit, and one-fifth mice. They are destructive of potato beetles, grasshoppers, white grubs and mice around buildings. They are active at night.

Skunks are active all year. They may sleep for several days during very cold weather but do not hibernate. Skunks give birth to four to 10 naked, blind young. Only one litter a year is raised. Adults weigh from 8 to 10 pounds. Females are usually somewhat smaller.

When a skunk raises its tail, it is a warning. Ordinarily, there is no discharge. But if the skunk believes it is in danger, one discharge will not



Skunk

Skunks

empty the reservoir. An effective method to neutralize the odor is to wash everything with ammonia water. Neutroleon alpha mixed at 2 ounces to 1 gallon of water can also be sprayed in the area contaminated with the skunk odor and is effective in clearing the air.

Habitat

Skunks normally use an underground den to which they retire during daylight hours. Dens are seldom occupied by single individuals. Most are used by a female and her current brood. It is not unusual for several adult females to occupy a den with a single male. During cold weather as many as a dozen adults may sleep intermittently for several weeks in a single den. Occasionally a skunk den is occupied by a solitary older male.

Legal Status

Striped skunks are classified as furbearing mammals. The season is open year around. No poisons are registered in Kansas for use on skunks.

Control

Properly constructed foundations will prevent skunks from denning beneath buildings. In lieu of continuous foundations, screening with quarter-inch hardware cloth is effective.

Removal

The procedure with individuals or families of skunks is best accomplished with live traps. Other traps that kill or maim may result in serious odor problems and death or injury to non-target animals. Bait live traps with a portion of peanut butter on bread. Skunks are relatively easy to trap. When the trap is covered with canvas or a plywood shell and handled with a minimum of jarring or shaking, the trapped skunk can be disposed of in a humane manner.

Bats



The bats found in Kansas occupy various portions of the state with considerable overlap of distribution. Some migrate in winter but other species are permanent residents. For positive identification of bats, contact the Museum of Natural History at the University of Kansas. One species of bat, the gray bat, is an endangered species and may be found in extreme southeastern Kansas.

Habitat

All bats in Kansas are nocturnal, roosting in crevices, caves, tunnels, tree foliage or buildings during the day. Some species have a separate night roost to which they retire between feeding flights. Some species are more particular about the kind of roost they select than others. Many hibernate in caves in winter and may move from one cave to another several times. The most stationary species may inhabit the same roost throughout the year.

Before you can determine the habits of a particular kind of bat, you need to identify the bat. It is important to know the habits of a bat before control procedures are determined.

Bats rely on reflection of high-pitched squeaks they emit to avoid collisions and to determine location of prey. Most bats live almost totally on insects captured and eaten on the wing. Bats hang upside down when resting, and many species conserve energy during the day by lowering body temperature.

Breeding occurs in autumn before hibernation or at the winter roost, depending on the species. Ovulation occurs after winter dormancy is over, at which time the stored sperm fertilizes the egg. The young (usually only one or two, though a few species bear up to four) are born 2 to 3 months later, in May to July. Young are born naked and many cling to their mother for some time after birth. No nest is ever built. The young are able

to fly at 3 to 4 weeks, though some continue to nurse for several weeks longer. In this case, they are left in the nursing colony.

In many species the adults segregate when the young are gone. Each male lives alone through the summer while the females remain together. Most species of bats are colonial but some are solitary. Both conditions may occur in some species. Bats have few enemies, such as owls, snakes, and some bats live to 20 years or more.

Legal Status

Bats are classified as nongame mammals by the Kansas Fish and Game code. Nongame mammals which are damaging property may be taken by the owner or tenant of the premises. One species, the gray bat found in southeastern Kansas, is classed as endangered.

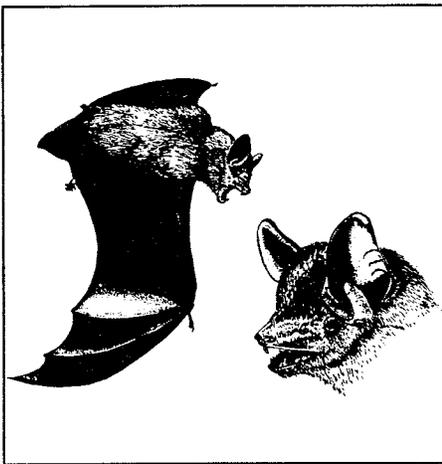
Damage

Bats inhabiting buildings produce offensive odors and distracting noise. Bats can carry rabies. Transmission need not be from a bite from an infected bat. There is evidence that exposure of abraded skin to bat urine or even inhalation of cave air may be infective. A number of bats live in Kansas. As there are no true blood-sucking bats in the United States, a bite is unlikely unless one is handling or disturbing bats.

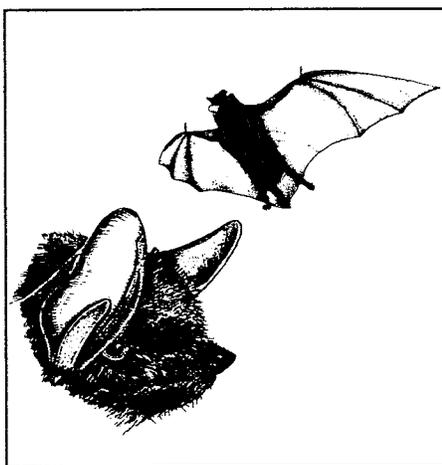
Brown bats are reservoir hosts of encephalitis, which may be transmitted to humans by mosquitoes. Encephalitis can cause death, spastic paralysis or mental retardation. Histoplasmosis, a systematic fungus disease of humans, may be contracted by inhalation of dusty bat manure containing air-borne spores of the fungus.

Repellents

Bats may be driven out of attics or other enclosed spaces by spreading naphthalene over the area at a rate of about 5 pounds for every 2,000 cubic feet. If the area does not lend itself to



Big Brown Bat
(*Eptesicus fuscus*)



Little Brown Bat
(*Myotis lucifugus*)

spreading the material, it may be suspended from rafters in cheesecloth bags. This material dissipates upon exposure to air and repeated applications may be necessary if entrance holes are not plugged after the bats have left.

After the bats have left the treated area, seal off openings by which they are gaining entrance to the building,

such as small crevices around eaves, bases of rafters, etc., with strips of wood, metal or caulking compound.

New individuals may be attracted by the odors left by departed bats. Therefore, a thorough clean-up and bat-proofing should be considered necessary adjuncts to the use of repellents.

STUDY QUESTIONS *for pages 46-49*

Skunks and Bats

1. (46) Skunks cause problems to homeowners because of their:
 - a. odor
 - b. digging around house foundations
 - c. digging in lawns
 - d. all the above
2. (46) Skunks are documented to shed rabies virus in their saliva up to ____ days before clinical signs appear.
 - a. 7
 - b. 9
 - c. 11
 - d. 13
3. (46) There two species of skunks in Kansas. They are the striped skunk and the _____.
 - a. spotted skunk
 - b. pole cat
 - c. lined skunk
 - d. white skunk
4. (47) Skunks normally spend the daylight hours:
 - a. under leaves and branch piles
 - b. boards and trash around buildings
 - c. in nests in low tree branches
 - d. in under-ground dens
5. (47) When using live traps to capture skunks, bait them with:
 - a. cheese
 - b. dead grasshoppers
 - c. peanut butter on bread
 - d. bacon fat
6. (48) All bats in Kansas are active only:
 - a. at dusk
 - b. at night
 - c. at dawn
 - d. at mid-day
7. (48) Bats are classified as _____ animals.
 - a. furbearing
 - b. non-furbearing
 - c. game
 - d. nongame animals
8. (48) Brown bats are a reservoir host for ____ which may be transmitted to humans by mosquitoes.
 - a. encephalitis
 - b. yellow fever
 - c. rabies
 - d. histoplasmosis
9. (48) Bats can be repelled by spreading naphthalene in the attic or by:
 - a. spraying it as a fine mist
 - b. suspending it from the rafters in bags
 - c. spraying in as a course spray
 - d. blowing the fumes into the attic
10. (49) Because new bats may be attracted to the odors of previous bat roosting areas, _____.
 - a. trap them on arrival.
 - b. thoroughly clean-up and bat-proof the controlled site.
 - c. shoot them with No. 10 shot.
 - d. place poison at the entry points.

Rodents



Field Rodents

Approximately 16 different kinds of field rodents live in Kansas. Health problems associated with these animals is not believed to be serious. Some do carry fleas that might transmit plaque, especially in extreme western Kansas. Other field rodents are important as reservoirs of Rocky Mountain spotted fever. Control methods for field rodents are similar to the following description for prairie dogs. (See appendix page 78.)

Prairie Dogs

Biology

Prairie dogs are social mammals that live in colonies on short- and mixed-grass prairie. Of the five species native to the United States, it is the black-tailed prairie dog that is found in Kansas.

The black-tailed prairie dog is a thickset, burrowing squirrel with a black-tipped tail. The fur has a distinct reddish cast, the eyes are large and the ears are inconspicuous. The legs are short with five toes on each foot and the head is broad and round. Adults vary from 10 to 12 inches in length and weigh between 1½ to 2½ pounds.

Prairie dog colonies, called towns, house from a few to thousands of individuals. Within a town, prairie dogs form small social groups known as coteries.

The species native to Kansas is active only during the day and does not hibernate. Between four and five are born per litter each year in March or April.

The population of dogs per acre is greatest during the spring after the young are born and lowest in late winter. The population density of black-tailed prairie dogs varies from 5 in late winter to 20 per acre in the summer.

Legal Status

Prairie dogs are classified as non-game animals in Kansas. There is no closed season on them. Some laws

relate to the authority of county boards to levy taxes for prairie dog control.

Bridled weasels are common in southwest Kansas and are often confused with the black-footed ferret.

Endangered Species

Products used in prairie dog control are hazardous to other wildlife. The user of any control method is responsible to insure that the area proposed for treatment is not inhabited by the black-footed ferret, an endangered species. If a ferret is suspected to inhabit the area, report its presence to state fish and game authorities before undertaking prairie dog control.

Control

If artificial control is practiced, the most workable method now known is baiting with a single dose poison. All poison grain and fumigant material used in controlling black-tailed prairie dog damage should be registered by the Environmental Protection Agency and the state of Kansas. If you use these materials, follow instructions on the label.

Prairie dogs will take oats readily whenever green food is not available. During the spring and summer when the prairie dogs feed almost entirely on green food, they are very difficult to poison. It is after the grasses and roots have become dried that they will take poisoned grain. Therefore, late summer or early winter is the best time to start a poisoning program.

Pre-bait the area with clean, unpoisoned grain. Allow 2 days to elapse. Check to see if pre-bait has been consumed. If pre-bait has been eaten, then thoroughly treat the entire colony. Usually a large percentage of the prairie dogs will be destroyed. A week or 10 days later, apply poison grain again to occupied burrows. Any animals that survive then can be destroyed by fumigation.

Results are better when the poison is scattered in the early morning. Wind and rain drastically reduce the



Prairie Dog

effectiveness of the treatment and should be avoided. All burrows in a large colony must be treated. One person can treat 8 to 10 acres. Therefore, a person on foot can cover 80 to 100 acres daily. Carry the poison grain in a cloth sack and distribute it with a tablespoon. Wear rubber gloves and work during calm weather. After distributing the poison grain, stay away from the area for at least 24 hours.

Do not place the grain inside the burrow entrance, on the mound or in the grass away from the mound. Do not put the grains in lumps or piles. If the grain is scattered well, danger to livestock is minimal. The safest way to avoid poisoning livestock is to treat only pastures where livestock has been removed.

When placing poison grain, use only the small amount recommended on the label and put the grain on the flat, bare ground between the mound and the grass.

Fumigating

The prairie dogs that have survived the poisoning can be killed with a fumigant. A permit from the Kansas Department of Wildlife and Parks is required to use a fumigant on prairie dogs. On a small scale, fumigating is neither too expensive or laborious. Fumigate only burrows known or strongly suspected to be occupied.

Mark all burrows to be treated. As the burrows are treated, the markers can be removed or pushed over. Suffocating cartridges are ignited and inserted into closed burrows to remove available oxygen and suffocate all burrow occupants.

The burrow should be closed with soil after fumigation to make the gassing more effective. Frequently one fumigation will kill all of the prairie dogs. If any burrows are reopened or activity is noted after treatment, the active burrows should be fumigated within a week after the first treatment.

There are limitations on the use of fumigants. Any fumigant tends not to be effective in dry soil, especially

sandy soil. Fumigation fails sometimes because of configuration of the burrow system, length of the burrow system, and absorption of gasses into soil cracks or into interconnecting burrows. Fumigation when carried out as the initial control method on large prairie dog colonies is expensive, laborious, often disappointing, and therefore, a waste of time and money.

Commensal Rodents

Norway rats and house mice are commensal rodents. Rodents that live in close association with man are called "commensal." Both rodents are found throughout Kansas.

Norway rat and house mouse control is different. One needs to study the habits of each before control is started. (See page 78, appendix.)

There are five important steps in rat and mouse control. You need to go through each step starting at number one. You cannot start at number two and achieve control.

1. Cleanup—put rodents under stress.
2. Single dose toxicant.
3. Anticoagulant.
4. Traps.
5. Program of rodent proofing.

No poison bait can solve the problem alone. Commensal rodents are a social problem rather than a biological one.

