

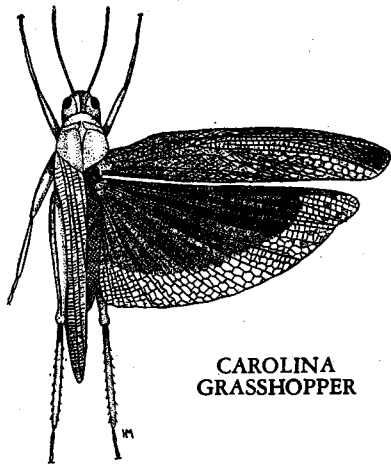
# Grasshoppers and Their Kin

By

E. LAURENCE PALMER

*Illustrated by Heinz Meng*

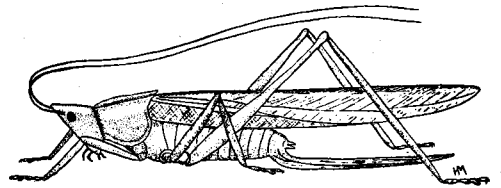
*This is the forty-eighth in Nature Magazine's series of educational inserts.*



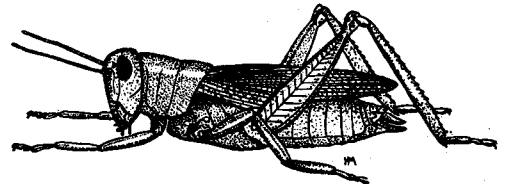
CAROLINA GRASSHOPPER



LESSER MIGRATORY LOCUST

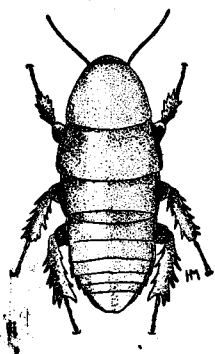


ROBUST CONE-HEADED GRASSHOPPER, AND, BELOW, TWO-STRIPED GRASSHOPPER

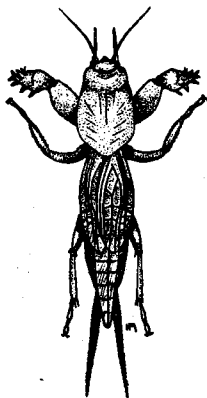


MEADOW CONE-HEADED GRASSHOPPER

IT may seem strange to offer an insert on grasshoppers at this time of year. It is the fall and late summer when they reach their greatest abundance, and it is then that the air is filled with their music. But when we broaden our subject—as we have—to include the kin of grasshoppers, there is no time of year when we cannot study them.



WOOD ROACH



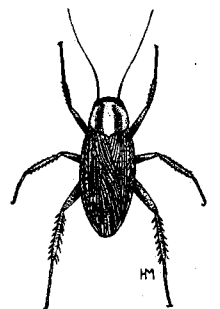
MOLE CRICKET

Cockroaches roam at will throughout the year in some homes. Wood roaches can be found under the rotting bark of trees even in winter. And in regions where praying mantes are in abundance, children bring their egg cases into the house and then wonder what they can do to feed the young mantids that hatch in the warmth of the house, only to have to eat each other or starve. It is in the spring that home gardeners, looking for something to buy to help their gardens, buy mantis egg masses, thinking that a few of these judiciously placed will make it unnecessary to fight the bugs later in the season. A professor friend of mine does this regularly, and, I am sure, without the slightest effect on his garden problems.

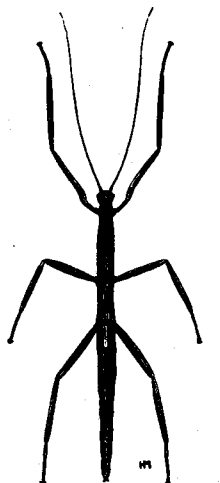
But what *are* the orthoptera, to which all of these insects belong? Any one who has been through a high school course in biology has, no doubt, drawn a pickled grasshopper. He has examined the chewing mouth parts and labelled the parts of the parts. He has learned, probably, that the critters have incomplete metamorphoses, which means that the little

grasshoppers show a striking resemblance to their parents when they hatch from the egg, and do not follow the egg, larva, pupa, and adult plan as do butterflies and some other insects. The student may even have studied the internal workings of a grasshopper and has wondered at what he found. The first time I did this my specimen was well filled with a large parasitic worm that did not look at all like what the picture in the book had indicated was to be found in the insect. My teacher, an English teacher, was equally stumped and told me to forget what I found and copy what I found in the book. It did not make sense to me, but I respected the authority under which I worked.

However, grasshoppers and their kin in a classroom jar of preservative, and the live, free animals, are quite different objects of study. One is disgusting to some of us, while the other is intensely interesting. In the order orthoptera, those species that have wings as adults have the wing covers straight or orthodox. This is where the group gets its name. But some have no wings, and yet, because of their general obvious relationships, they are still placed in our group. In this group, in fact, is a tremendous variety of insects. There are the primitive cockroaches, which are probably very much like their ancestors that roamed the earth as early as the Jurassic times, in the middle of the Age of Reptiles. There are the gro-



CROTON BUG



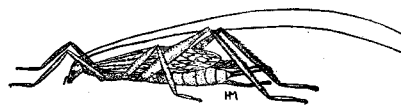
WALKING STICK

tesque walking sticks, praying mantes and leaf insects, the leaping grasshoppers, and the burrowing mole crickets. There are katydids and walking sticks that live in the tree tops, roadside grasshoppers that frequent the dusty roads, meadow grasshoppers that haunt the grass jungles, cave crickets that live in dark, cool, damp spots. They leap, crawl, run, fly and burrow, and there is probably no place outdoors where man himself works or plays, or indoors where he lives, that some orthopterans do not offer some claim to the same territory. They are meek or aggressive, noiseless or loud, harmful or useful, amusing or disgusting, hardy or sensitive, active night or day, in drought or flood, in winter or in summer. It is quite a different thing to know an insect case of dead orthopterans and to know the life habits of any one kind.

