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The Tree Crickets of Oregon

By

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CORVALLIS, OREGON

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SUMMARY

Prune, apple, peach, loganberry, raspberry, blackberry, and grape are subject to tree cricket injury at times. The injury is due to (1) the habit of feeding on fruits, and (2) the egg laying in stems and bark. Egg punctures are sometimes associated with bark diseases.

Control is easily accomplished by means of a spray of lead arsenate in late June or early July while the crickets are small. On berries they may be controlled by a scattering application of sweetened arsenical spray.

The eggs of tree crickets remain in the host plants over winter and hatch usually in June. The crickets mature about the first of August and live until heavy frosts kill them.

Three species occur in Oregon. One of these exists as two distinct races identical in appearance but differing in habits; one race lives in orchards, the other on berry bushes. A second species lives among tall herbaceous plants and a third on wild shrubs.

The Tree Crickets of Oregon

By

B. B. FULTON

The tree crickets are a small group of crickets, which live among foliage and not on the ground as in the case of the well-known field crickets. Not all of them live in trees as might be expected from the name, some species living among bushes and others on tall herbaceous plants.

They are of interest to the fruit grower because of the fact that certain species become destructive at times. In Oregon there are three species of tree crickets. The most destructive one occurs in two races, one living in orchards and the other on berry bushes.

ECONOMIC IMPORTANCE

The injury caused by tree crickets is due to the feeding habits and to the deposition of eggs. Although they are not generally considered as serious pests of plants, yet there are places where conditions have favored the increase of certain species over a period of years until they have become very destructive. The plants most liable to be affected are prune, apple, peach, loganberry, raspberry, and blackberry.

Fruit injury. Destructive feeding habits of tree crickets have been noted from time to time. They have been reported injuring tobacco leaves, but on most plants the consumption of foliage is negligible. In the case of fruits, even if the amount of material consumed is relatively small, the injury may be severe due to numerous surface blemishes and to subsequent rot infection. The tree crickets chew holes through the skin of the fruit and often enlarge the cavities below the surface by further feeding on the pulp with the head projecting into the hole (Fig. 1). The adults feed more extensively than the young crickets.

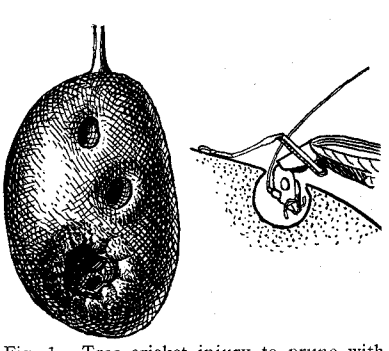

Fig. 1. Tree cricket injury to prune with diagram to show method of feeding.

Garman[1] has observed tree crickets in Kentucky, feeding on ripening plums, peaches, and grapes, the injury causing brown rot infection in the stone fruits and black rot in the grapes. In more recent years fruit injury by tree crickets has been reported in the western states. A fine crop of peaches in the Sacramento Valley was reported by Urbahns[2] to be materially damaged by the snowy tree cricket eating holes in the ripe peaches, causing extensive infection by

brown rot with a resulting loss of about a hundred tons of peaches in a single orchard. Wakeland and Whelan[3] have described a similar outbreak on prunes in the Boise Valley of Idaho and adjacent parts of Oregon. In a large commercial orchard at Parma, Idaho, the tree crickets had been a pest of considerable importance for a number of years and in 1921 caused a loss of about one-fourth of the crop. Yothers[4] in a later account of the same outbreak, stated that the annual loss in prune orchards of Southern Idaho amounts to hundreds of thousands of dollars. He says that crickets in the last two stages before maturity feed on the half-grown prunes, gnawing holes in the surface. The injury starts about the first of August and increases in extent as the crickets mature and the prunes ripen. It often happens that the percent of injured fruit is so great that it does not pay to harvest, sort, and pack the crop. The injured fruit often starts to decay after being packed, causing a slime which spreads and renders the whole box unmarketable. According to Wakeland the number of individual tree crickets in this infestation may be as high as 1386 in a single tree.

Oviposition injuries. Certain species of tree crickets have become injurious by their method of depositing eggs. Egg punctures in the bark of trees and bushes permit the entrance of organisms causing bark diseases. Under some conditions tree crickets actually inoculate the plants with certain parasitic fungi.[5] In Oregon bark diseases associated with tree cricket egg punctures have been found on prune and apple. The bark canker develops as a circular discolored area surrounding the puncture. Later the dead portion is separated from the healthy bark by a distinct line or narrow crack. Egg punctures in raspberry are sometimes associated with a disease known as raspberry cane blight.

In berry bushes oviposition by tree crickets often causes injuries of a purely mechanical nature. The canes break or split easily at points where a row of eggs has been deposited. Unusual numbers of eggs in canes may permit evaporation to the extent of killing the tips. This effect is more common on loganberries.