Norway Rat

Habitat

Norway rats can be found in warehouses, farm buildings, houses, irrigation dikes, sewers, rubbish dumps, wood piles and building foundations. They are good climbers. They can reach a height of 18 inches and jump 24 inches vertically. Rats are good swimmers and can stay afloat for 72 hours.

The Norway rat is a good digger and burrows along foundations of buildings, beneath rubbish piles, and in fields. He is a superb gnawer and can gnaw through concrete and soft metal. Norway rats are dominant and aggressive. They will not hesitate to



Before fumigating, look for ferret ramps.

Rodents

attack children, and fight viciously if cornered. They can walk on wires and descend headfirst.

The tail of a Norway rat is shorter than its head and body combined. Norway rats have relatively poor vision but keen senses of smell, touch taste and hearing. The sense of touch is served by the long whiskers (vibrissae) on the snout. Domestic rats and mice run close beside a wall where these sensory hairs touch to give the animal information about its surroundings. The home range is frequently 100 to 150 feet.

Norway rats and other domestic rodents are nocturnal but may go about in undisturbed places during the day. They feed on virtually anything edible. They may move up to 4 or 5 miles in their wanderings. Norway rats are unable to vomit. They must drink water to survive.

Rats and mice are normally not abundant in the same place. One or the other will be dominant.

Norway rats are prolific breeders, a fact which has made them useful in their albino form, as the standard laboratory rat in biological experiments. The average length of life is about 1 year, and sexual maturity is attained in 3 to 5 months. The young average 8 to 10 per litter (extremes of 2 to 22). Although 12 litters a year are possible, the average is 4 to 7 per year. The gestation period is 21 to 22 days and the young may run about at 3 weeks of age. The average number of young weaned per year by a female out of captivity is 20. It is theoretically possible for a pair to increase to 2,000 in one year.

The Norway rat is colonial. It is not native to North America. It is apparently vulnerable to predation by owls, hawks, weasels and coyotes.

Legal Status

Norway rats are not classified by Kansas laws.

Damage

Grain and vegetables are among the crops damaged by Norway rats. Stored agricultural commodities may

be consumed or contaminated by rat urine, hairs and feces, thus endangering human health and requiring stringent inspection procedures and preventive measures to exclude rats from warehouses and other food handling facilities. Rats may eat eggs and kill young birds on poultry farms as well as eating feed.

Rats are hosts to the Trichina worm. Man may become infected if he eats poorly cooked pork after the hog has eaten an infected rat. Rat urine may transmit leptospirosis and the feces may contain Salmonella bacteria. Bubonic plague and murine typhus fever may be transmitted by infected rat fleas. Rat bites may cause bacterial ratbite fever or infection, as well as ugly scars.

Rat gnawing causes spillage of feedstuffs and damage to woodwork and electrical wiring, resulting in shorted circuits and fires. Rats cut and shred clothing and other fabrics when making nests. And rats may annoy or frighten some persons.

Baits

Suggested baits for Norway rats include steel cut oat groats, rolled barley, whole corn, yellow corn meal, rolled oat groats and rolled wheat. In special problem areas such as in dumps, chunk type dog food or meat baits may be used. Sugar, to 5 percent by weight, may be added to improve bait acceptance.

Toxicants

Single dose poisons: Place a teaspoon of bait (about 80 per pound) in each active burrow or scatter small amounts of bait in protected places frequented by rats, but inaccessible to livestock, poultry, wildlife and children. Prebaiting 2 days before applying acute or one-shot toxic bait will achieve better control and will indicate how much toxic bait to put out. Prebaiting should be conducted where natural food is abundant. If possible use natural foods as a bait and reduce access to natural foods.

Bait should be picked up and disposed of upon completion of the rodent control program. Do not re-treat with single dose baits for at least 3 months and preferably 6 months.

Anticoagulant baits: A single feeding on anticoagulant baits will not control rats. Bait must be eaten at several feedings on five or more successive days with no periods longer than 48 hours between feedings. It is important to use enough baits so all the rats can feed.

Place 4 to 16 ounces of bait in bait box or shallow container, preferably in protected feeder stations. Place bait stations in dry locations such as in concealed places, in corners, or along walls where rats frequent. Inspect stations daily and add bait as needed. Increase the amount when bait in feeder is entirely consumed overnight. Replace moldy or old bait with fresh bait. Maintain an uninterrupted supply as long as any bait is taken which may be 2 to 4 weeks. For Norway rats put bait at or near ground level and at burrows and haborages.

Where a continuous source of infestation is present, establish permanent bait stations and replenish as needed. Pick up and dispose of all bait upon completion of the rodent control program.

Paraffin bait blocks: Cereal baits embedded in paraffin are used in sewers, outdoors or excessively damp locations where unprotected bait would spoil rapidly. The bait blocks are reasonably weather-proof, eliminating the need for bait stations.

Paraffin bait blocks are not as readily accepted as comparable bait in the loose form. Paraffin bait blocks should only be used where environmental conditions demand a moisture-resistant type bait or use of loose bait is impractical.

As old blocks are eaten away, replace with new ones. Pick up and dispose of all bait upon completion of the rodent control program.

Traps

Recommended traps for rats include line traps, expanded trigger snap traps and 110 conibear traps.

House Mice

House mice are found throughout the state. Occasionally, they are found in fields, but usually in buildings. House mice build nests in boxes and crates, as well as stationary objects, enhancing their rapid distribution.

Biology

House mice live in a variety of man-made structures. Mice living in the open may move into buildings when weather becomes severe. They soon become accustomed to ordinary noises and as a result may be active near people, animals or machines.

The poor vision of mice is compensated by keen senses of smell, taste, hearing and touch. Because the long whiskers on the nose and above the eyes serve the sense of touch, mice normally make runways near walls.

House mice eat the same foods as man, showing a preference for foods high in protein or carbohydrates. Different environments offer varied diets and sometimes mice will feed upon such things as live insects, starch in clothing, and glue in book-bindings. They require very little water and can live for many months on a dry gain diet.

Because of their small size, mice must feed several times during a 24-hour period. This means they will be active during the day as well as the night. Their range is normally 10 to 30 feet from the nest. The nest is lined with soft materials such as cotton or paper and may be built in walls, cabinets, upholstered furniture or other convenient spaces. Their urine and droppings mark the trail for others. Mice are poor swimmers.

The usual length of life is about 1 year. During this time a female house mouse will raise an average of 30 to 35 young. Sexual maturity is attained at 1½ months, gestation period is 18 to 21 days, and of several litters (up to 8 per year) of 3 to 11, usually 5 or 6 young are raised. The young are born blind.

Rodents

Legal Status

House mice are not classified by Kansas law.

Damage

House mice are omnivorous. They consume and contaminate stored grain and cereal products as well as fruit, vegetables, cheese, meat and hay. They are often a pest in chicken houses where they consume the chicken feed. Other property damage, including gnawing of electrical wire insulation, will occur.

Mice and their ectoparasites are involved in the transmission of diseases: salmonella food poisoning by infected rodent feces on suitable foods; rickettsialpox by the bite of the house mouse mite; and lymphocytic choriomeningitis, a virus infection of house mice, transmitted to man by means of food or dust contaminated with respiratory droplets or powdered feces of infected animals.

Baits

Suggested baits for house mice include oatmeal, rolled oats, yellow corn meal, cracked corn, rolled wheat, peanut butter, and jelly beans. Sugar, to five percent by weight, may be added to improve bait acceptance.

Toxicants

Anticoagulants. *Spot baiting*—bait boxes, bait traps and place packets.

Broadcast baiting—rarely used but may be used in some special situations where repeated applications can be made until control is achieved.

House mice are naturally less susceptible to anticoagulants than rats and have different feeding patterns, thus anticoagulant baits are sometimes prepared at double strength. Double strength baits increase the potential for hazards to pets and domestic animals. Therefore, use them with even greater caution than normal strength baits.

Single dose poisons. *Spot baiting*—bait boxes and place packets.

Broadcast baiting—rarely used except where house mice reach high field densities.

Tracking power—put small amount in bait boxes or pipes along walls.

Directions for use of single dose poisons: Place tablespoon amounts ($\frac{1}{4}$ to $\frac{1}{2}$ ounce) of bait in shallow containers spaced 8 to 12 feet apart. Place in dry locations such as in concealed places, in corners, or along walls where house mice frequent.

Bait placements should be inaccessible to children, pets or domestic animals or exposed in tamperproof bait boxes. Dispose of bait upon completion of the rodent control program.

Do not re-treat with single dose poison bait for at least 6 months.

Anticoagulant baits: A single feeding or drinking of anticoagulant bait will not control house mice. Bait must be eaten ten or more successive days to give adequate control. Paraffin bait blocks are not particularly effective or necessary for house mice.

Place tablespoon amounts ($\frac{1}{4}$ to $\frac{1}{2}$ ounce) of bait in bait box or shallow container, preferably in protected feeder stations. Place bait stations at 8 to 12 feet intervals in dry locations such as in concealed places, in corners, or along walls where house mice feed, drink or frequent. Inspect stations daily and add bait as needed. Increase the amount when bait in feeder is entirely consumed overnight. Replace moldy or old bait with fresh bait. Maintain an uninterrupted supply of bait as long as any bait is taken, 2 to 4 weeks.

Where a continuous source of infestation is present, establish permanent bait stations and replenish as needed. Pick up and dispose of bait upon termination of control.

Traps

Numerous traps should be set in small areas. Peanut butter, oatmeal and jelly beans are good bait. Expanded trigger traps can be used. Sticky compounds on boards are effective in reducing mice traffic.

STUDY QUESTIONS for pages 50–54

Rodents

1. (50) There are approximately ____ different kinds of field rodents in Kansas.
 - a. 5
 - b. 11
 - c. 16
 - d. 20
2. (50) The best time to poison bait control program for prairie dogs is:
 - a. late winter or early spring
 - b. early spring or early summer
 - c. late summer or early winter
 - d. actually, prairie dogs only eat green grass
3. (51) When placing poison grain bait for prairie dog control:
 - a. place it in the burrow entrance
 - b. scatter on bare ground between the mound and the grass
 - c. scatter on the mound only
 - d. scatter on the grass only
4. (51) The first step in rat and mouse control is:
 - a. single dose toxicant
 - b. traps
 - c. use of an anticoagulant
 - d. cleanup to put them under stress
5. (52) The tail of the Norway rat is shorter than the combined length of its:
 - a. head and body
 - b. two front legs
 - c. two hind legs
 - d. front and hind legs
6. (52) Norway rats are prolific breeders and have an average gestation period of _____ days.
 - a. 15 to 16
 - b. 21 to 22
 - c. 27 to 28
 - d. 32 to 33
7. (52) Stored agricultural commodities may be consumed or contaminated by Norway rat:
 - a. hair
 - b. urine
 - c. feces
 - d. all the above
8. (52) The addition of sugar in Norway rat bait, of ____ percent by weight may improve acceptance.
 - a. 5
 - b. 10
 - c. 15
 - d. 20
9. (53) _____ should only be used for rat control where environmental conditions demand a moisture-resistant bait.
 - a. Paraffin bait blocks
 - b. Toxic plastic strips
 - c. Dried meat containing poison
 - d. Naturally occurring rat diseases
10. (53) House mice have very poor _____.
 - a. sense of smell
 - b. sense of taste
 - c. vision
 - d. sense of touch
11. (54) Rickettsialpox is transmitted from mice to man by:
 - a. mouse bites
 - b. mosquito bites
 - c. house mouse mite bites
 - d. flea bites
12. (54) For anticoagulant baits to be effective on mice, they must be eaten for a minimum of _____.
 - a. 5 days
 - b. 7 days
 - c. 10 days
 - d. 15 days



Large roosting concentration of birds can lead to potential public health problems. They can be noisy, their droppings create an objectional smell, and the droppings and the weight of the birds break limbs and destroy vegetation. The droppings also form a medium for the growth of bacteria and fungi. In addition, birds may act directly as carriers or vectors for some diseases. See page 79, appendix

Diseases From Birds

Histoplasmosis

Histoplasmosis is a respiratory disease in humans caused by inhaling spores from the fungus of *Histoplasma capsulatum*. Birds do not spread the disease directly. The spores are spread by the wind and the disease is contracted by inhaling them. Nevertheless, the birds' droppings enrich the soil and promote growth of the fungus.

Infection by only a few spores generally produces a mild case in humans and a person may be unaware that he had the disease unless it is detected later through a skin reactivity test or lung x-ray which reveals healed lesions. A person may acquire immunity without realizing it. A more severe infection may result in an acute pulmonary case with symptoms much like the flu. In fact, it is often misdiagnosed as flu. As with flu, the patient generally recovers spontaneously after a period of several weeks.

The most serious infections, usually resulting from massive spore inhalation, may involve a disseminative case in which the fungus is dispersed through the blood stream. Such cases may become chronic, recurring at later times.

There are also other possible sources for histoplasmosis infection, including: poultry farms (chicken coops are a serious source); natural fertilizers (especially rich soils

enriched with chicken droppings and later used as fertilizer); and enclosed buildings where birds or bats have roosted. In addition, the fungus can grow in various natural soils with or without droppings. In some areas, such as the Ohio Valley, histoplasmosis is so widespread that 95 percent of the human population becomes infected whether associated with birds or not.

Not all blackbird or starling roosts pose an immediate public health problem of histoplasmosis. The histoplasmosis fungus grows readily in bird roosts, but an active, undisturbed roost may not present an immediate human health hazard. Although the fungus grows well in bird droppings, it cannot form spores under the acidic conditions of fresh droppings. An active undisturbed roost may only give off a few spores that may result in the normally undetected kind of case.