In the chart section accompanying this article we have given some details of the life history of a number of orthopterans. Ordinarily, we have accepted as typical a life history such as we give for the lesser migratory locust, but this pattern cannot be applied to all members of the group with any safety. Those who might wish to get good notes on the love life of many members of this group should read Fabre's *The Life of the Grasshopper*. Few writers have presented with greater skill, humor and probable accuracy the story of these insects' behavior. His account of the trials and tribulations of a male praying mantis seeking favor with a prospective mate is a masterpiece. It has been presented in greater detail, possibly, by Wheeler in his *Foibles of Insects and of Men*, but without Fabre's artistry.

Of course, when we speak of the mating instinct in animals, we are often likely to accept anthropomorphic explanations of what we see. Frank Lutz exploded beautifully the idea that crickets sang to win favor with the opposite sex. By the simple expedient of placing males and females so that they could or could not see each other, he found that it is obvious that the sounds are, as they are probably in birds, really challenges to other members of the same sex. Lutz' amazingly simple experiment upset completely much that had before been accepted as fact. Anyone can make a little box, an inch on a side, of screen wire and in it confine a sound-making orthopteran and learn much himself.

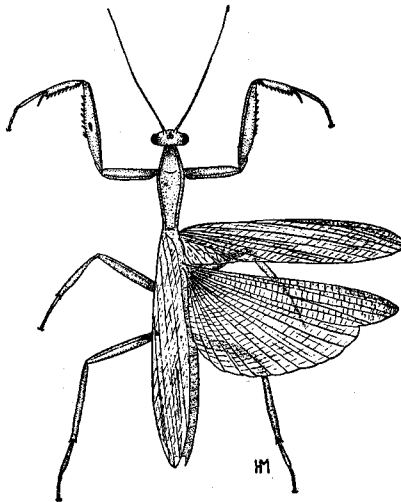
In some parts of the world, of course, orthopterans are kept in confinement for reasons other than study. In some



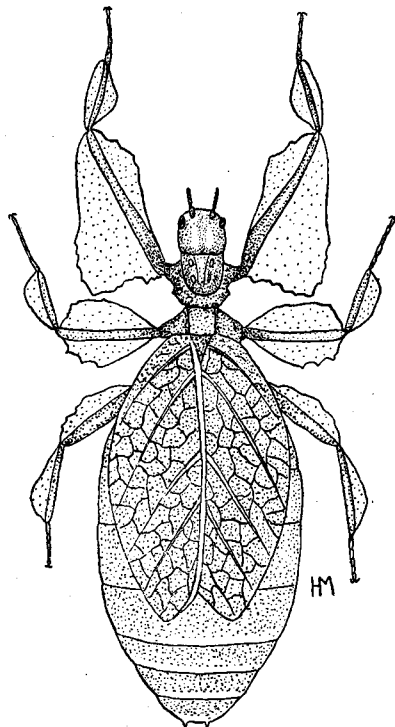
SNOWY TREE CRICKET



FIELD CRICKET



PRAYING MANTIS



TROPICAL LEAF INSECT

places, they are kept merely for the sake of listening to them sing. In others, they are kept to be used in contests with others of their kind for the sake of having something on which to bet. One friend of mine, a number of years ago, earned his doctor's degree by feeding cockroaches that he kept in small cages and observed the effect of different diets on the experimental animals. He found that, for the purpose of studying some kinds of diets, the cockroaches are ideal laboratory animals.

But let us not forget this sound-producing ability of some grasshoppers and their kin. The sounds are not produced by vocal organs as is the case in many other animals. Rather, they are produced by what the zoologists prefer to call stridulating organs. These may be on the legs, wings, or on other parts. While an insect without wings cannot fly, we cannot assume that because some grasshoppers make noises with their wings that wingless relatives must be noiseless. The Jerusalem cricket of the West makes its sounds, apparently, by rubbing its third pair of legs against the abdomen. The resultant sound is like that of rubbing sandpaper, but it, no doubt, serves a purpose somewhat similar to that attained by other means with most of the orthopterans.

The hearing organs are variously placed in the different grasshoppers and their kin. In some cases, the receivers are on the legs. In others they may be on the abdomen. The pitch of the sounds varies from the relatively low sounds produced by some of the katydids to sounds produced by many of their relatives that are beyond the pitch audible to most of us. Dr. Allen and Dr. Kellogg, who have given us such fine records of the sounds produced by birds and amphibia, will, we hope, some day offer us equally attractive records of the sounds made by insects. They already have some recordings in this field that should be generally available. When that time comes, then we can all sit down in front of our phonograph and learn to distinguish at least a few of the characteristic sounds of these insects. It is easy to recognize the katydids' oft-repeated "katy-did-she-did." It is equally easy to learn the

rhythmic chorus caused by great numbers of snowy tree crickets calling in unison. These sounds are as typical of late summer and early fall as peepers are of the spring, and bullfrogs of the summer.