CONTROL

The fact that tree crickets are always rare or absent in apple orchards that are regularly sprayed for codling-moth shows that their control is not a difficult matter. One spraying with lead arsenate in late June or early July while the crickets are young is usually all that is necessary to control them. This was demonstrated in a small orchard at the edge of Corvallis, belonging to H. M. Wight. During the summer of 1922 this orchard was uniformly infested with tree crickets. A large number of males could be heard singing in each tree and many females were observed ovipositing in the branches. Early in the summer of 1923 these trees received one spray after the tree crickets had hatched, lead arsenate being used at the usual strength of 1 pound to 50 gallons. After the tree crickets had matured no males could be heard singing in the orchard except in one tree which was in contact with a large unsprayed blackberry bush. Adjoining unsprayed cherry trees still contained tree crickets, showing that the nearly complete extermination of the insects was due to the spray and not to parasitism.

Control of tree crickets on loganberries by means of a sweetened arsenical spray was demonstrated on the J. L. Johnson farm near Eugene. The loganberries contained numerous egg punctures. All plants were affected and on many of them several hundred punctures could be found in a single cane. Those most severely attacked were dying at the tips due to loss of moisture. On July 11, 1922 the bushes were sprayed with the following mixture:

Water	5 gallons
Lead arsenate	¼ pound
Molasses	1 quart

The spray was applied with a compressed air hand sprayer. No effort was made to spray the bushes thoroughly, but each was given a few dashes as the operator walked along. One part was treated in the afternoon and the other in early evening so that when the crickets became active at dusk they would find the material still liquid.

On November 11, 1922, the experiment was checked. No difference was noticed between the plots sprayed in afternoon and evening, but both showed a remarkable difference in number of egg punctures from the condition in early summer. A search of a whole row in the part sprayed in the evening revealed only one cane containing eggs, of which there were 23, scattered in several short rows. A similar examination of a half row in the other plot disclosed only one short row of eggs.

The control had been aided by the disposal of the old canes immediately after the last of the crop had been removed. They had been carried away and burned, taking many crickets along with them. In the unsprayed plot, however, where this practice was also carried out, eggs could be readily found, but were not numerous enough to be serious.

LIFE-HISTORY

All of our species of tree crickets deposit eggs in the stems of plants in the late summer and fall. These remain over winter and hatch early in the following summer, in the Willamette Valley usually near the middle of June. The young crickets grow rather slowly for insects and shed their skin five times before reaching the adult form. Each stage is characterized by progressive changes in the development of the wing pads and ovipositor. The life stages and other facts concerning the biology of the tree crickets have been described in detail by the writer in a previous discussion.[6] It will suffice here to give some of the more important features of the life-history.

There is but one generation a year and in the vicinity of Corvallis the adult stage is usually reached near the first of August. By that time some of the males can be heard singing and the chorus is augmented later by other individuals until it becomes the most characteristic and most musical insect sound of late summer evenings. The sound is made by vibrating the raised fore wings in a transverse direction, thus scraping a file-like structure located near the base. The song can be heard until the crickets are all killed by heavy frosts, in some years as late as mid-November.

A few weeks after the early maturing males begin their song, the females can be found ovipositing in the manner peculiar to their kind. While the placement of the eggs differs for each species the method of drilling the hole in the plant is essentially the same for all.

The female's ovipositor consists of two pairs of rods fitted closely together to form a tube through which the slender eggs can pass. The rods are provided with teeth at the tips and the upper pair can slide on the lower by means of a tongue-and-groove connection. The female usually prepares a place on the bark by chewing out a few bits. Then she arches the back and brings the tip of the ovipositor perpendicularly against the place selected. The drilling is accomplished by twisting the body so as to rotate the ovipositor in alternating directions and at the same time the lower pair of rods are periodically thrust downward so that their sharp points cut in. The upper rods have small teeth at the tip which ream out the sides of the hole. The completed hole slants backward from the body of the cricket. While the ovipositor is still buried for nearly its full length in the plant an egg is pushed through and the ovipositor is then slowly withdrawn, leaving a small amount of gelatinous substance in the hole with the egg.

The food of tree crickets consists of both plant and animal matter, and their individual diet depends largely on the kind of food available. Besides their habit of chewing holes in fruit as previously described, they are known to feed to some extent on leaves, floral parts, especially the anthers, and fungous fruiting bodies. Tree crickets readily feed on small, easily captured insects such as aphids and scale insects, and no doubt are of some benefit in reducing the numbers of such pests.

HOW TO RECOGNIZE OREGON SPECIES OF TREE CRICKETS

Tree crickets can be superficially distinguished from most other insects by their pale whitish color, the long slender antennae exceeding the body, and the elongated hind legs adapted for jumping. The males are peculiar in having the fore wings broadly expanded and paddle-shaped; the wings lie horizontally over the abdomen, the right one superimposed on the left.

The outer border of each wing is abruptly bent toward the body, concealing the sides of the abdomen. The second pair of wings are folded fanlike under the fore wings. The females present an entirely different appearance; their front wings are narrow and wrapped closely about the body. The tip of the abdomen is provided with a rod-shaped ovipositor about a quarter of an inch long.

The crickets may be distinguished from all related jumping insects by the horizontally disposed wings of the male and the rod-shaped, rather than sword-shaped, ovipositor of the females. Since the only other species of true crickets occurring in Oregon are dark colored, ground-inhabiting insects they are not likely to be confused with the tree crickets.