Old or abandoned roosts, however, can be a different matter. After droppings have dried out or been leached by the rain, the right conditions develop for spore release. If the soil is stirred up under dusty conditions, as may be the case in land clearing or bulldozing, massive amounts of spores may be released. The bad epidemics associated with bird roosts have occurred from such conditions.

Birds in large roosts can sometimes be dispersed by the use of various frightening devices or by roost thinning or clearing. In severe situations, bird populations at roosts may be reduced by using wetting agents. Take precautions when working around an old or abandoned roost site. Wear a respirator or face mask with dust filter to prevent inhalation of the spores.

If an area that was once a bird roost is going to be cleared or bulldozed, do the work when the weather is wet or cold. Avoid clearing under the dry, dusty conditions of late summer. A roost may be decontaminated by treating it with a diluted formaldehyde solution before clearing. It is wise to test for the presence of *Histoplasma* before beginning any work.

Ornithosis (*psittacosis*)

The pigeon is the wild bird species most commonly associated with the transmission of ornithosis to humans. Ornithosis is caused by a virus-like organism and is usually an insidious disease with primarily pneumonic involvement. It can be a rapidly fatal infection.

Birds have become adapted to the disease and show no symptoms. They act as "healthy carriers," shedding the organism in their feces which later may become air-borne as dust. The disease may also be contracted from parakeets or farm poultry.

Several cases of ornithosis are usually diagnosed in Kansas each year. Since the disease has a low fatality rate (less than 1 percent of cases reported in the United States) and is usually mild, many cases undoubtedly occur in human beings that are undetected or incorrectly diagnosed.

Salmonellosis

Salmonellosis, a form of food poisoning, is a common disease. It is an acute gastroenteritis produced by members of the *Salmonella* group of bacteria pathogenic to man and other animals. The organism can be spread in many ways, one being through food contaminated with bird feces or with *Salmonella* organisms carried on the feet of birds.

Other Diseases

Pigeons, starlings, sparrows, black-birds and other birds have been implicated in the transmission of various diseases of significance to humans or livestock.

Starlings have been shown to be vectors of TGE (transmissible gastroenteritis) of swine. The virus can be carried in an infective state in the bird's intestine or on its feet for up to 30 hours. It is generally fatal to baby pigs and causes weight loss in adults. Starlings may also be involved in the transmission of hog cholera.

Cryptococcosis is a fungus causing chronic meningitis. It is spread by pigeons and starlings and is usually

fatal. Various species of birds may also play a part in the transmission of encephalitis, Newcastle disease, aspergillosis, toxoplasmosis, pseudotuberculosis, avian tuberculosis, and coccidiosis.

Birds should be dispersed or controlled when they form large concentrations near human habitations and are judged to pose a threat to public health or livestock. Concentrations of birds that do not pose a serious problem to human health or agriculture are usually better left undisturbed.

Avoid working around bird roosts during dry, dusty weather conditions and wear a face mask with dust filter whenever working around an established roost. Merely controlling or dispersing birds at a large roost does not necessarily eliminate the public health problem. Before the soil or droppings under a roost are disturbed, test the soil for *Histoplasma*. If positive, pretreat with decontaminates.

Problem Birds

The Australian crow trap was designed to capture crows. The entrance is ladder shaped with holes measuring 6 inches by 12 inches. Whole corn, whole oats, watermelon, eggs, an animal carcass or whatever the birds have been feeding upon have been effective baits. Provide adequate water as crows need a lot of water and drink several times a day.

House Sparrow (*English Sparrow*)

The house sparrow is found throughout Kansas. It lives in cities and towns, and in agricultural areas.

Biology

Nest building begins as early as April with both sexes participating in the activity. Nests are constructed of grass, straw and debris and may be located almost anywhere. Three to seven eggs are laid (commonly five) and two or three broods are raised each year. The same nest has been occupied by up to four different

females in a season, leading to higher estimates of the number of broods raised than is probably the case.

The incubation period of the sparrow is 11 to 12 days. The age at first flight is about 15 days. Soon after the young leave the nest they gather in small flocks. As the summer advances the juveniles are joined by adults until the flock may number several hundred.

The house sparrow is primarily a grain eater. An adult bird eats about 6 grams of dry grain a day. Bread crumbs and other human debris, no doubt, substitute for grain in cities. Some weed seeds and insects are eaten, but animal food accounted for less than 5 percent of the annual diet (Kalmbach 1940). The young are fed most of the animal matter. Succulent vegetable matter including fruit, young plants and blossoms of beans and peas are also taken.

Legal Status

Kansas law does not define house sparrows in any way and they may be taken and possessed by any person at any time. There are no federal restrictions on taking house sparrows.

Crop and Health Damages

Damage to crops include the following: grain, especially sorghums, near ranch buildings; grain in poultry rations, storage sheds and livestock feedlots; sprouting vegetables and flower crops and newly seeded lawns; disbudding of fruit trees and ornamentals; and occasional pecking of ripening fruit.

The house sparrow harbors the chicken louse and the bird louse. House sparrows are capable of transmitting fowl cholera, turkey blackhead, Newcastle disease, avian tuberculosis, Eastern equine encephalitis, pullorum, canary pox, anthrax and numerous helminth, fungal and protozoan parasites. The noise and filth associated with their nests are nuisances in urban areas.

Control Materials

Frightening devices: The sparrow's range of hearing is reported between 675–111,500 cps so that ultrasonic devices are ineffective. Fireworks, blank shot, shell crackers and other noise making devices, if permitted by local regulations and persistently carried out, will eventually dislodge birds from an evening tree roost. These devices are usually ineffective where they are also nesting. Flags, foil strips and dangling paper are relatively useless as the birds readily adapt to them.

Repellents: Carefully screening around poultry houses, barns, etc. with $\frac{3}{4}$ -inch or smaller mesh will keep them out. Sticky repellents applied to ledges, rafters, beams, etc. are effective in keeping sparrows away. However, the ability of sparrows to cling to small projections makes this an expensive, laborious and messy process. Some success has been achieved with frighten-type chemical treated bait. This bait is commercially available from some pest control operators.

Shooting: Shooting will reduce the number of birds present, but is costly and rather futile as a method of complete crop protection. Nevertheless, it is fairly effective in large buildings. Use bird shot in smooth bore rifle barrels.

Trapping: A wide variety of traps have been used for local control of house sparrows. Traps that are designed to catch only a few birds at a time include the double funnel trap, nest trap and the commercially available elevator trap. Modified Australian crow traps and cotton trailers converted to traps have caught larger numbers of birds. Aviary wire of $\frac{1}{2}$ inch by $\frac{1}{2}$ inch mesh hardware cloth should be used for the wire covering of these traps. Chick scratch, fine cracked corn, milo, wheat, bread crumbs or their combinations make good baiting material and food sources for decoy birds left in the trap and captured birds. Traps are better, effective and cheaper than use of toxic baits.

Frightening chemical: A commercially prepared frighten chemical grain bait for use by public agencies and licensed pest control operators qualified in bird control is available. Use according to label directions.

Toxicants: Single dose poison on grain bait (pre-baiting is very important). Directions for use: Before exposing treated baits, make thorough observations to determine the number of house sparrows present, their feeding habits, their preferred locations, their daily behavior patterns, and the presence of nontarget species. Continue observations throughout the day. During these observations select desirable locations for bait exposure. If adequate precautions are taken in selecting baiting sites, no other species should be harmed. Secondary poisoning can occur using registered single dose poisons. Especially, watch for damage in hogs, cats and dogs.

When the daily activity pattern of the birds has been established and baiting locations selected, clean bait should be used to determine the preferred bait. Continue prebaiting for several days or until there is good bait acceptance. Do not use toxic bait until good acceptance of clean bait occurs.

Placement of bait trays: Flat bait trays or rain troughs can be placed on rafters in garages, sheds, barns, hangers on standards, etc. where house sparrows frequent to feed or perch and where there is no danger to man or other animals. Construct and place troughs soundly to prevent bait spillage.

Prebaiting: Prebaiting with clean, untreated bait is essential for good control. Prebait and treated bait should be of the same grain bait. If trays and troughs are well located and birds are numerous, acceptance of bait should be well established within one week. If at the end of 10 days some fail to show acceptance of bait, move to a new location. Expose prebait sparingly but replenish as needed to keep birds feeding.

Exposing poison bait: When prebait is accepted freely in all or nearly all trays or troughs, they should be emptied and poison bait substituted. Spread poison bait sparingly and evenly. Place bait in troughs during early morning. Do not allow bait to become wet. After 2 days, remove poison bait, replace with clean bait for 1 week or until good acceptance is obtained. The process of prebaiting and exposing treated bait is then continued until the birds are under control or the damage period is over.

Summary of instructions: After prebaiting, place poison bait sparingly in trays or troughs that are located in trees, shrubs, on fence posts or on standards in areas frequented by sparrows. Remove after 2 days. Refill with clean bait for 1 week or until good acceptance is obtained. Remove prebait and again expose poison bait for 2 days. Repeat process every 6 months.

Pigeons

Domestic pigeons carry pigeon ornithosis (psittacosis), Newcastle disease, aspergillosis, pseudotuberculosis, pigeon coccidiosis, toxoplasmosis, encephalitis and Salmonella typhimurium. Except for the latter three these diseases rarely infect man, but the effects may be serious if diagnosis is delayed. Salmonella is found in about 2 percent of pigeon feces and is statistically the most frequent cause of salmonella food poisoning in man.

Histoplasmosis and Cryptococcosis are systematic fungus diseases of man which may be contracted while cleaning up accumulations of dusty pigeon manure. Pigeon ectoparasites such as bugs, fleas, ticks and mites may bite man, possibly transmitting disease. Welts and skin infection may result from mite bites. Ectoparasites frequently invade homes from pigeon nests in or on the building.

Pigeon droppings deface and accelerate deterioration of buildings and automobiles and may land on unwary pedestrians. Pigeon feces is a common contaminant of grain destined for use as human food. Pigeon

nests may clog drain pipes, interfere with awnings and render fire escapes hazardous. The nests harbor numerous ectoparasites.

Pigeons are widely distributed in Kansas cities and on farms in barns.

Biography

Building ledges, barn rafters and similar man-made shelters are usual nesting sites. The pair constructs a rather messy nest in which the female lays one or two eggs. The male cares for and guards the female and nest.

The incubation period of pigeons is 17 to 19 days. The young are fed pre-digested food until they are weaned just before leaving the nest at 35 to 37 days of age. More eggs are laid before the first young are weaned. Breeding occurs at all seasons and several broods are raised each year. The average pigeon lives five years or more and some live over 15 years.

An adult pigeon will eat about a pound of food a week, consisting of seeds and other grains augmented with some amounts of fruit, green feed, insects and sufficient grit for digestion. Pigeons are generally monogamous although when a mate dies the survivor will select a new mate.

Legal Status

Feral pigeons are not protected by federal or state statute. However, the taking of homing pigeons (banded individuals) should be avoided. There may be municipal restrictions on the methods used to take feral pigeons.

Control Materials

Nest removal: Removing nests and destroying young helps depress populations.

Frightening devices: Pigeons have a strong territorial sense and are less responsive to noises than are most other birds. No practical alarm or distress calls have been found. Recording of loud noises sometimes works to frighten pigeons. Scarecrows such as stuffed owls are ineffective for

repelling pigeons. Flags, dangling paper, foil strips, etc. will sometimes work briefly.

Repellents: As a pigeon's sense of smell is rudimentary, odor repellents are not effective except in confined locations. Sticky materials which are available commercially are applied to ledges or rafters where birds roost. They repel pigeons by entangling their feet and sometimes their feathers. It is advisable to protect porous surfaces with tape or a silicone spray undercoating as these sticky materials may seriously stain buildings.

Shooting: Where local ordinances permit, pigeons may be shot. Normally, .22 shorts or shotguns are necessary, but compressed air guns or .22 dust shot is effective at close range.

Trapping: A colony of pigeons tends to use regular feeding and roosting areas and can sometimes be controlled by intensive trapping at these locations. Large, walk-in traps have been reported to be more effective than smaller ones. Smaller traps are less expensive to construct and easier to transport. Suggested baits include whole or coarse-cracked corn. The trap should be tended each day in mid-morning and after dark.

Traps with the "bob" type entrances (light rods that swing inward to allow the bird entrance) are the most common. Other trap designs include funnel traps, double entrance funnel traps, lily pad traps and cloverleaf traps.

Heavy prebaiting for a period of time in and around traps with the doors left open may be necessary to get pigeons to visit the trap readily. Live decoys should be placed in the trap to help attract other pigeons. White or light colored birds make better lures than drab, blue gray ones. If possible, leave the same individuals in the trap.

Return pigeons marked with leg bands to their owners or turn them over to the local humane society.

Bait: Whole kernel corn is the most widely used bait.

Frightening chemical: A fright producing chemical commercially prepared on a grain bait for use by public agencies and licensed pest control operators qualified in bird control. Use according to label directions.

Chemosterilant: A commercially prepared grain bait containing a chemosterilant to reduce the breeding potential of a target flock. Use according to label directions.

Toxicants: Single dose poison—prebaiting up until time of switch is very important. Can be effective if used not more than every 6 months. Pick up is important. Watching flocks establishing feeding stations and planning is important.