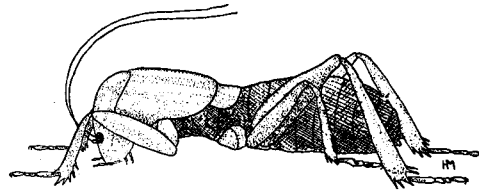
While it is easy to learn to recognize the sounds produced by a few kinds of crickets, grasshoppers and their kin, it is

not always so easy to learn how to locate the singer. Dr. Lutz used to use the simple triangulation method. He would line up his students in a straight line and get them all to point to where they thought the sound came from. While some would be unable to do much satisfactory orientation, usually the sum total of the judgments would be significant. Once a general area had been agreed upon, the group would move towards the center and repeat the pointing technique. Eventually, the singer would be located. I well remember doing this with him one moonlight night when we could just see each other in the field. When we had finally agreed as to about where the insect was, we formed a circle, and, at a signal, all turned our flashlights on the spot we thought most promising. Sure enough, there on a low shrub was a stridulating katydid that we never in the world would have found by individual effort.

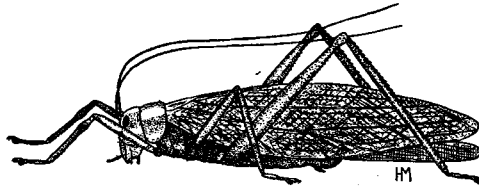
The different insects of this group vary greatly in the amount of light that induces activity and the temperature at which they are most active. Here is a whole field in which little has been done that is really satisfactory. In the fourth section of our tabulated material, we have given some clue to some of the findings. Reading this material over, you will find that some are at their best in bright sunshine, some on cloudy days, and, of course, many on the darkest night.

Lutz, again experimenting with cockroaches in this group, once learned that they are sensitive to different parts of the light spectrum than are we. With this information, he went to work and got cockroaches to be active in what, to them, was darkness but, to us, was some sort of light. This made it possible for him to get cockroaches to come out into his museum case and perform for visitors who otherwise would have been able to see no activity whatever. These experiments of his were characteristic of the man, and make many of us wish that there could be many more like him investigating the commonplace things of Nature, and finding new and perfectly rational conclusions that contradict what may have been accepted as wholly valid for an indefinite period. His little rule of trying to find the significance of changing the smallest factor that influenced an animal never seemed to get into the classroom program where it should have yielded remarkable results.

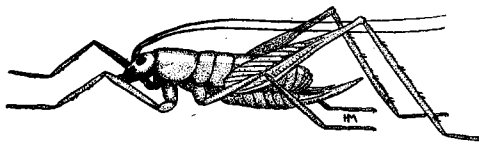
Man judges most of his associated animals largely by how they compete with his own selfish interests. Orthopterans, for the most part, are serious competitors with man's interests. The great scourges of "locusts" that have wiped



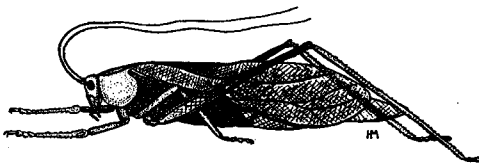
JERUSALEM CRICKET



BROAD-WINGED KATYDID



CAVE CRICKET



FIELD CRICKET



MEADOW GRASSHOPPER

out man's food supply and contributed to famines are standard incidents in the history of almost any country. We find it recorded in Biblical times. The Mormons faced the issue with prayer, and got an answer from the gulls, to whom they erected a monument in Salt Lake City. Locusts provide a spectacular incident in Pearl Buck's *The Good Earth*, her story of the trials and tribulations of survival in China. Fortunately, these scourges have, to a considerable extent, been lessened by reasonably sound agricultural practices, but whether this was due to intelligent planning or to luck is a matter of one's judgment of the reasoning.

We find in many cases in history that man has turned the tables on the grasshopper pests, and has, in some cases, even sought their appearance in overwhelming numbers. This is among peoples who have learned to use the insects themselves as food. Margaret W. Morley in her intriguing little book, *Grasshopper Land*, has given us as readable a summary of the use man has made of these animals for food as is to be found anywhere. She even goes into the details of preparing the animals by boiling them in oil, of drying them, of grinding

them and of making them into cakes and other delicacies. I fail to find where she speaks from personal experience as to how they taste, although she does say that they "should taste" as good as prawns, shrimps and similar animals. One wonders whether she had the courage of her convictions.

During the recent war, many men in our armed forces were given some suggestions as to how these relatively abundant animals could be used, at least as survival food. I have heard of no wholesale effort to make the animals popular as an early morning appetizer. There is no doubt but that man could turn an abundance of grasshoppers into some value by drying them and preserving them for use as food for poultry and for fish.

Of course, any animal so universally abundant and spectacular in behavior as the grasshopper must now and then creep into the folklore of a people. In such cases, it is not uncommon for the stories to increase in their bizarre qualities as they are handed down from one generation to another. Pliny, for example, reports, from India, grasshoppers more than three feet long with legs so strong that women used them for saws. Swedish boys, and boys of other lands, for that matter, are reported to use the "spit" of grasshoppers to drive away warts, and in many parts of the world the mass attacks of great numbers of insects are reputed to be directed by (Continued on last page of insert)