In Oregon there are three species of tree crickets, one of which is divided into two physiological varieties as indicated by their habits and host plants. The following key will enable one to separate the species readily in any stage of the life-history.

A. *Adult.* Nearly pure white, with a slight greenish cast. Two basal segments of the antennae each with single round black spot in front (Fig. 2, A). *Nymph.* Greenish white with a few black dots and lines on the head and thorax.

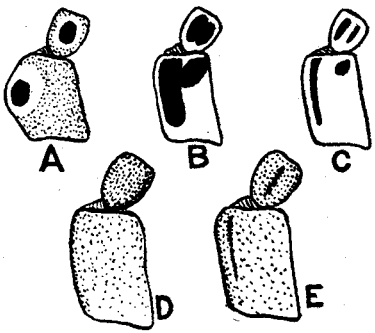

Fig. 2. Basal antennal segments.
A. *O. niveus.*
B. *O. nigricornis argentinus.*
C. *O. n. quadripunctatus.*
D, E, *O. californicus.*

1. Living in trees.

   Eggs deposited singly in the bark (Fig. 4, A). Song, 160 notes per minute at temperature of 70° F.

   O. niveus, Race A.

2. Living in bushes.

   Eggs deposited in long rows in the pith stems of shrubs such as wild rose and berries *(Rubus)* (Fig. 4, B). Song, 90 notes per minute at temperature of 70° F.

   O. niveus, Race B.

B. *Adult.* Very pale, dull greenish yellow; in dried specimens a soiled white. Basal antennal segment ornamented in front with a black line and spot which are often connected (Fig. 2, B). *Nymph.* Pale greenish yellow, faintly suffused with gray on the dorsal area full length of the body. *Eggs* deposited in rows in the stems of pithy weeds (Fig. 6).

O. nigricornis argentinus.

C. *Adult.* Color variable, from pale dead grass color to light brown; in pale specimens, top of head and first two antennal segments tinged with red, or reddish brown, basal antennal segment unornamented or with a single dark line along the inner edge of the front side (Fig. 2, D, E). *Nymph.* Pale yellowish ground color with a light purplish red dorsal band in the early stages, brown band in later stages. *Eggs* deposited in the pith core of woody stems, in two groups on opposite sides of the puncture (Fig. 7).

O. californicus.

THE SNOWY TREE CRICKET

Œcanthus niveus De Geer (Fig. 3).

The snowy tree cricket is the only Oregon species which has so far proved to be destructive. It is generally distributed over the United States and adjacent parts of Canada and has been recorded also from Cuba, Mexico, and Guatemala. As indicated in the key there are in this state two physiological varieties or two races which are alike in form and color but differ in their habits and place of abode. By a series of experiments, reported elsewhere,[7] in which each race was confined on the normal host plants of the other, it was shown that the habits remain fixed regardless of surroundings. The females exhibit extreme reluctance in ovipositing except when on their normal host plants.

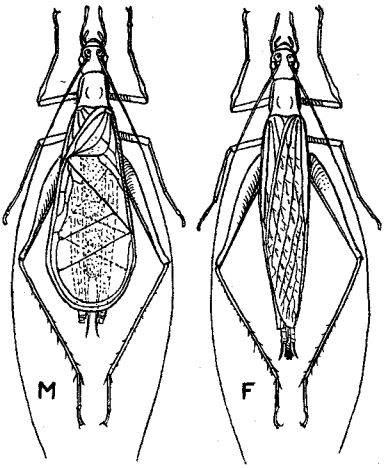

Fig. 3. The snowy tree cricket, *O. niveus*. M. Male. F. Female.

The two forms are rarely found on the same plants, one being entirely tree-inhabiting while the other lives among bushes. The habits of the former, here designated for convenience as race "A," differ only slightly from those of the same species in the eastern and central states, but in Oregon it is more strictly arboreal. The other Oregon form, designated as race "B," is quite distinct. It lives in wild rose thickets, wild brambles or cultivated berries *(Rubus)*. Only one race of the snowy tree cricket has been found in the eastern states. There the species inhabits both trees and bushes, but all of them have similar habits.

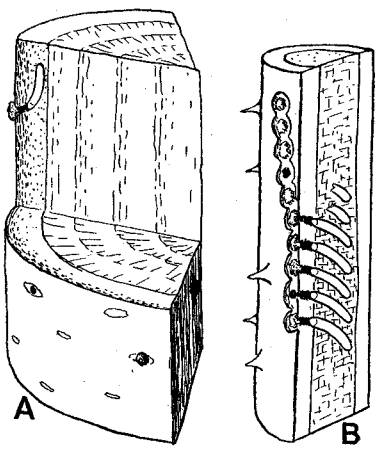

Fig. 4. Oviposition of *O. niveus*.
A, Race "A." Egg in bark (upper left) and two egg punctures (below) one plugged with excrement.
B. Eggs of Race "B" in berry cane.

RACE "A"

This form of the snowy tree cricket is the one which is found in orchards and which has in some places proved so destructive to prunes and peaches by eating holes in the fruit. In Western Oregon, this form is also quite common on the Oregon ash and Garry oak and can be found on other deciduous trees. It is usually more abundant among the higher branches and can

be heard singing in the tops of large trees. Occasionally it is found in high bushes which are near trees.