Directions for use: Before exposing treated baits, make thorough observations to determine the number of pigeons present, their feeding habits, their preferred locations, their daily behavior patterns, and the presence of nontarget species. Continue observations throughout the day. During these observations select desirable locations for bait exposure. If adequate precautions are taken in selecting bait sites no other species should be harmed.

When the daily pattern of the birds has been established and baiting locations selected, clean bait should be used to determine the preferred bait. Continue prebaiting for several days or until there is good bait acceptance. Do not use toxic baits until good acceptance of clean bait occurs.

Bait should be applied only under the supervision of responsible adults and with full knowledge of local authorities.

Starlings

Starlings are found throughout Kansas on farms, ranches, open country, open groves, fields and cities. The residents are joined by large flocks of migrants from the northern states in autumn and winter. In mild winters some southern birds may range into Kansas to spend the winter. They can cause crop damage, particularly grain in milk stage and in cattle feedlots, dairies and swine feedlots.

Biology

About mid-September migrants from the north begin arriving in Kansas. They merge with residents into large flocks which are found in and around animal feedlots, scattered over pasture and rangeland. By April 15 these birds have either paired off to nest in Kansas or have migrated from Kansas.

The nest is built in any tree cavity, hole in a building, or deserted woodpecker hole of suitable size. Nests used in successive seasons become foul-smelling. Two to eight eggs are laid, usually four to six. The incubation period is 11 to 13 days. Both sexes assist in this activity. Age at first flight is 19 to 22 days.

As fledglings come off the nest they gather in small family groups of up to ten birds including one or two adults. These small groups eventually merge together until large flocks are formed. Merging continues until all of the birds in a local area are in one large flock. These flocks are scattered throughout the state in summer and are responsible for depredations to soft fruits and other summer crops. Population build-ups in cattle feedlots begin by mid-October. Starlings share a communal roost at night and during the winter as many as 70,000,000 birds have been observed in one roost.

The starling's diet is almost 60 percent animal matter, mainly insects and other small invertebrates. Vegetable matter is largely berries and other fruit with some seeds and grain. Losses from starlings in feedlots result from fecal contamination of feed as well as the value of the rations consumed. Swine fever is known to be transmitted by starlings.

Legal Status

The Kansas law defines starlings as a nongame bird that may be taken and possessed by any person at any time. There are no federal restrictions on tapping starlings.

Control Materials

Frightening devices: Devices, such as shell crackers, propane exploders, devices to broadcast distress calls, and electronically produced sounds can successfully frighten starlings from roosts. Begin the use of these devices as soon as birds make an appearance in the evening until dark for 5 to 10 consecutive nights. A combination of frightening devices works better than one device.

Proper location of sound devices is important and enough of them must be used to provide sound over the entire roost area. Place devices to take advantage of the prevailing winds. Do not locate them in areas where the trees muffle the sound. Observations to determine their effectiveness should be made and individual units moved to new locations.

Repellents: Sticky repellents, mechanical barriers, and such may be effective when starlings are roosting on buildings or structures.

Trapping: Modified Australian crow traps and converted cotton trailers have been effective for capturing large numbers of starlings. A trailer may be converted to a large mobile trap by constructing entrances on top and plugging all escape holes. In some instances the slot entrance has proven more effective, while at other times the wire entrance was more successful. The location of the trap is important. Make observations to determine starling flyways, resting or perching areas and feeding areas before the traps are placed in operation. Traps have been more effective when placed in the open near, but not necessarily under, perching or feeding areas.

When a trap is first installed, check the bottom to see that an uneven ground surface does not leave holes that birds can escape through. It may be necessary to use a chicken wire bottom to prevent the entry of predators. Starlings can escape through holes dug by predators. Predation by house cats or other animals can be prevented by the use of live traps.

Baits that have been used successfully include soft fruits, grains and poultry pellets. Bait placed on the ground inside the trap in large amounts with a little on the top near the entrances is most effective. Use bait materials that the birds feed on in the area for best results.

The use of live decoy starlings is usually essential in attracting birds to the trap. From 10 to 35 live decoys are sufficient for the modified crow trap depending upon the trap size. Supply food and water at all times. In warm weather starlings will die rapidly without water. Provide shade by attaching burlap to one side of the trap. The traps must be kept clean and dead birds removed.

Trapped birds can be removed through a small exit hole which has been cut into the upper corner of the head of the trap and covered with a closeable door. A small holding cage can be placed over the hole and the starlings herded into this cage. The birds can then be removed and disposed of.

Shooting: Shooting is costly and rather futile as a method because of the large number of starlings usually causing the problem. However, killing a few birds reinforces the use of noise makers.

Frightening chemical: A fright producing chemical works in some situations.

Toxicants: Single dose poison. Direction for use: Before exposing treated baits, make a thorough observation to determine the number of starlings present, their feeding habits, preferred locations, daily behavior patterns and the presence of nontarget species. Continue observations throughout the day. During these observations, select the desirable locations for bait exposure. If adequate precautions are taken in selecting baiting sites no other species should be harmed.

When the daily activity pattern of the birds has been established and baiting locations selected, clean bait should be used to determine the preferred bait. Continue prebaiting for

several days or until there is good bait acceptance. Do not expose toxic bait until good acceptance of clean bait occurs.

In most situations roost control may be difficult, in which case birds might best be controlled where they breed.

Starling control at swine feedlots: When the daily activity pattern of the birds has been established and baiting locations selected, clean bait should be exposed to determine the bait preference. A pelleted type animal feed has been found to be the best accepted bait. Usually the same pelleted feed in the swine ration being fed will be the preferred bait.

When the preferred bait has been determined, expose some untreated bait at the selected feeding locations.

Several methods of bait application may be used. The material may be "stripped" down feed alleys, placed in rain troughs at selected locations, placed in troughs attached to the outside of feed bunkers, placed in rubber calf pans near other similar pans filled with water or broadcast thinly in alleyways and pens if weather permits.

Continue observations throughout the program. If poor prebait acceptance occurs, change baiting locations as conditions indicate. Run trials to see if poor acceptance is due to a change in bait preference.

Continue prebaiting until acceptance is achieved. This may be for a considerable period of time or for a few days, depending upon the number of birds present and the rate of movement of new starling populations into the feedlot. When acceptance is achieved for sure, then place the toxic baits in their place. Baits will lose their toxicity in rainy weather. Continue feeding bait until birds disappear. Death usually occurs while birds are on the roost, so lack of dead birds at the baiting site is not a sign of failure.

Blackbirds

Blackbirds and starlings often establish large winter roosts. These frequently occur in areas where their presence is objectionable because of actual or potential safety, health, economic and nuisance problems.

Bird species found in roosts are red-winged blackbirds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*), brown-headed cowbirds (*Molothrus ater*), rusty blackbirds (*Euphagus carolinus*), Brewer's blackbirds (*Euphagus cyanocephalus*), and starlings (*Sturnus vulgaris*).

Robins (*Turdus migratorius*) are occasionally found roosting with these species and may even account for a large part of the total roost population in individual roosts.

Legal Status

Starlings are not protected by federal law. Blackbirds are federally protected except when damaging or about to damage agricultural crops or ornamentals, or when causing a public health, nuisance or safety hazard. Robins are protected by federal treaty.

A federal permit for taking robins or other protected birds must be secured from the appropriate Special Agent-in-Charge, Division of Law Enforcement, U.S. Fish and Wildlife Service, whenever such birds might be taken incidental to blackbird roost control efforts. Additionally, Kansas laws and regulations require permits for taking birds other than English sparrows, starlings or feral pigeons.

Roost Control Methods

PA-14 Avian Stressing Agent is a wetting agent and the only lethal pesticide registered for use at roosts.

Each PA-14 treatment has to be supervised and approved by a Federal Fish and Wildlife Service wildlife biologist, a cooperative agency wildlife biologist or other government personnel trained by the Fish and Wildlife Service to use PA-14 at the specific site. Even if the application is being supervised by one of the latter two individuals, a Federal Fish and

Birds

Wildlife Service wildlife biologist will be on site to furnish technical assistance and monitor the operation.

Weather requirements: PA-14 should not be applied unless there is a 90 percent probability of at least $\frac{1}{8}$ of an inch of rain and a temperature below 40 degrees F. within 24 hours of treatment. Preferably, temperature should not be below freezing during actual application.

In limited situations, the entire roost may be sprayed with water at the time of PA-14 application using standpipe sprinklers.

Aircraft requirements: Fixed-wing or rotary aircraft may be used, but rotary is preferable. Aircraft used must meet VFR standards. IFR and ground-to-air communication equipment would be desirable.

Pilot requirements: The pilot must hold a commercial license, preferably with instrument rating, an Agriculture Aircraft Operator's certificate, meet night VFR regulations, and conform to state pesticide application regulations. The pilot should carry a minimum of \$100,000/300,000 liability insurance valid under the proposed flight conditions. The area should be overflown by the pilot during daylight and after dark to familiarize himself with the area and, particularly, any safety hazards.

Application procedures: Actual application will be made when weather conditions meet or exceed FAA night VFR requirements. The pilot will be responsible for getting flight clearance and filing a night plan, if required. Winds in excess of 10 mph will cancel the treatment. Lights marking the roost will be of the type and placement desired by the pilot in accordance with no-spray zone needs. If a helicopter is used, the landing and loading site should be as close to the roost as possible without disturbing the birds. The site should be lighted to the pilot's requirements.

PA-14 will be applied at the rate of 20 gallons actual material per acre. The aerial applicator will calibrate the equipment to achieve this rate. The

concentration of PA-14, alcohol and water should follow label requirements.

Treatment can begin at the roost site as soon as birds settle. This is usually shortly after dark. Treatment altitude will vary from 75–150 feet due to equipment safety hazards and bird behavior and should be agreed upon between supervisor and pilot. Landing lights may be used over the roost at the pilot's discretion.

The pilot will make the final determination if weather conditions are satisfactory for flying.

Health hazard protection: The recommendations of federal, state and/or local health and pesticide regulatory agencies should be followed in protecting personnel from exposure to histoplasmosis and pesticide accident.

Alternatives to Registered Pesticides

Alternatives for registered pesticides for use on blackbird roosts are presently limited to one choice and the conditions for application are seldom found in Kansas. Therefore, other methods often seem more practical.

There are a number of tools or ways to cause the dispersal of an established blackbird roost. Noise-making or scaring devices are the most popular and effective tools. Other frightening devices and habitat manipulation are also important in dispersing roosts.

Recorded Distress and Alarm Calls. Distress and alarm calls of starlings and blackbirds have been used singly and in conjunction with other scare devices to successfully move roosts. They are available on records and tapes. Play the calls back on mobile sound equipment in the roost intermittently for 10 to 15 seconds each minute as the birds attempt to enter or continuously when most birds have entered the roost.

Gas-operated Exploders. These devices, operating on acetylene or propane gas, are designed to produce loud explosions at controllable intervals. They should be placed (elevated

above the vegetation, if possible) in high-use areas of the roost and set to fire at no greater than 30-second intervals. Since birds are known to easily habituate to exploders, it is best to move the exploders about during the scaring operation and/or combine their use with other scare devices. Exploders can be left in the roost after dispersal is completed to discourage birds from returning.

Exploding Shotgun Shells. These devices known as shellcrackers or scare cartridges are 12-gauge shotgun shells containing a firecracker which is projected into the air about 300 feet before exploding. Fire the shells so that they will explode in front of or underneath flocks of birds attempting to enter the roost. The purpose is to produce an explosion between the birds and the roost site.

Noise Bombs/Whistle Bombs/Racket Bombs. These devices are fired from a 15 mm flare pistol. Noise bombs, also called bird bombs or clow bombs, are firecrackers that travel about 75 feet before exploding. Use them similarly to the exploding shotgun shells. Whistle bombs are similar to noise bombs but do not explode. They produce a noticeable response just prior to darkness because of the trail of smoke and fire as well as the whistling sound. Racket bombs make noise in flight but do not explode.

Habitat Manipulation. Thinning roost vegetation often produces longer term results than using scaring devices. This practice makes the roost less attractive to birds. When feasible the roost vegetation should be thinned to discourage birds from returning after a dispersal program. However, vegetation thinning is not a permanent solution. In a few years the vegetation will again become dense and provide attractive roosting habitat.

Procedures to Disperse a Roost. Before beginning dispersal efforts, inform local residents near the roost of the planned operation to avoid apprehension on their part. Work with local authorities so they can

assist in the dispersal program and provide for spectator safety and traffic control.

Begin scaring as soon as possible after a roost develops. Generally, the longer a roost is established, the more difficult it is to disperse.

Begin scaring as soon as the birds start arriving at the roost in the evening. This requires that all personnel and equipment are ready before the first birds arrive. Once birds are in the cover of the roost vegetation, especially after dark, they are extremely difficult to force to leave. Therefore, continuing scaring efforts after dark is pointless and sometimes harmful because the birds may habituate to the stimuli. Using scaring devices in the morning one-half hour before normal roost departure, as well as in the evening, may speed up roost dispersal.

Be persistent. Population reduction is often not noticeable the first or second night. Scaring often needs to be continued for four or more nights before the birds abandon the roost.

Use a combination of scaring devices. Although birds have been dispersed using one device, different devices often complement each other and make the dispersal effort easier.

Cover the entire roost in the dispersal effort. The number of personnel and the amount of equipment required depends on the size and type of roost and may change each night in response to bird movement. Normally one person shooting shellcrackers or with a hand-held speaker for playing distress calls can adequately patrol 1 to 2 acres of roosting habitat.