FAMILY	BLATTIDAE		MANTIDAE	PHASMIDAE
SUBFAMILY	Blattinae	Panesthinae	Mantinae	Racunculinae
COMMON NAME	Croton-bug. German Cockroach	Wood Roach. Brown Wingless Roach	Praying Mantis European Mantis	Common Walking-stick
SCIENTIFIC NAME	<i>Blattella germanica</i>	<i>Cryptocercus punctulatus</i>	<i>Mantis religiosa</i>	<i>Diaperomera femorata</i>
DESCRIPTION	Length, including antennae: nearly 2 inches; body, about ½ inch. Brown, with 2, rather wide, black lines behind the antennae to near the base of the wings. Wings when folded are about ¾ the length of the animal minus the antennae. Body: smaller than in male wood-roach or in American cockroach.	Length of body: slightly over 1 inch. Male and female: practically identical, externally. Dark, chestnut brown, shining, with antennae and legs, reddish brown, and margins of the body somewhat paler than the back. Eyes are concealed and the face is finely and sparsely dotted as are the dorsal segments.	Length: about 2 inches. Green or brown. Forelegs: used in grasping prey and held as though in prayer, with forward part of body bent upward and head twisting from side to side. Antennae: erect and short. Hind legs: used in walking and in leaping. Four well developed wings permit slow, extended flight.	Length, overall: to 4 inches, or more, with diameter of body only about ⅛ inch at most. Six legs are in widely separated pairs, and may be held so that animal resembles a green or a dead stick, since color may be green or brown. Legs and antennae: about equal in length. Eyes: small and to front.
WHERE FOUND	Native of Asia but made their way hence into Europe and thence into America coming to special attention in New York about the time water from the Croton dam came into use in New York, hence the name Croton-bug. It is now found over most of the world, spreading and being introduced by ships largely.	In mountainous and hilly country, from New York to Georgia and west to Kentucky; also on the West Coast, from Washington through Oregon to California. Usually, found just under the bark of soggy logs from which the bark may be easily stripped. There is but the one genus to be found in this country.	European Mantis is native of Europe, well established in eastern United States. Known as rear-horses, mule-killers, devil-horses and sooth-sayers. Native smaller mantis of eastern United States is <i>Stagmomantis carolina</i> . About 20 species in the country. Chinese Mantis, <i>Paratenodera sinensis</i> has established itself in the eastern states.	Relatively common in United States, except in more southern states. About 20 species found in country and group is mainly tropical, where it is represented by over 600 species, some over 16 inches long and one the famous tropical leaf-insect, <i>Phyllium scythe</i> .
REPRODUCTION	Instead of laying her eggs in cracks and cran-nies as does the American cockroach, the female of this species carries them in a small capsule attached to the rear of her body. From these, emerge the young cockroaches that closely resemble the adults. In some species, it may take a year to complete the life cycle while other cockroaches do this in much less time.	Information regarding the life history and general reproductive habits does not seem to be easily accessible. It is probably in general similar to that of the related cockroaches discussed in the preceding column.	Large, straw-colored egg masses of to 1000 eggs are laid on boards, weeds or buildings in fall. They normally hatch in May or June into little mantids that resemble the parents except for size and absence of fully developed wings. Young grow slowly acquiring wings and maturity about August. Egg masses: often an inch long may be hatched indoors but if so young may starve.	Eggs: white, with a black stripe, dropped to ground from trees in fall, sounding like rain, hatch in spring. Young: resemble adults in shape, but not in size. Full size may be attained in 6 weeks after hatching. In some species, eggs do not hatch until the second spring after they are laid.
HABITS	Cockroaches avoid light and favor moisture. They feed upon any suitable organic matter discharging what they may have eaten to make room for further feeding. They may eat filth, good food, book bindings and even the parts of living animals and serve in the spread of disease through the contamination of food stuffs as well as through the destruction of valuable food.	Food is probably soft, soggy, decaying sapwood in which the animals can and do burrow. In North Carolina and Virginia, they are most frequently reported in decaying chestnut and pine while in Oregon it is reported most completely from decaying fir logs.	Food: largely flies, grasshoppers and other insects. Female frequently eats her smaller mate after the breeding act or even before if her hunger exceeds her romantic feelings. Prey is grasped and held by spine-laden forelegs, eaten at leisure with most comical display of indifference.	Food: largely foliage of trees of the forest. Sometimes destruction of leaves is complete and hence serious. Activity greatest at night. No noises are made. Since there are no wings, locomotion is by walking, though some species leap and others run. Individuals may remain practically motionless during daylight.
ECONOMIC IMPORTANCE	These are serious enemies to health. The newer insecticides such as DDT have been effective in keeping the animals under some control and where these may be used safely they should be used generously and constantly. At the first sign of an infestation, prompt action should be taken to eliminate them.	It is probably not of economic importance and while it may be found about camps it is not likely to become a serious household pest under any circumstances. Because of this, no control measures are probably necessary.	All exceptionally useful destroyers of other insects and should be encouraged in gardens where they may play an important role in insect control. Larger species widely introduced. Egg masses are collected and sold for establishment of colonies. Read Fabre's description in "The Life of the Grasshopper."	May be serious pests to trees. Are entirely harmless to man himself. When abundant as pests, they are sometimes controlled by use of a sprayed stomach poison. Food is chewed, not sucked. Superficially resemble water scorpions of fresh-water ponds (See insert #1), but these suck their food rather than chew it.