Oviposition. The eggs of race "A," are placed singly in the bark of trees in which the crickets live (Fig. 4, A). The eggs are about 3 millimeters or one-eighth inch long and three-fourths of a millimeter wide. They are slightly curved, pale yellowish in color, and at the end nearest the bark surface have a whitish cap, where the surface is covered with minute finger-like projections. The eggs are imbedded in the cambium layer, but where this is thin a shallow groove may be gouged out of the sap-wood. The deeper portion of the egg lies nearly parallel to the wood while the cap end curves slightly toward the outer surface.

The eggs are mostly deposited on branches from one to three inches in diameter. On the smaller branches, roughened areas around side twigs are favorite places. The females show a tendency to oviposit on the lower side of branches, and on vertical or sloping branches they usually work head downward so that most of the eggs have the inner end directed upward. This is at variance with the habits of the species in New York, where it was observed that the females preferred to work head uppermost on the upper surface of the branch.

Most of the egg punctures are plugged with pellets of excrement. The female places this on the bark just before depositing the egg, and after withdrawing the ovipositor she forces the pellet into the puncture with her mouth. In some cases she plugs the hole with particles of chewed bark.

Song. The song of the males in late summer is a very characteristic sound and once recognized cannot be mistaken for the song of any other insect. In localities where this tree cricket has become a pest the song could serve as an indicator of the extent and severity of infestation. It may be described as a rhythmical series of short, whistling notes indefinitely repeated. It is one of the clearest and most musical of all insect songs and is peculiar in that the notes of all individual singers in the same tree are sounded simultaneously or synchronized. Especially on warm evenings a whole orchard will seem to throb with the multitude of notes like a great orchestra under the direction of a leader.

The song of race "A" differs from that of the bush-inhabiting form in the frequency of notes. In both races the speed varies with the temperature, being faster on warm nights, but a distinct difference in rate is always maintained between the two races. At a temperature of 70° F. race "A" has a frequency of 160 notes per minute while race "B" has only 90 notes per minute. At 82° F. a record was taken of 230 notes per minute for race "A," while the slowest rate observed for this race was 56 notes at 48° F.

RACE "B"

This race of the snowy tree cricket is the one which is common in plantings of loganberry, raspberry, and blackberry. Among the wild vegetation it occurs most abundantly in the wild rose and wild blackberry thickets. It is also found more or less commonly in all shrubby growths including the scrubby young oaks, and among the great areas of brake ferns and associated plants in old burns.

Race "B" is widely separated in its song and egg-laying habits from other members of the species generally distributed over the United States. The geographical limits of the race are not well known, observations on the living insects being necessary to determine this. The writer has observed it only in Western Oregon where it is most common in the valleys but also occurs in burned areas of the Coast Range and foothills of the Cascades. The race undoubtedly occurs in Western Washington and possibly in British Columbia. There is reason to believe

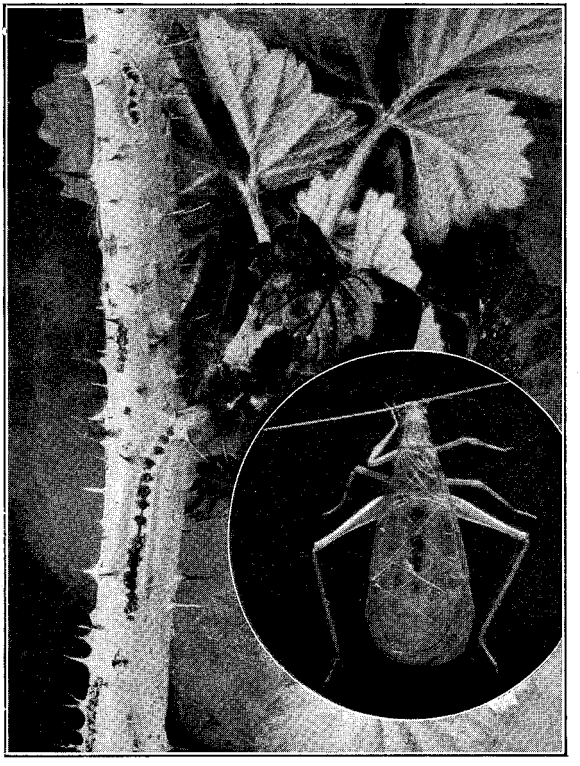

Fig. 5. Egg punctures of *O. niveus*, Race "B" in raspberry cane. Adult male.

that it may occur in Eastern Oregon and Washington at least in the Columbia Valley, for eggs found by the writer at Walla Walla, Washington, appeared to belong to this variety. It probably also occurs in California.*

Oviposition. The local distribution of tree crickets seems to depend quite largely on the type of plant material which each species selects

*E. O. Essig. Injurious and Beneficial Insects of California, p. 31. Under the name *Œcanthus californicus* an account is given of oviposition habits which correspond to those of race "B," while the excellent photograph (Fig. 27) accompanying the article appears to be *O. niveus* and is certainly not *O. californicus*.

for the deposition of eggs. In the case of race "B" of the snowy tree cricket there is an instinctive demand for woody plant stems with a wide central pith. Cultivated berry canes seem to be ideal for its requirements. Wild plants of the genus *Rubus* and some of the common species of wild rose are also used. The females usually select stems from 6 to 10 millimeters thick. The eggs are deposited in a series of punctures along one side of the cane (Fig. 5). They are imbedded in a slanting direction across the pith. The number in each row varies from two or three to forty or more, but rows of about ten to twenty are most common. The punctures are placed close together, about one to each millimeter, but occasionally they are more scattered. On horizontal or sloping stems the females most often work on the under side.