Very little emphasis has been put on finding out where birds go once they are dispersed from a roost. Understandably, some birds may move to nearby areas where they continue to be a problem. If so, make an effort to move them from these areas also. Once birds have been moved from one site they usually become more responsive to dispersal efforts and moving them another time is rather easy.

Safety Precautions

Special care should be taken when using any of the pyrotechnic devices and firearms. Wear safety goggles and ear protectors when using any of these devices. When firing the exploding shotgun shells the shooter should inspect the gun barrel after each shot for wadding that sometimes jams. The use of non-choked or open bore shotguns will help to eliminate this problem. Carry a ramrod (wood dowel) to remove the wadding if jamming occurs. Use single-shot break open guns to facilitate inspection and cleaning of accumulated powder residue.

When using noise or whistle bombs, fire the flare pistol at arm's length to avoid a close-to-the-face explosion. When using the flare pistol, hold the thumb in front of the hammer until ready to fire.

Persons using pyrotechnic devices and exploding shells should be aware of their potential fire danger. Use extreme care near buildings or when vegetation is dry. Make fire fighting equipment available at the scene if conditions warrant.

Do not use live ammunition during roost dispersal efforts because of the additional hazards to personnel and the possibility of killing protected bird species sometimes found roosting with blackbirds and starlings. Additionally, crippled birds may actually tend to decoy birds into the roost.

Personnel working in or around bird roost should take certain precautions against exposure to the respiratory disease, histoplasmosis.

A face mask or self-contained breathing apparatus and protective clothing, including coveralls, gloves, caps and rubber boots should be worn. Soiled clothing should be plastic-bagged immediately on leaving the roost and washed as soon as possible. Clean rubber boots before

entering vehicles to prevent heater fan circulation of spores. These precautions are especially important when bulldozing a roost site. The disturbance of the soil can cause large amounts of spores or fungus fragments to become airborne.

Precautions and Uses

Pesticides and repellents used improperly can be injurious to man, animals and plants. Follow the directions and heed all precautions on the labels.

Store pesticides and repellents in original containers, out of reach of children and pets, and away from foodstuff.

Apply pesticides selectively and carefully. Do not apply them when there is danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide it is advisable that the person be fully clothed.

After handling a pesticide, the person should not eat, drink or smoke until he has washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatments given on the label and get prompt medical attention. If a pesticide is spilled on the skin or clothing, remove clothing immediately and wash skin thoroughly. Wash clothes thoroughly before reuse. Take the pesticide container with you when you visit the physician.

It is difficult to remove all traces of a herbicide from equipment. Therefore, to prevent injury to desirable plants, do not use the same equipment for insecticides and fungicides that was used for a herbicide.

NOTE: Registrations of pesticides and repellents are under constant review by the U.S. Environmental Protection Agency (EPA). Use only pesticides and repellents that bear the registration number and carry directions for the pest to be controlled.

STUDY QUESTIONS for pages 56–66

Birds

1. (56) Histoplasmosis is a respiratory disease in humans caused by a _____ in bird droppings.
 - a. fungus
 - b. mite
 - c. bacteria
 - d. virus
2. (56) When working around an old or abandoned bird roost site, wear a:
 - a. full face shield only
 - b. hard hat
 - c. gas mask
 - d. face shield with dust filter
3. (57) Wild birds spread the virus-like organism that causes ornithosis in their:
 - a. saliva
 - b. feces
 - c. feathers
 - d. egg shells
4. (57) Transmissible gastroenteritis (TGE) of swine is transmitted by:
 - a. pigeons
 - b. sparrows
 - c. starlings
 - d. black birds
5. (57) Birds should be dispersed or controlled when they form large concentrations:
 - a. near human habitations
 - b. pose a threat to public health
 - c. pose a threat to livestock health
 - d. all the above
6. (58) The house sparrow:
 - a. damages sprouting vegetables
 - b. disbuds fruit trees
 - c. feeds on poultry rations
 - d. all the above
7. (58) Screening to repel house sparrows should have a mesh of _____ or less.
 - a. 1.25 inch
 - b. 1 inch
 - c. 0.75 inch
 - d. 0.5 inch
8. (59) Before exposing single dose baits to control house sparrows:
 - a. make sure it will be a sunny day
 - b. be sure it will not rain
 - c. determine the number present, feeding habits and location
 - d. notify the game warden
9. (59) Pigeons carry many disease and salmonella is found in _____ percent of the pigeon feces.
 - a. 1
 - b. 2
 - c. 3
 - d. 4
10. (60) The incubation period for pigeon eggs is:
 - a. 12 to 14 days
 - b. 17 to 19 days
 - c. 22 to 23 days
 - d. 26 to 29 days
11. (60) Suggested bait for pigeon traps is:
 - a. wheat
 - b. oats
 - c. sorghum
 - d. whole corn
12. (61) Single dose poisons can be effective in controlling pigeons if not used more often than every:
 - a. 2 months
 - b. 4 months
 - c. 6 months
 - d. 8 months
13. (61) Starlings are found:
 - a. throughout Kansas
 - b. only in southwest Kansas
 - c. only in northwest Kansas
 - d. only in eastern Kansas
14. (61) The starling's diet consists of almost _____ percent animal matter.
 - a. 20
 - b. 40
 - c. 60
 - d. 80
15. (62) Effective frightening devices for starlings include:
 - a. shell crackers and propane exploders
 - b. broadcast distress calls
 - c. electronically produced sounds
 - d. all the above
16. (62) Before exposing single dose poisons for starlings:
 - a. check with the game warden
 - b. get a permit from the governor
 - c. determine the number, feeding sites, etc.
 - d. dig a large hole for disposal

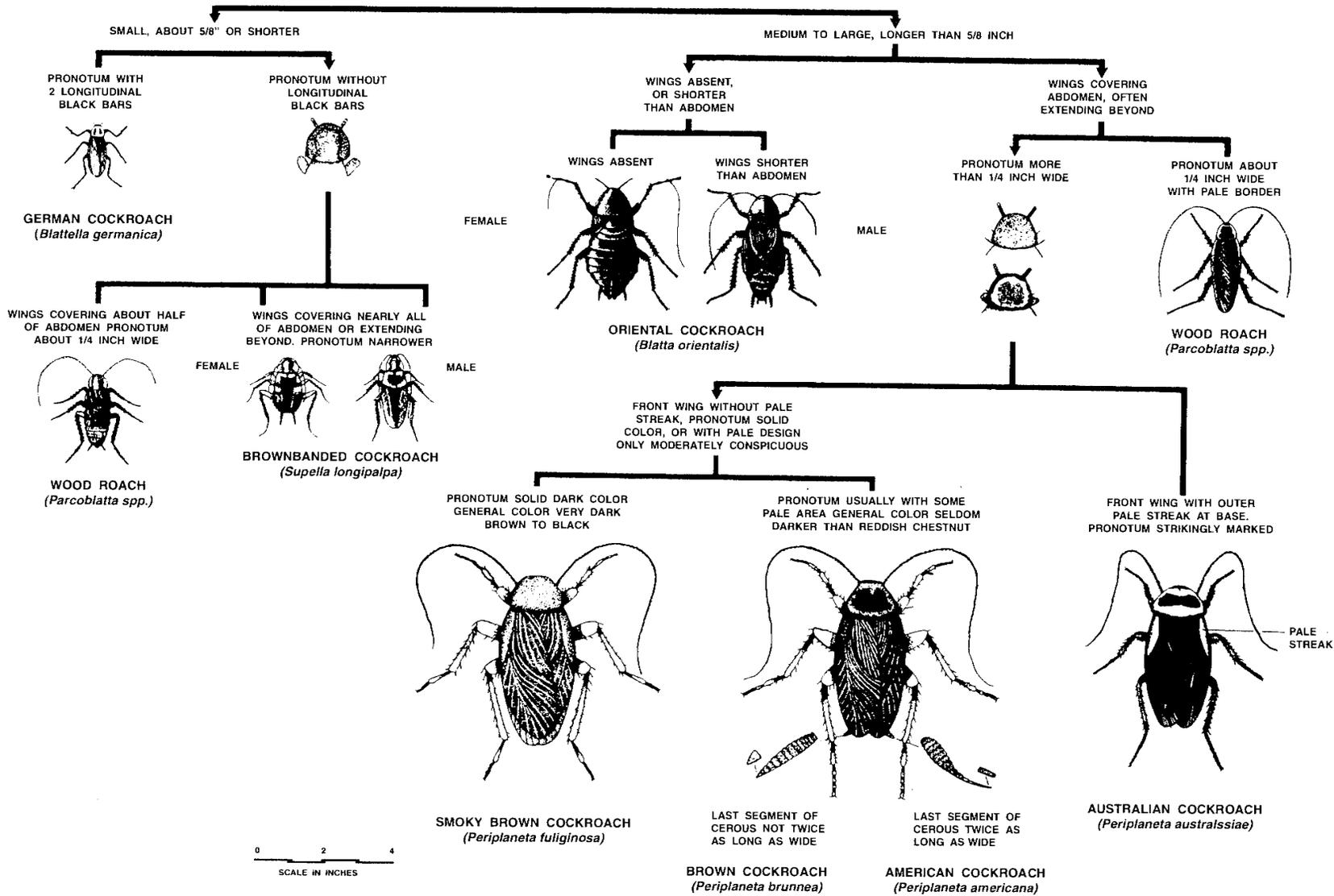
continued on page 68

STUDY QUESTIONS for pages 56–66 continued from page 67

Birds

17. (63) Toxic baits for starlings should be applied in swine feedlots:
- a. only on cloudy overcast days
 - b. only on the week ends
 - c. only after prebaiting is accepted
 - d. only in the month of January
18. (63) Blackbirds are protected by federal laws, except:
- a. when damaging agricultural crops
 - b. when causing public health or safety hazard
 - c. when damaging ornamentals
 - d. all the above
19. (64) PA-14 blackbird roost treatment must be applied at the rate of _____ actual/acre.
- a. 10 gallons
 - b. 20 gallons
 - c. 25 gallons
 - d. 30 gallons
20. (64) Distress and alarm calls for blackbird roost sites should be played at _____ as the birds attempt to enter.
- a. 3 to 5 seconds/minute
 - b. 10 to 15 seconds/minute
 - c. 20 to 25 seconds/minute
 - d. 30 to 35 seconds/minute
21. (65) Habitat manipulation of blackbird roosting sites involves:
- a. thinning the roost vegetation
 - b. planting elm trees
 - c. piling rocks around the edges
 - d. draining the swamps
22. (65) To disperse a blackbird roost, begin scaring:
- a. in the evening before the first birds arrive
 - b. in the evening when approximately 75% of the birds are present
 - c. around mid-night when the neighbors are in bed
 - d. two hours after sun-up
23. (66) When using pyrotechnic devices for blackbird control, safety equipment includes _____.
- a. rubber gloves and boots
 - b. coveralls
 - c. long sleeved shirt
 - d. goggles and ear protectors
24. (66) After handling a pesticide, a person should not _____ until after washing.
- a. eat
 - b. drink
 - c. smoke
 - d. all the above