PHASMIDAE	ACRIDIDAE			TETTIGONIIDAE
	Oedipodinae	Locustinae		Phaneropterinae
Tropical Leaf Insect	Carolina Grasshopper	Lesser Migratory Locust	Two-striped Grasshopper	Forked-Tail Bush Katydid
<i>Phyllium scythe</i>	<i>Dissosteira carolina</i>	<i>Melanoplus mexicanus</i>	<i>Melanoplus brevitatus</i>	<i>Scudderia furcata</i>
A group of exotic insects varying in size to some inches long. Expansions of the legs and of the back have a close resemblance to leaves on which the animals live even to the imitation of veins that may be found in leaves. Since the movements are slow, the insects easily escape detection by their enemies.	Length: to 2 inches. Dull, grayish brown, with inner black wings margined conspicuously with yellow. With some dark clouding in the body color but usually appears to be unspotted and generally dust-colored. Wings extend from 1/4 to 1/3 their length beyond end of abdomen. Jumping legs well developed.	Length: about 1 inch. Yellow or tan, with dark bars across hind legs. Fore-wings: grayish, extending beyond the end of the body, with a few dark spots near the middle. Female: with end of abdomen as shown in figure. Antennae: relatively short. Hind legs: suitable for jumping great distances, even without help of the wings.	Length: 1 1/2 to 1 3/4 inches. With yellow stripes extending along the back from the compound eyes almost to the tips of the folded wings but united near the middle of the wings. Antennae: relatively short, straight and forward directed. Body and abdomen: plump and whole animal substantial.	Length: about 2 inches, overall. Fore-wings: nearly uniform in breadth through length, differing in this respect from angular-winged katydid, <i>Microcentrum</i> that has a short, abruptly up-curving ovipositor, and the oblong-winged and round-winged katydids <i>Amblycorypha</i> , that have long, curved ovipositors.
Members of this genus are native of the tropical parts of the Old World, but our nearest native relatives are the walking sticks that resemble twigs rather than leaves, both belonging to the family Phasmidae. Members of this family almost invariably get protection through mimicry of the parts of the environment in which they live.	Found practically throughout the United States appearing most frequently along dry, dusty roadsides or in relatively barren spots. There are 6 species of the genus known to be found in the United States of which this may be the best known though not necessarily the most common.	Wide distribution in North America. Found in fields and meadows. Often serious pest in the East. Commonly found with red-legged grasshopper. <i>M. femur-rubrum</i> . Rocky Mountain grasshopper formerly known as <i>M. spretus</i> is merely long-winged migratory phase of <i>M. mexicanus</i> which until recently was known as <i>M. alanis</i> .	Found throughout the United States except in the south Atlantic states, in fields, on crops, or in a great variety of places. The related <i>Melanoplus spretus</i> or migratory Rocky Mountain locust migrates east from the Rocky Mountain area in great flocks destroying all plants in their way.	<i>Scudderia</i> in different species, is found throughout the United States and most of Canada, but mostly east of the Great Plains, living on bushes. True katydid, <i>Pterophylla</i> , is found in trees, usually in restricted colonies, but throughout United States, east of Rockies.
Notes on the reproductive habits are not available but the story is probably much like that to be found in the walking sticks discussed in an adjacent column.	Male may hover in air over female in apparent courtship behavior making a purring or beating sound with males sometimes apparently competing vigorously with rivals or actually fighting. There may be 2 broods a year with adults being found in the North from June through November and mated individuals appearing by first of July.	Mates, and in fall, female lays eggs in burrow underground, in clusters of 12 to 80, in 2-inch burrows. Eggs: about 3/16 inch long, like taper-ended cylinders; hatch in spring into nymphs that shed skins 5 times before attaining maturity and wings. No pupal stage.	Egg: placed in a pit about 1 inch deep, in clusters of 25 to 80 and covered with a fluid that hardens forming a pod. One female may lay a number of pods. Unless disturbed by plowing or other means, eggs hatch in spring and in about 3 months young grasshoppers can reach maturity and breed.	<i>Scudderia</i> lays flat eggs, 1/3 to 1/4 inch long, in rows on leaves, in late summer. These hatch in following season and young resemble adults, except for absence of wings. There is of course no pupal stage.
Food: largely plant materials among which the insects are found. Food is chewed. Animals are harmless to others though they may possibly serve as food for species clever enough to recognize them as eatable.	Wings are used extensively in travels, the flight being usually noiseless, zigzag and rather well maintained for some distance. Hind legs are powerful enough to give the insect a good initial start. Animals are somewhat social and when excited tend to fly to bare open areas rather than to dense cover as do many other grasshoppers.	Food: almost any plant material, often serious pests to crops. Some grasshoppers give weak sounds. The Carolina locust of the roadside displays yellow-bordered, black, hind-wings and the cracker locust gives a clicking sound in courtship. Ear-drums or hearing membranes are on sides of body behind the wing bases.	Relatively inactive grasshoppers as compared with some of the smaller species. Adults commonly found from June through to November through most of the range. Commonly attempt to escape detection by hiding on the opposite side of the plant on which they are resting. Feeds on almost any kind of plant but common on low forms.	Food: leaves of plants on which insect is found. <i>Scudderia furcata</i> gives a soft, high, oft-repeated, <i>zeep, zeep, zeep</i> , from bush or tree; <i>S. curvicauda</i> calls <i>bzrwi</i> in day, and a shorter <i>schw</i> at night; <i>Amblycorypha</i> gives a shrill <i>sbrie-e-k</i> ; <i>Microcentrum</i> calls a high, repeated <i>tzeet-tzeet-tzeet-tzek-tzek-tzuk-tzuk</i> .
Of little economic importance probably but of tremendous interest because of the remarkable mimicry they exhibit.	Food is largely plants, of course. The species is not so likely to be abundant as are other species and therefore the insects are less likely to be considered as serious pests. It is known to cause serious injury to corn, wheat, alfalfa and soybeans. It is figured and discussed in Farmer's Bulletin, 747, U. S. Department of Agriculture.	Late fall plowing may destroy eggs in ground. Rolling of fields may kill young before they have developed wings. Hopper-dozers dragged across fields, and ditches dug through or around them, provide some control. Possibly some dried grasshopper bodies may be used as chick food or as fish food. This might make capture profitable and offset the normal losses they would cause.	One of the most destructive grasshoppers to alfalfa, wheat, corn, weeds and garden plants but not ordinarily favoring woody plants if other plants are available. In some years, have been serious pests but cultivation of land has reduced the menace. Excellent trout bait. See Farmer's Bulletin 747, U. S. Department of Agriculture for further information.	None of these is of great economic importance but all are interesting in part because of their songs. The calls of some of these are too highly pitched to be heard by persons with limited ranges of hearing.