The eggs slant across the pith at about a forty-five-degree angle (Fig. 4, B). On more or less vertical stems they are usually directed downward from the point of entrance showing that the females prefer to work head uppermost. After depositing each egg the female plugs the hole with a little wad of chewed bark which she removes from a point just above the puncture. The cavity so formed serves as a starting point for the next drilling operation.

Song. The song of the male is like that of race "A" in being rhythmical and of a clear musical quality. It seems to be even more mellow in tone and slightly lower in pitch. The greatest difference is in the frequency of notes. When one hears both songs at once the divergence is striking. The chorus of race "B" issues from the berry bushes in slow somnolent measures in contrast to the feverish throb of their kin in the neighboring orchard.

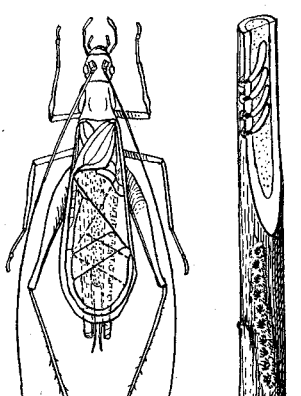

Fig. 6. The prairie tree cricket. *O. n. argentinus.* Adult male. Eggs and egg punctures in gum plant.

On cool nights the frequency is slow and the pitch is lower. The slowest rate observed was 25 notes per minute at 47° F. The fastest rate observed was 133 notes at 84½° F. At 70°, which is an average evening temperature, the rate is 90.

THE PRAIRIE TREE CRICKET

Œcanthus nigricornis argentinus Saussure (Fig. 6).

The name Prairie Tree Cricket was selected for this species because it lives in the treeless areas. It is most abundant where certain herbaceous perennials are dominant. In Oregon the preferred host plant seems to be the gum plant *Grindelia integrifolia* D. C., but it is also found on many others.

Although this tree cricket is probably only a geographic race of the species which is commonest on berry plantings in the northeastern states, it is here seldom found in such situations, and has not yet proved to be injurious to any cultivated plants.

The geographical limits of this race are not definitely known.* It is characterized by heavy black antennal markings in combination with pale body color. Typical *O. n. nigricornis* has some parts of the body infuscated including the abdominal sternites, which are usually quite black. Material referable to *O. n. argentinus* can be found at least as far east as North Dakota and Kansas and as far south as Arizona.

Oviposition. The degree of abundance of this species in any locality seems to depend in part on the prevalence of the coarse perennials which serve as depositories for the eggs. The stem must have a central pith and the dead stalks must be durable enough to harbor the eggs until the following summer. For some reason, the more woody plants such as berries and wild rose are not desirable, but in the absence of more suitable material they are sometimes used, especially the smaller stems.

The eggs are deposited in the pith in rows usually about one egg to each millimeter as in the case of *O. niveus* B (Fig. 6). The method of oviposition is almost identical with that form except in the size of stems selected. Even if ovipositing on the same kind of plants—e.g., loganberry or wild rose—this species selects stems less than five millimeters in thickness and often works in terminal growths not more than one and one-half millimeters thick. In such small stems, the egg practically fills the pith cavity and of necessity the punctures must be more scattered, at least the length of the egg apart. The small branches of Grindelia, its favorite host plant in Western Oregon, are used for oviposition as often as the stems, and parts over six millimeters are seldom selected.

Song. As might be expected from the narrow front wings of the males of this species, the sound is lacking in volume as compared to the other native tree crickets. The song is indefinitely prolonged rather than intermittent as in case of the snowy tree cricket. The quality as compared to the latter species is somewhat tinny and in late fall some individuals develop a decidedly rasping undertone.

This species sings by daylight as well as at night. In old weedy fields the combined whistling of many males produces a diffused resonance which seems to permeate space and come from nowhere in particular. Although quite loud, it is so continuous, unvaried and monotonous, that it can be likened to the ringing in one's ears after taking quinine. It goes on unnoticed by many people.

THE WESTERN TREE CRICKET

Œcanthus californicus Saussure (Fig. 8).

This western species is common in brushy thickets in both Western and Eastern Oregon. Specimens have been taken at Ashland, Gold Hill, Eugene, Corvallis, Hood River, and La Grande. It seems to be quite generally distributed over the western states from the eastern border of the Rocky mountains to the coast. In the southern states its range extends farther eastward into Texas and possibly beyond. A female speci-

*The four-spotted tree cricket, *Œcanthus quadripunctatus* Beut. has been found by Wakeland to be common around Boise, Idaho. It may also occur in southeastern Oregon. The race is characterized by the pale body color and extreme reduction in the antennal markings (Fig. 2, C). The writer is making a further study of the relationship of the three races of the *O. nigricornis* group.

men in the National Museum collection labeled Hot Springs, Arkansas, seems to belong to this species.