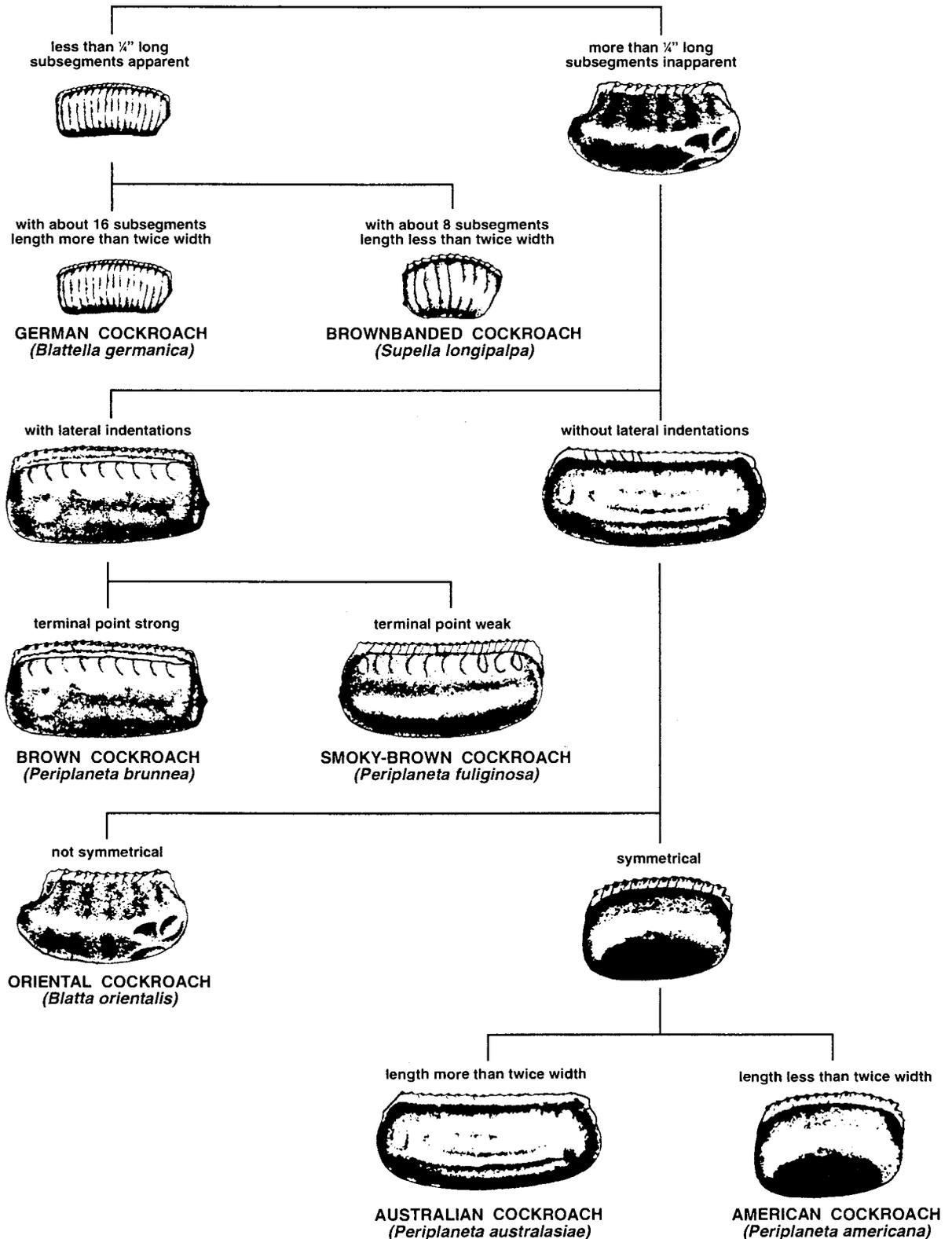
Harry D. Pratt

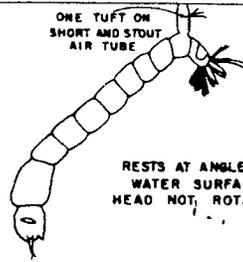
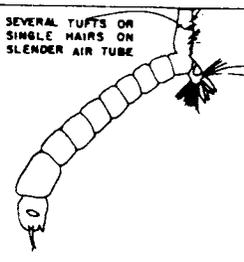
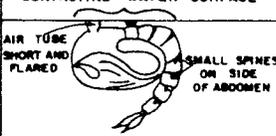
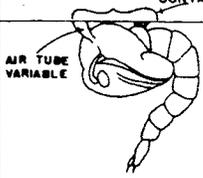
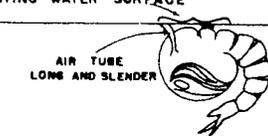
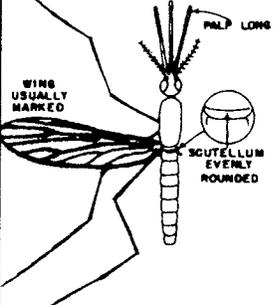
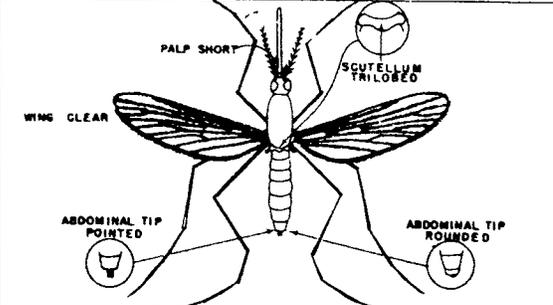
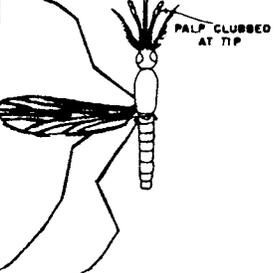
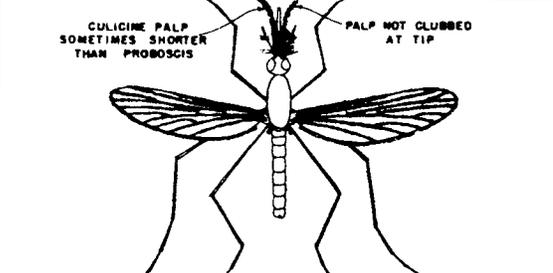
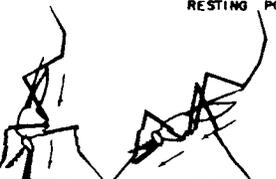
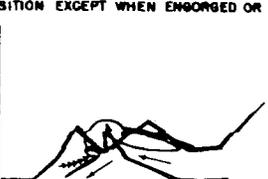


Cockroaches: Pictorial Key to some common species

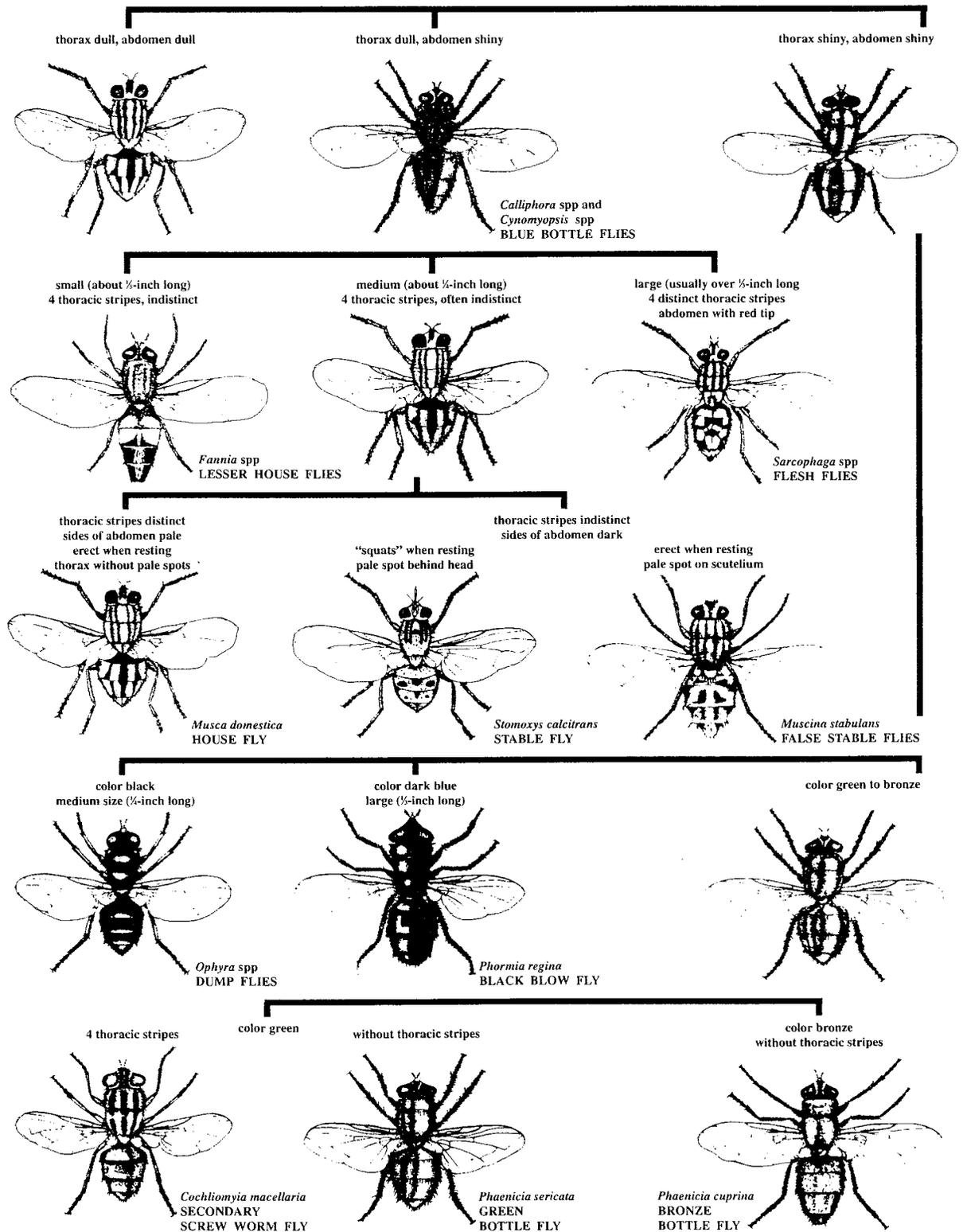
Appendix

Cockroaches: Key to egg cases of common domestic species
 Harold George Scott, Ph.D. and Margery R. Borom

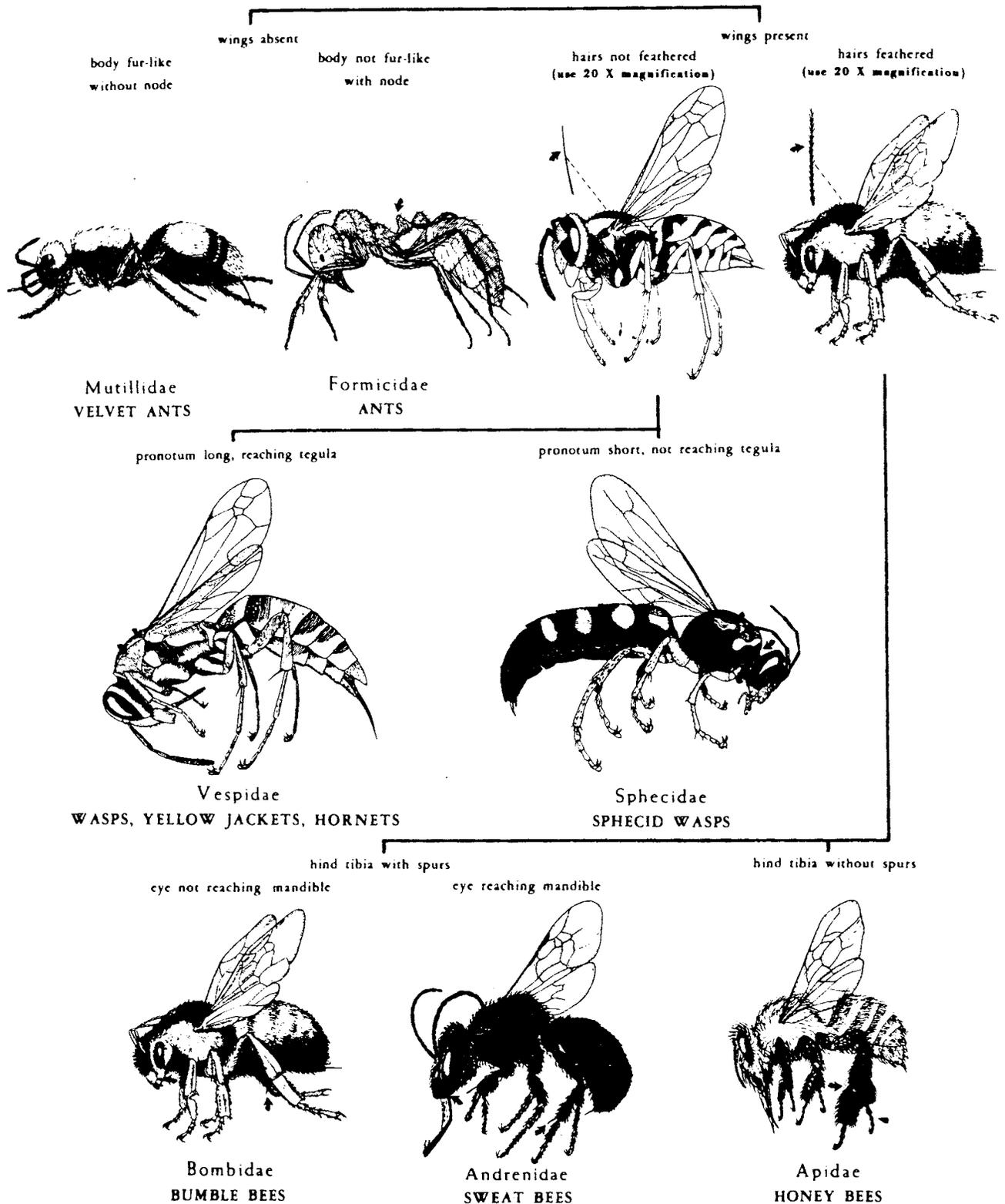


ANOPHELINES		CULICINES	
ANOPHELES		AEDES	CULEX
EGGS	 WITH FLOATS  LAID SINGLY ON WATER	 NO FLOATS  LAID SINGLY ON DRY SURFACE	 NO FLOATS  LAID IN RAFTS ON WATER
	 PALMATE HAIR NO AIR TUBE RESTS PARALLEL TO WATER SURFACE HEAD ROTATED 180° WHEN FEEDING	 ONE TUFT ON SHORT AND STOUT AIR TUBE RESTS AT ANGLE TO WATER SURFACE HEAD NOT ROTATED	 SEVERAL TUFTS OR SINGLE HAIRS ON SLENDER AIR TUBE RESTS AT ANGLE TO WATER SURFACE HEAD NOT ROTATED
PUPPAE	GREATER PROPORTION OF BODY CONTACTING WATER SURFACE  AIR TUBE SHORT AND FLARED SMALL SPINES ON SIDE OF ABDOMEN	SMALLER PROPORTION OF BODY CONTACTING WATER SURFACE  AIR TUBE VARIABLE  AIR TUBE LONG AND SLENDER	
	FEMALES  PALP LONG WING USUALLY MARKED SCUTELLUM EVENLY ROUNDED	 PALP SHORT WING CLEAR ABDOMINAL TIP POINTED SCUTELLUM TRILOBED ABDOMINAL TIP ROUNDED	
MALES  PALP CLUBBED AT TIP	 CULICINE PALP SOMETIMES SHORTER THAN PROBOSCIS PALP NOT CLUBBED AT TIP		
RESTING POSITION EXCEPT WHEN ENGORGED OR HIBERNATING   			