FAMILY	TETTIGONIIDAE			
SUBFAMILY	Phaneropterinae	Copephorinae	Conocephalinae	
COMMON NAME	Broad-winged Katydid	Robust Cone-headed Meadow Grasshopper	Meadow Grasshopper	Meadow Conehead Grasshopper
SCIENTIFIC NAME	<i>Microcentrum rhombifolium</i>	<i>Neoconocephalus robustus</i>	<i>Orchelimum vulgare</i>	<i>Conocephalus</i> sp.
DESCRIPTION	Length: to 2¼ inches, with front wing to 5/8 inch broad, light green and with veins that suggest the veining in leaves. Male: with sound-producing organ long, triangular, opaque and coarse dotted. Face: under-surface, fore and middle legs, greenish yellow fading to a clay-yellow. Sexes nearly equal in size.	Length: body, to 1 1/5 inches, with female slightly longer than the male. Female: with long bayonet-shaped ovipositor, nearly equal to the length of the body and with its tip exceeded only slightly by the wing tips. Antennae: as long or longer than the rest of the animal and curving backward. Head: pointed. Pale green or rarely brown.	Length: about 2 inches, from tip of wing to tip of head. Slender, pale green, with long, slender antennae. Head: slender, pointed. Eyes: relatively small and near front of head. <i>Conocephalus</i> is smaller and more slender and commonly with straighter ovipositor.	Length of body of most members of this genus: about ½ inch. Antennae usually longer than body. In most species, the ovipositor of the female is slender and straight but in <i>C. nemoralis</i> is curved. In related <i>Orchelimum</i> , body is stouter and usually over 2/3 inch long.
WHERE FOUND	Found most commonly in low bushes and shrubbery. Ranges from New York to Minnesota and south to Florida and California with related species extending range into northwest areas. The genus is essentially American with 26 species, of which 2 are found in the United States and the others mostly tropical in range.	Found in drier sandy areas from Cape Cod to Virginia and along the shores of the larger lakes inland. There are 101 known species of the genus in the world of which 16 are listed from the United States though some consider each of these numbers too small. They are all practically terrestrial.	Found in moist pastures and meadows, usually among grassy plants, with <i>O. vulgare</i> ranging from the Rocky Mountains to Atlantic Coast and generally common. Not commonly found high above the ground, even though suitable food might be available there.	Members of this genus favor dry uplands while those of the genus <i>Orchelimum</i> favor borders of wet spots. This genus is found in open fields, gardens, weed patches, orchards and similar spots. Over 90 species of the genus are known throughout the world, of which 14 are found in the United States.
REPRODUCTION	In early September, after mating, 2 to 30 eggs at a time are laid, day or night, in almost any place. Eggs are flattened. In May, the eggs hatch into young katydids that within 10 minutes begin eating and growing. By mid-July, the insects have grown from 1/8 inch long to a mature 2 inches or more and calling begins.	May sing night or day but particularly in early afternoons on cloudy days. Eggs are placed in grass tissue or in the pith of woody plants with assistance of long ovipositor. Usually eggs are placed close to ground between stems and root-leaves. Young hatch the following season into insects like adults but for absence of wings.	Eggs: laid in plant tissues with aid of the curved ovipositor; hatch in spring. Young: resemble adult in general form but do not develop wings until maturity is reached in early summer. No pupal stage of course.	Eggs are usually deposited in plant material being thrust in with the assistance of the ovipositor. The common <i>C. fasciatus</i> or slender meadow grasshopper may be found in adult form from July through September but in South it may persist into the winter. Winter is spent in egg form.
HABITS	Calling takes place at night. Males produce a series of 25 to 30 raspings with wing structures. Female answers with a single sharp chirp or "tschick" by sudden upward jerks of the wings. When temperature goes below 65° F. calling by both sexes stops. One female may in season lay to over 200 eggs.	Singing night or day sounds like buzzing of cicada or the prolonged humming of a bee. Exceedingly noisy. When disturbed, may hide on opposite side of a plant or fall to ground and stand on head leaning against a plant and most difficult to detect because of position and color.	Food: mostly grasses. Front-wings of males differ from those of female. In male, left front-wing overlaps right and by means of scraper causes a rasping sound when moved due to vibrating membranes. These sound-producing organs are on the wings close to body. "Ears" of cone-headed grasshoppers appear as 2 vertical slits on the fore-legs.	Sounds produced are weak and to one writer sounds like "plee-e-e-e-e, tzit, tzit, tzit, tzit." Other species have other songs but all are weak and to some barely audible. In open winter seasons nymphs of <i>C. fasciatus</i> may be found as early as March but this is not common in the North.
ECONOMIC IMPORTANCE	Probably of little economic importance but popular with those who like to live in the country because of the sounds produced at night. Known to eat cabbage, lettuce, purslane, apple, cherry and oak but apparently survive best on the leaves of the woody plants such as some of those listed above.	Feeds on plants but usually not those considered by man as of great economic importance. Most of the species feed on plants of relatively little economic importance and the animals are rarely in sufficient abundance to be considered as serious pests. Some species may burrow in sand to a slight extent.	Meadow grasshoppers are not commonly listed as being serious pests to grass crops in comparison with some of the other grasshoppers here considered.	These grasshoppers may cause some destruction to grasses and other economic plants but they rarely reach the abundance of the more destructive species. Someday someone will make recordings of the sounds of these insects and their relatives, to the end that we may learn to recognize them as we do the sounds of birds and amphibia.