The choice of host plants must differ considerably over such a varied range as that occupied by the western tree cricket, but everywhere that the writer has observed the species it loves a dense thicket. In the Willamette Valley it is common about the scrubby young oaks with their attendant miniature jungles of poison oak, wild rose, and other plants. In the Rogue River Valley it is commonest on a blue-flowered shrub, *Ceanothus integerrimus*. Near La Grande the egg punctures were found in wild rose thickets in mountain side gullies. In northern Arizona the species was found in the lower branches of small pines and junipers, and occasionally in scrub oaks and other low plants under the trees. The writer has examined specimens loaned by Claude Wakeland, which he collected from choke-cherry, willow, and a number of other wild shrubs and weeds, at Banks, Idaho, in the mountains at an elevation of about a thousand feet higher than Boise.

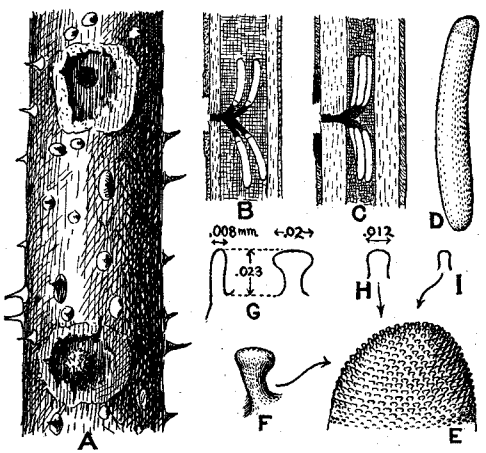

Fig. 7. Eggs of the western tree cricket.
A, Egg punctures in rose. B, Section of same showing relation of eggs to puncture. C, Eggs in *Ceanothus*. D, Egg. E, Cap on end of egg. F, G, Lateral projection of cap much enlarged. H, Projection near apex. I, Projection at apex of cap.

Oviposition. A search for the egg punctures of this species in the scrub oak thickets about Corvallis failed to reveal anything until attention was given to a very small species of rose with small thorns, *Rosa gymnocarpa* Nutt. This plant was usually found around the borders of the thickets and among weeds. The smallest of these rose plants, some of them not more than a foot high, were the ones most often found with egg punctures. Shoots of the current year's growth are more often selected for oviposition than more woody stems. Stems used are seldom more than five millimeters (one-fifth inch) thick, and sometimes are as small as one and one-half millimeters.

The eggs are deposited in the pith in two groups, one above and one below the puncture (Fig. 7). The same exit hole serves for all. The eggs lie nearly parallel to the plant stem. The number in each group varies from one to three and is usually the same in the two groups or differs by one egg. Usually there are several punctures in the same stem, sometimes as many as eight, the distance apart varying from seven to twenty millimeters. The punctures are surrounded by a small area from which the bark has been removed, and sometimes the hole is closed with a plug of chewed bark.

Near Ashland, Oregon, the eggs of this species were found most common in *Ceanothus integerrimus,* a shrub common in Southern Oregon, but not in the Willamette Valley. Most of the eggs were concentrated on one or two branches, usually low overhanging ones, five to seven millimeters thick. These would have a series of several punctures an inch or less apart along the under side. One branch had twenty-eight. The pith core in this plant is rather narrow but the number of eggs in a cluster averaged more than in the rose. Sometimes four or five would be crowded into a space one and one-half millimeters in diameter.

Song. The song of the western tree cricket is loudest of all the Oregon species. It resembles that of *O. argentinus* in being a continuous whistle. The pitch was determined one evening as E flat above middle C with the temperature at 62° F. The song has a clear bell-like quality and can be heard for a considerable distance. In places where the crickets were widely separated, the song of a single individual could be distinguished from other sounds of the night for a distance of a hundred yards.

The song of this species usually begins a little while after sunset and continues on after dark. A favorite place of the males for singing is on the under side of an oak leaf with the head sticking up above the edge between two of the lobes.

DESCRIPTION OF *ŒCANTHUS CALIFORNICUS*

Since no English description of *Œcanthus californicus* Saussure has been published it seems desirable to include it here. The identification of this species is based on Saussure's original description in French, which agrees closely with the specimens at hand except that no mention is made of the color which in most specimens is quite different from that of *niveus* with which it is compared. Pale specimens occur, however, and it is possible that the type specimens were of that sort. No comparisons have been made with the type, which Mr. Morgan Hebard informs the writer is probably in the Musee de Geneve, Geneva, Switzerland. The species is quite common in California, which is the locality given for the type.

If this identification is correct, as seems very probable, *Œcanthus marcosensis* Baker is most likely a synonym, since its description corresponds in most respects to dark specimens of the species. The relative lengths of antennal segments are too variable to be used as specific characters. The dark brown lines on the front of the first two antennal segments may be very distinct, faint, or entirely absent in specimens from the same field.