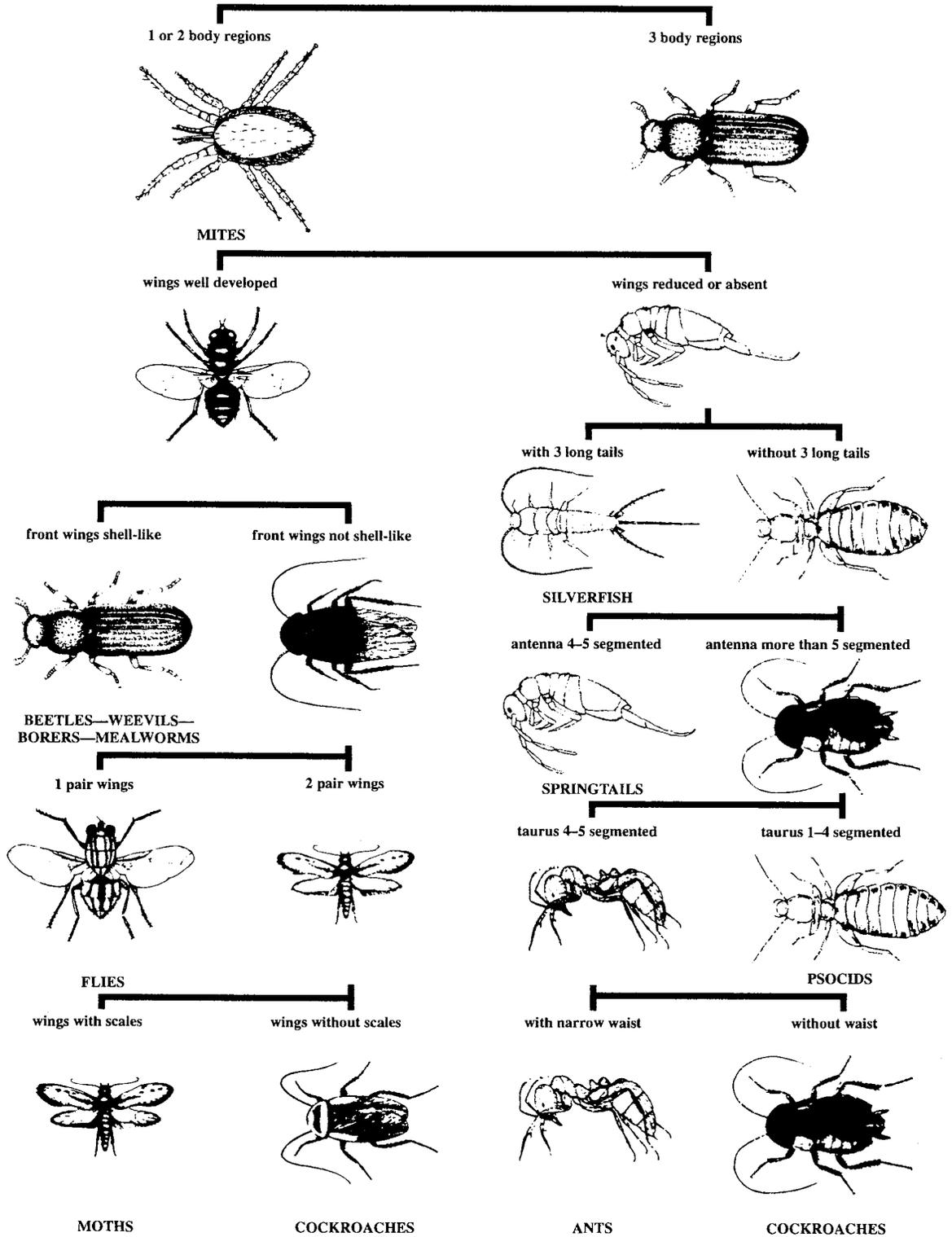
Domestic Flies: Pictorial Key to Common Species
 Harold George Scott, Ph.D. and Margery R. Borom



Stinging Hymenoptera:
Pictorial Key to Some Common United States Families
 Harold George Scott and Chester J. Stojanovich

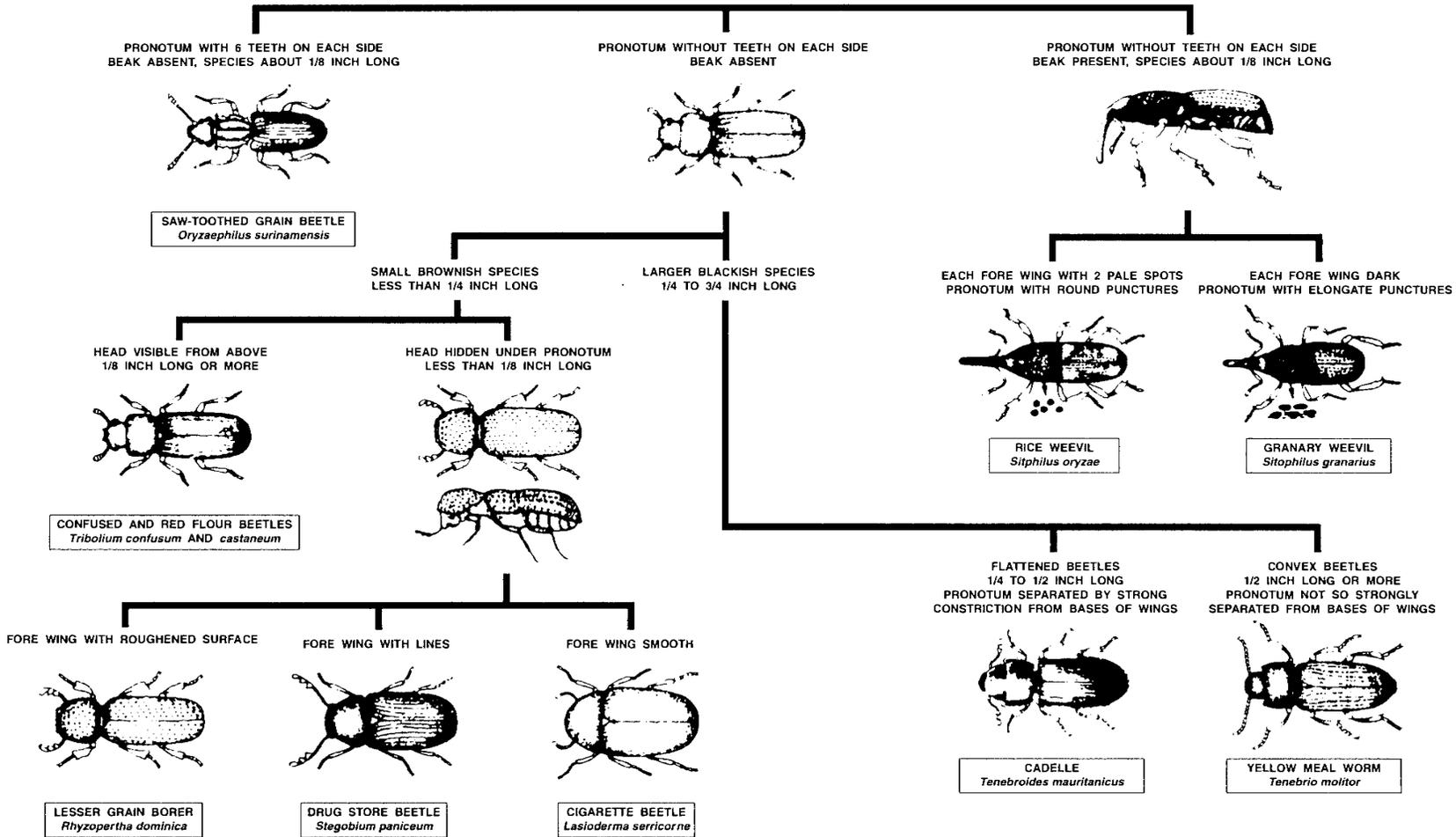


Household and Stored-Food Pests: Key to Common Adults
 Harold George Scott and Chester J. Stojanovich