TETTIGONIIDAE		GRYLLIDAE		
Rhaphidophorinae	Stenopelmatinae	Gryllotalpinae	Gryllinae	Oecanthinae
Cave Cricket	Jerusalem Cricket Sand Cricket	Common Mole Cricket	Field Cricket	Snowy Tree Cricket
<i>Ceuthophilus gracilipes</i>	<i>Stenopelmatus longispina</i>	<i>Gryllotalpa hexadactyla</i>	<i>Gryllus assimilis</i>	<i>Oecanthus niveus</i>
Wingless. Pale brown, or dirty white, with brown spots. With high, arched back and remarkably long, hind legs and antennae. Body: short and thick-set for a grasshopper, in female terminating in curved sword-like ovipositor. Lacks the sway-back of related sand-cricket.	Large, awkward insects without wings, with head bent forward and medium-long, slender antennae bent in either direction. Front legs and hind legs: much stronger than the middle pair and useful in getting animal through the soil. Abdomen: large somewhat arched and relatively shiny.	Length of body of male and female: from 4/5 to 1 1/5 inch. Brown to blackish brown. Front legs: shortened and remarkably suited for digging. Second and third pairs of legs: suitable for pushing body through the soil. Head: streamlined and rounded permitting pushing the way through soft soil.	Length, overall: about 1 inch. Female: with long, slender ovipositor which is lacking in the male. The smaller brown cricket <i>Nemobius</i> is possibly more common. It is 3/8 inch long, brown, with 3 darker abdominal stripes.	Slender, pale green. about 1/2 inch long, with long antennae. Female: with wings closely wrapped about body. Male: with more slender body, and with wing broader and relatively free and, of course, without long ovipositor. Male secretes, at base of wings, a liquid that female seems to enjoy eating.
Common in cellars and moist caves, or in woods, or gorges, or wells. Usually, where there is little light. There are at least 12 species of cave crickets or camel crickets in the United States. The related sand-crickets are found on the Pacific Coast.	Found burrowing in the soil since it lives practically wholly underground in burrows of its own preparation. Common in the West in the Rocky Mountain area and along the Pacific Coast. Technically it is not a cricket nor a native of Jerusalem. A single genus with several species.	Found from British Columbia to South America including much of Canada and on to Brazil. It is most commonly found in burrows and runways in soft soil near small lakes and ponds. Burrows may enlarge into side cavities. The genus is widely represented over the earth and 3 species are found in eastern United States.	Field crickets live in dwellings, fields, pastures and gardens. The cricket-on-the-hearth or house cricket, <i>Gryllus domesticus</i> is slender, yellowish brown, pale, with 3/5 inch body. It is native of Europe but has become established in America.	Commonly found singly or in pairs on trunks of trees or shrubs in late summer, with several species covering United States and Canada. Common species include snowy, the narrow-winged, the black-horned or striped, the four-spotted and the broad-winged, all of which are good singers.
Since these crickets have no wings, they can make no sound. Eggs: laid in late summer, probably in the ground, may hatch in fall but more commonly in the spring, into young nymphs that resemble the adults in general shape and may be found in early spring as wintering individuals.	Notes on reproduction indicate that the behavior is somewhat like that of other grasshoppers. The ability to make a noise and to fight indicates the possibility of courtship preceding the mating and egg-laying.	Females lay eggs in masses of 60 to 100, attached to rootlets, spherical, almost colorless, about 1/50 inch in diameter. The young may leap about actively but develop slowly it being reported that maturity is not reached until nearly 3 years have passed. Females show no visible external ovipositor.	In late summer or fall, the female lays several hundred eggs singly or in masses in holes in the ground. Eggs hatch in fall or spring. Those hatching from eggs in July may mature by mid-August. Immature crickets resemble adults but lack developed wings. No pupal stage.	Male sings. Female may approach and feed on liquid on back. Mate. Eggs deposited on bark or stems such as raspberry canes, 40 to 50 together; hatch in early summer into little crickets that resemble parents but for undeveloped wings. Reaches maturity by midsummer. Killed with advent of cold weather.
Food: meat, fruit, vegetables or almost anything organic and available. While cave crickets are not ordinarily considered of great economic importance the related Jerusalem cricket and western cricket, <i>Anabrus parascens</i> , may be serious pests to crops in West sometimes reaching plague proportions and eating their own kind.	Sounds are produced by rubbing the hind or third pair of legs against the abdomen. The sound is similar to that produced by rubbing two pieces of sand-paper together. Sounds may be produced when the insect is annoyed and while it shows an aggressive fighting pose. "Cerci" at rear may serve to warn of danger from rear.	Food: plant material, earthworms, larvae of various insects. Song is a sharp, repeated, relatively loud 2-syllable chirp, difficult to locate but audible at over 10 foot distance, given in forenoon or afternoon but preferably on cloudy days. It sounds much like that of the snowy tree cricket.	Food: plant or animal matter, but mostly plants. Males begin singing by wing-rubbing about June and continue through August, purpose apparently being to defy other males. Chirps loudest when weather is brightest and warmest. Males will fight each other if confined, chirp pitch rising as fight progresses.	Generally most active at night. Males fly readily and give calls in unison with other males. Add 37 to number of times males call in 15 seconds to get approximate Fahrenheit temperature. Calling is done during night of warmer months and is described as "slumbrous breathing." Amply protected from enemies by coloration.
In certain sections of the West the related species referred to above are only too well known. The animal of the East is more of a curiosity than of a pest because of the fact that it is rarely found in abundance, — fortunately.	Omnivorous insects feeding on potatoes, roots, earthworms, insect larvae and other organic materials. Because of habit of sometimes feeding on potatoes is in some parts known as the potato bug though this name of course is more commonly applied to the Colorado potato beetle.	Probably somewhat useful as destroyer of other insects. It apparently does no damage to man's economic plants. Female is reported to be able to chirp, producing a single note in contrast with the male's two-note call. Call reported as at 130 to 150 a minute two octaves above middle C continued for 2 to 3 minute intervals.	May destroy grass, clothing, food and other materials. May be controlled by baits, such as sliced potatoes poisoned with Paris green or partly opened jars containing sweetened vinegar. Another bait is made of 1 pound of Paris green or white arsenic to 25 pounds of coarse bran, and 2 quarts of cheap molasses.	Young and old feed largely on plant lice and so are essentially useful to man. One species, <i>O. nigricornis</i> , may injure raspberry canes by laying eggs too closely together on stems but most other species do little if any damage, and much good so are worthy of protection because of pleasing music and useful food habits.