A translation of Saussure's original description is as follows:

"Similar to *O. niveus* but shorter; with no tubercle or black line on under side of base of antenna; head and pronotum shorter; elytra broader, tip more obtuse; wings subabortive."

Length of body (male)	12 mm.
Length of elytra	11.5 mm.
Width of dorsal field	6.2 mm.
Length of pronotum	2.5 mm.
Width of pronotum	2.3 mm.
Length of hind femur	9 mm.

"Male. This species is more thick set than *O. niveus.* The pronotum is short and quite broad; the latero-posterior angles are broadly rounded, not square as in the species cited, and the posterior border is distinctly bisinuate. The elytra are broader and more obtuse at the end than in *O. niveus,* which renders the mirror a little broader than long and more obtuse, its posterior end forming a semi-circle and not a semi-elipse as in *O. niveus,* and the anterior angle being distinctly obtuse. There are only 3 oblique veins; the marginal field presents at the base the costal veins less oblique than in the species cited. Finally, the wings are noticeably atrophied, for they do not exceed the

end of the abdomen, and in repose only reach to the middle of the mirror of the elytra. Habitat: California."

Saussure's description and the illustration in this bulletin are sufficient for the identification of typical specimens. Over the entire range of the insect there is some variation in the relative width of the male tegmina. In the table below is a summary of measurement (in millimeters) showing the extent of variation. As a matter of comparison some measurements are given for *O. latipennis* in the lower part of the table. These were taken from 14 males from localities as follows: 3 Yankton, S. D. (smallest), 1 Leland, Miss.; 1 Lakehurst, N. J.; 2 Mt. Pleasant, Iowa; 7 Newark, Ohio (largest). The following symbols are used: l = length of pronotum; w = width of posterior border of pronotum as viewed from above; L = length of tegmina; W = greatest width of dorsal field of male tegmina; $\frac{w}{l}$ = width of pronotum divided by length, an index to relative shape; $\frac{W}{L}$ = width of tegmina divided by length; $\frac{L}{w}$ = length of tegmina divided by width of pronotum; (in side column) E = extremes, A = average.

Locality, number and sex of specimens		Pronotum l	Pronotum w	Pronotum w/l	Tegmina L	Tegmina W	Tegmina W/L	L/w	Ovipositor	Hind femur
Corvallis, Oregon.	E	2.1	2.5	1.12	11.5	6.2	.52	4.3	....	7.5
		2.4	2.8	1.23	13.0	7.0	.55	4.8	....	9.0
15 males	A	2.26	2.65	1.17	12.0	6.49	.538	4.54	....	8.26
Corvallis, Oregon.	E	2.0	1.9	.88	8.0	....	....	4.1	5.2	7.5
17 females		2.6	2.4	1.10	11.5	....	....	4.8	6.0	9.3
	A	2.31	2.18	.943	9.88	....	....	4.51	5.8	8.5
Eugene, Oregon.		2.2	2.4	1.09	11.7	6.4	.54	4.9	....	8.2
2 males		2.3	2.7	1.17	11.5	6.2	.55	4.3	....	8
1 female		2.4	2.1	.87	10.0	....	....	4.8	6	8.5
Ashland, Oregon		2.2	2.3	1.05	11.5	5.9	.51	5.0	....	8
3 males		2.5	2.8	1.12	12.7	6.4	.50	4.5	....	....
		2.4	2.6	1.08	12.8	6.5	.51	4.9	....	....
1 female		2.2	2.5	1.14	10.0	....	....	4.0	....	....
Ontario, Calif.		2.4	2.2	.92	9.0	....	....	4.1	....	8.5
1 female										
Banks, Idaho.	E	1.9	2.2	1.08	10.0	5.2	.49	4.2	....	8.2
5 males		2.5	2.7	1.24	12.0	6.0	.55	4.7	....	....
	A	2.1	2.44	1.15	10.9	5.68	.52	4.48	....	....
Fort Collins, Colo.		2.2	2.6	1.18	11.8	5.8	.49	4.5	....	8.0
2 males		2.2	2.4	1.09	12.0	5.9	.49	5.0	....	....
Grand Canyon,		2.1	2.4	1.14	11.0	5.2	.47	4.6	....	7.7
Arizona.		2.2	2.4	1.09	11.0	5.4	.49	4.6	....	8.3
3 males		2.3	2.6	1.13	12.0	5.6	.47	4.6	....	9.0
Durango, Colo.		2.3	2.5	1.09	12.0	5.3	.44	4.8	....	8.8
1 male										
Texas Pass, Arizona.		2.0	2.1	1.05	10.8	5.4	.50	5.1	....	....
1 male										
Œcanthus	E	2.3	2.3	.92	13.0	6.8	.48	5.0	....	9.0
latipennis		2.8	2.9	1.08	16.0	8.1	.53	6.1	....	11.0
14 males	A	2.64	2.68	1.01	14.5	7.4	.51	5.4	....	9.9

The following color descriptions show the extent of variation in that respect. Corvallis specimens (Fig. 8, A). Ground color a dead grass color or pinkish buff (Ridgway*) more or less obscured by fine stippling of light or dark brown. Head between eyes and antennae and two basal antennal segments more reddish brown. Segments 3 to 8, black to dark brown, beyond that rapidly fading into the ground color. Hind femora marked with fairly definite pattern of short dark brown dashes, shading to black at distal end. Male tegmina with infuscated pattern as follows: (1) narrow borders along principal veins; (2) lines of variable width giving a blotched or patchy appearance paralleling the main veins on both sides but separated from the dark borders by a narrow clear space; (3) fine streaks following the fine striæ in the larger cells; (4) dark patches in cells around the border of the dorsal field. In females the veins only are pale and all cells enclose dark patches giving the tegmina a general dull brown color, snuff brown (Ridgway).