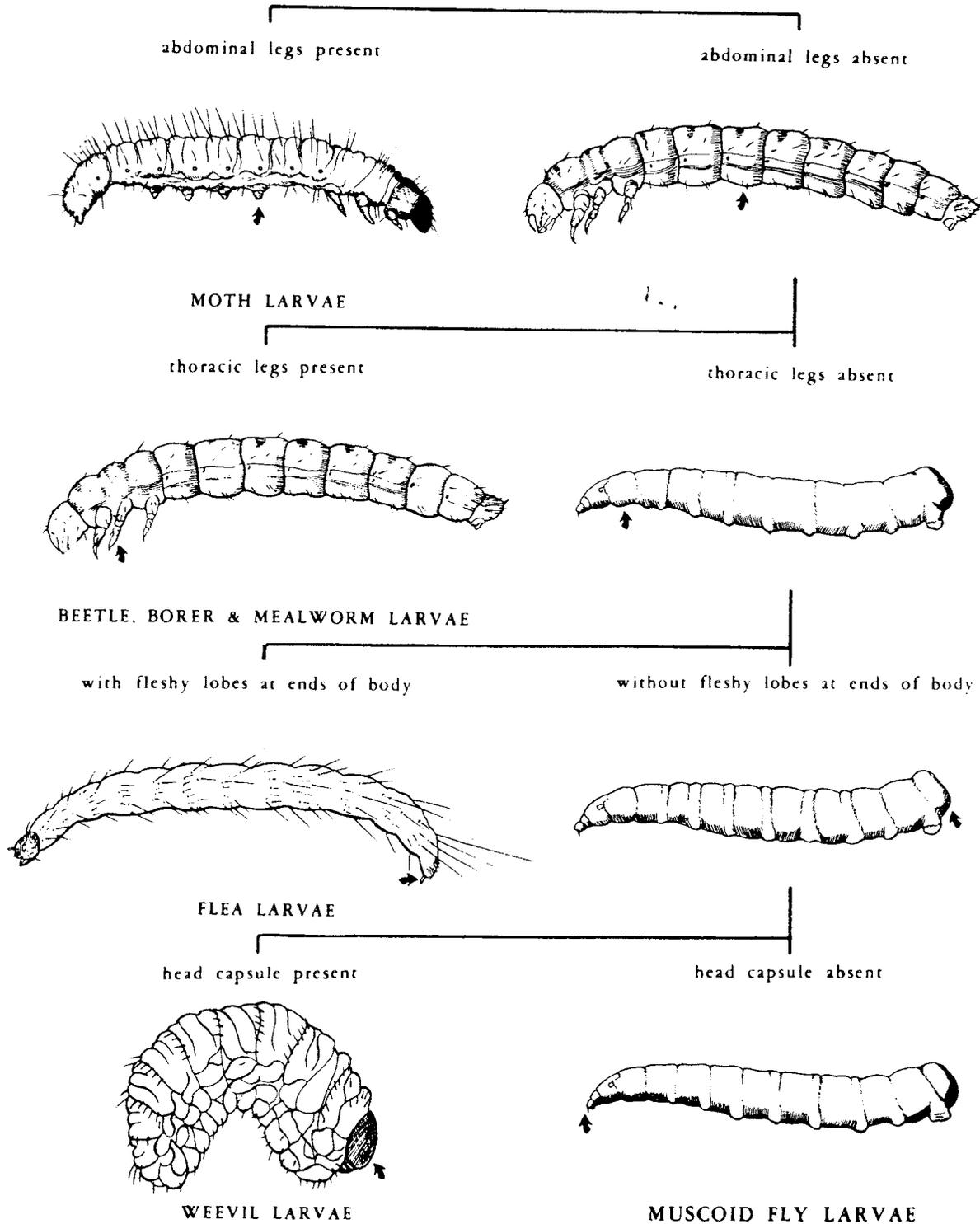


Beetles: Pictorial Key to Some Species Commonly Associated with Stored Foods

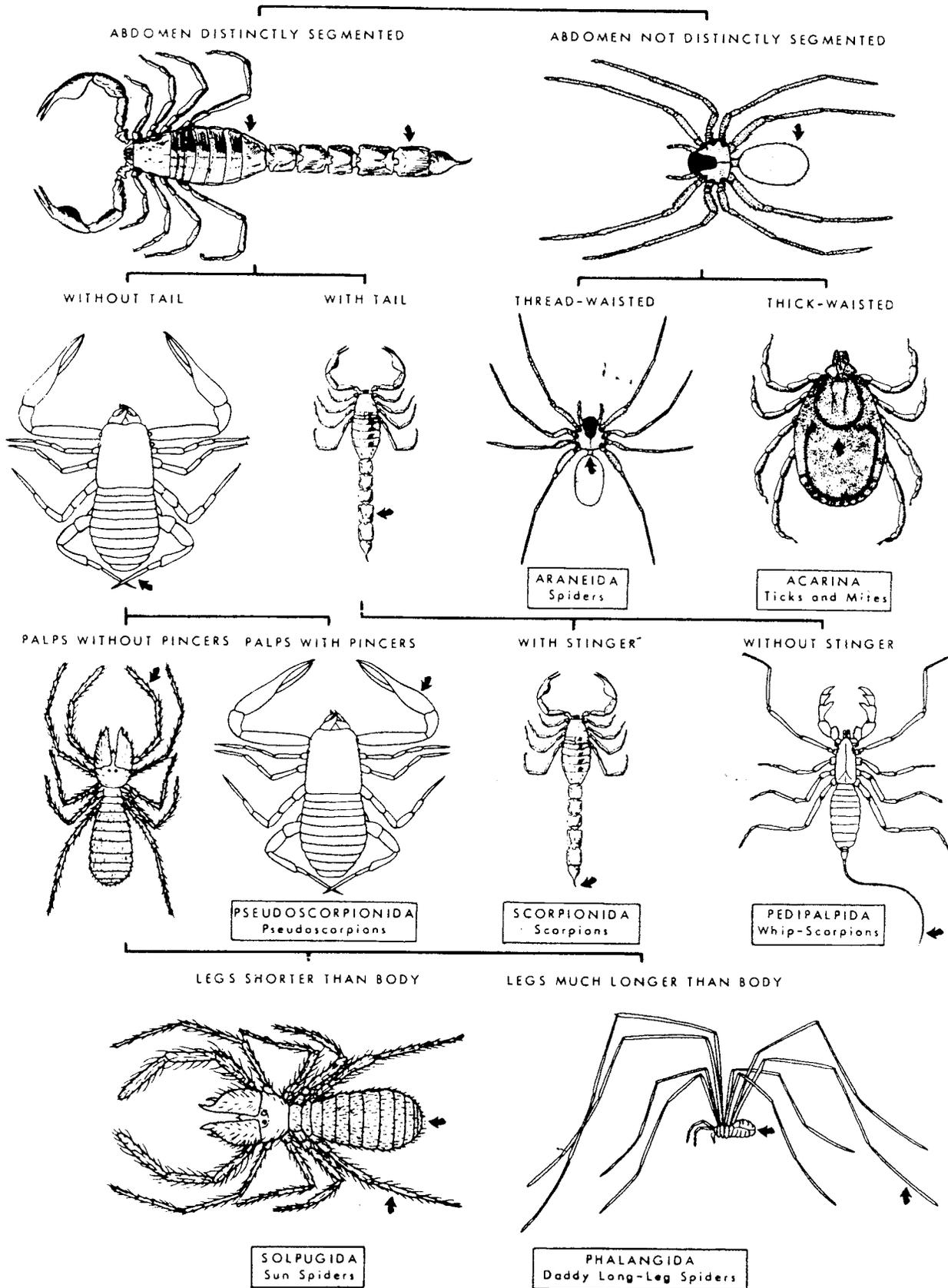
Harry D. Pratt



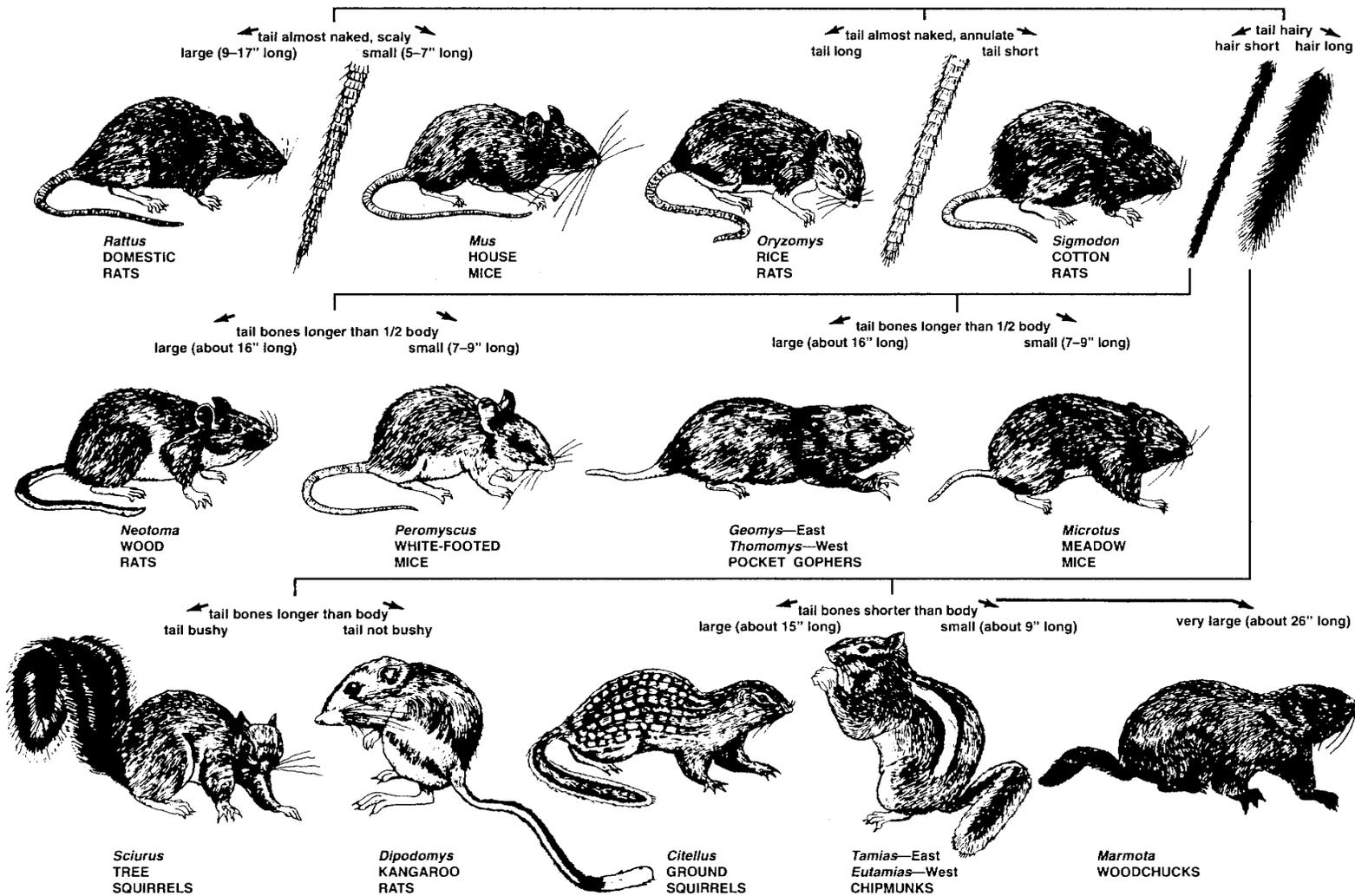
Household and Stored-Food Pests:
Pictorial Key to Common Larvae
Chester J. Stojanovich and Harold George Scott



Arachnida: Key to Common Orders of Public Health Importance
 Harold George Scott and Chester J. Stojanovich

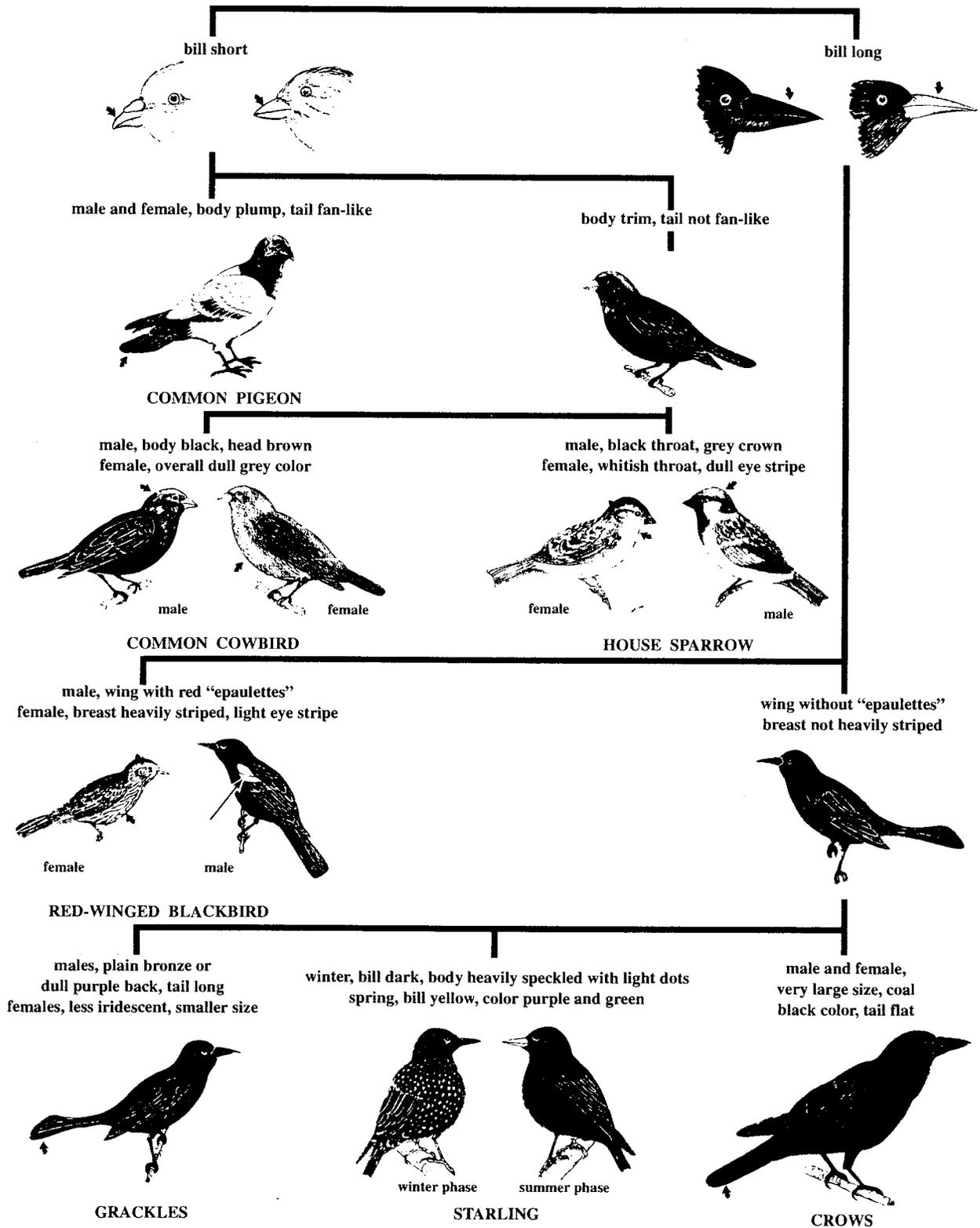


Rodents: Pictorial Key to Some Common United States Genera
 Harold George Scott and Margery R. Borom



Birds: Pictorial Key to Some Common Pest Species
of Public Health Importance

Margaret A. Parsons and Chester J. Stojanovich



ANSWERS TO STUDY QUESTIONS

Pages 2-8

1. d 2. b 3. b 4. d 5. a 6. a
7. a 8. b 9. c 10. d 11. c 12. b

Pages 9-11

1. c 2. d 3. a 4. d 5. d 6. c
7. b 8. a 9. d 10. d

Pages 13-18

1. a 2. d 3. b 4. d 5. c 6. b
7. c 8. d 9. b 10. c 11. d
12. d 13. d 14. b 15. d 16. c

Pages 20-25

1. a 2. b 3. a 4. c 5. d 6. a
7. a 8. b 9. a 10. d 11. c 12. b
13. c 14. d 15. b 16. a 17. c
18. d

Pages 27-37

1. d 2. a 3. d 4. c 5. c 6. d
7. b 8. d 9. a 10. b 11. c 12. a
13. b 14. d 15. a 16. d 17. b
18. a 19. b 20. a 21. b 22. a
23. d 24. a 25. c 26. d 27. a

Pages 39-44

1. a 2. b 3. c 4. b 5. c 6. a
7. c 8. c 9. d 10. a 11. c 12. b
13. b 14. a

Pages 46-49

1. d 2. b 3. a 4. d 5. c 6. b
7. d 8. a 9. b 10. b

Pages 50-54

1. c 2. c 3. b 4. d 5. a 6. b
7. d 8. a 9. a 10. c 11. c 12. c

Pages 56-66

1. a 2. d 3. b 4. c 5. d 6. d
7. c 8. c 9. b 10. b 11. d 12. c
13. a 14. c 15. d 16. c 17. c
18. d 19. b 20. b 21. a 22. a
23. d 24. d

Frannie L. Miller
Pesticide Coordinator

Authors

Appreciation is expressed to the following for preparation of the material in this manual:

Donald C. Cress, entomologist, former pesticide coordinator, Kansas State University

Robert Bowden, plant pathology specialist, Kansas State University

F. Robert Henderson, wildlife damage control specialist, Kansas State University

Donald E. Mock, livestock entomology specialist, Kansas State University

Acknowledgments

Appreciation is expressed to the following for cooperation in the Commercial Pesticide Applicator Training Program:

Dale Lambley, director, Plant Health Division, Kansas State Board of Agriculture

W.A. Hawkins, Jr., administrator, Pesticide Use Section, Kansas State Board of Agriculture

Jeanne Fox, ecological specialist, pesticide use section, Kansas State Board of Agriculture

Drawing of appendix pages from a publication of the U.S. Department of Health, Education and Welfare, Public Health Service.

K-STATE Research and Extension

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned.

Publications from Kansas State University are available at: www.bookstore.ksre.ksu.edu

Contents of this publication may be freely reproduced for educational purposes. All other rights reserved. In each case, credit Donald C. Cress et al., *Public Health Pest Control*, Kansas State University, October 1993.