intelligent marshals who direct advances and retreats with well-obeyed disciplinary commands. This is in a way denied in the Book of Proverbs in the *Bible*, where we read: "The locusts have no king," etc.

Any good agricultural text will give you an abundance of figures showing the destructive ability of grasshoppers and their kin. Even more convincing may be what happened when you slept out some night in an open field and woke in the morning only to find that the insects had chewed your socks into a beautiful bit of lacework. Certainly, in these trying times, when the whole world is calling for more and more food, we are going to watch with great suspicion the activity of any animal that wants to eat what we want to eat ourselves. This means that grasshoppers must go, or must be kept under control in the great food producing areas. Corn, alfalfa, wheat, rye, potatoes and garden truck all may be injured for food in the field. These same foods, when kept in storage, may be injured by crickets, cockroaches and other members of this ubiquitous group. To keep them in control calls for all sorts of tricks of the gardener, farmer, merchant and housewife.

Farmers have learned that late fall plowing, after grasshoppers have laid their eggs, may bury the egg capsules so deep underground that the young insects can never get a start in life. Early fall plowing is not an effective control because the eggs are laid on the newly exposed surface. Once the insects have begun to develop, we use a great variety of means to get them under control. "Hopperdozers" are driven over fields and the insects that fall into them are destroyed. Baits are set that induce the insects to leave our food plants for more tasty arsenic, flavored with molasses. In some cases, farmers have used fire to fight grasshopper epidemics. This is not usually advised because only rarely does the fire destroy the eggs hidden in the ground at the time such fires are possible, but the fires may also be destructive of the valuable humus that is the backbone of our national prosperity.

Possibly, the wisest technique to follow is that of investigating and encouraging the activities of the natural enemies of these insect pests. There are hosts of these, ranging from the obviously conspicuous turkeys, quail and other birds that use the insects as food, to the skunks, shrews, and deer mice that feed on them more secretively. But more important than any of these are the invertebrate parasites that prey not only on the adult insects themselves but upon their egg masses as well. To these should be added certain bacteria, which are known to be of use in limiting the multiplication and destructive power of many of these pests, and which, in some cases, particularly with the related beetles, can be applied by mass distribution methods. Then too, of course, we have the newer chemical sprays that either serve to provide stomach poisons for the destroyers of our wealth or, better yet, serve as contact poisons and stop the feeding ac-

tivities of the animals once they have reached their goal. Unfortunately, we do not know all we should about the use of some of these wholesale control materials, and until we do we may reserve some judgment as to their ultimate importance.

Probably, the eventual winning of our battle against these insect foes will be effected by a combination of use of poisons, encouragement of natural enemies and agricultural practices that bring rain, sun and frost into play as controlling elements. It is not wholly unreasonable to predict that we may actually find some important use of these insects that has been unknown or ignored by those of us reared in our modern civilization. We may find, as we have in a number of other cases, that primitive peoples have recognized values we have been unable to appreciate; that they, unlike us, have now and then been able to turn a calamity into a blessing. Certainly, whatever the final decision may be, we will find our wits challenged by the activities of these common animals. We may use the animals directly in the form of a fancy breakfast food, or we may find that it is efficient to use them as food for other animals. These animals may have food value or may be of other worth to us.

Whatever methods we may use in attacking these animals we will probably find in the group some that are able to resist what we may do. They may not fight back. They will, of course, not be intelligent in what they do. But the requirements of the insects are so varied that no one or no few practices we may adopt are likely to meet the conditions set by the life habits of all. We may be able to destroy one kind of grasshopper, but another may take its place at another time or may make its attack at another place. We may learn how to fight the grasshoppers that attack the tops of wheat plants, but, then, those relatives that attack the roots may come into abundance. This is the sort of thing that makes life interesting.

It may sound absurd, but, if you can learn this year how far your local grasshoppers jump when they begin activity for the day, how much they eat and how much they destroy that they do not eat, what proportion of them that hatch this spring survive to breed this summer, you will have made a start in helping yourself and others to meet the threat they make to our productive capacity as a nation. Some of these little things may seem to have no significance, but the effectiveness of a hopperdozer is dependent on how far the hopper jumps and the direction in which it jumps, and the other points raised have similar practical applications.

So, in spite of the fact that there will be few orthopterans for you to hear or to study when this special insert reaches you, it will really be a good time of year to begin your investigations. When summer comes, the problem may be too big and too complicated for you to handle well.