Ashland, Oregon. 3 pale specimens have ivory yellow (Ridgway) ground color devoid of brown stippling. Head with faint red tinge between eyes. Tegmina with a few faint infuscated patches. A fourth specimen is like Corvallis specimens but paler.

*Name taken from Ridgway's Color Standards & Nomenclature, Washington, D. C. 1912.

Banks, Idaho. Similar to pale Ashland specimens.

Fort Collins, Colorado. Also as above except that tegmina show no trace of markings.

Texas Pass, Arizona. As above. Black line along inner edge of front face of basal antennal segment.

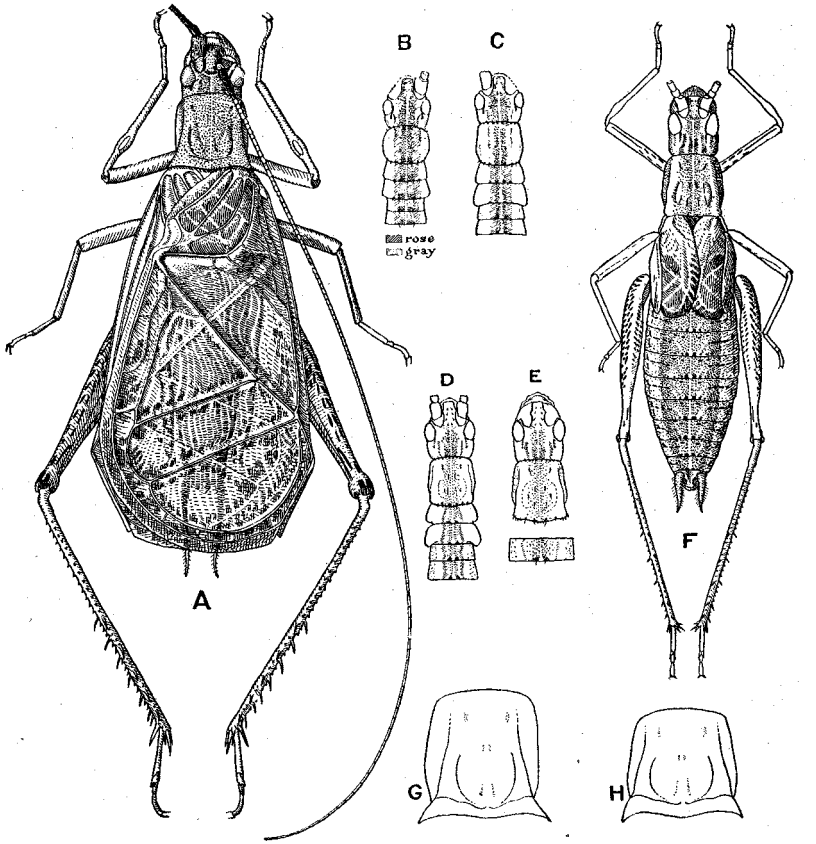

Fig. 8. The western tree cricket, *O. californicus*.

A, Adult male. B, First Instar, head, thorax, and two abdominal segments. C, Second Instar. D, Third Instar. E, Fourth Instar. F, Fifth and last nymphal instar. G, Pronotum of *O. latipennis*, male. H, Pronotum of *O. californicus*, male.

Grand Canyon, Arizona, and Durango, Colorado. Most of the body heavily stippled with dark brown or bister (Ridgway) buff ground color most evident on lateral margins of disk of pronotum. Head between eyes and basal antennal segments with more reddish brown. Male tegmina clouded with bister in a pattern similar to Corvallis specimens except that lines are not broken and patchy. Cells bordering the dorsal field and those anterior to the stridulatory vein all infuscated.

Some specimens from every locality represented in the collection show at least a trace of brown (or reddish) lines on the front side of the first two antennal segments. This character varies independently of general body color; some of the palest specimens

show it most distinctly while in some of the dark specimens it is entirely lacking. Of 29 Corvallis specimens, the lines are absent in 14, very faint in 8, and in 7 distinct on at least the first segment.

The species is most nearly related to the broad winged tree cricket, *O. latipennis* Riley, which occurs in the eastern half of the United States but has not been found in the far west. In both species the males have very broad tegmina, the greatest width of the dorsal field averaging about half the length. The lateral field in both becomes rather suddenly expanded at the level of the hind coxae so that the posterior part is about twice as wide as the front portion, which has a nearly uniform breadth up to that point. In other species of the genus there is some expansion of the distal part of the lateral field but the costal margin is rather gradually curved. In both species some males have the veins of the tegmina bordered by infuscated lines, very faintly in *O. latipennis.*

O. latipennis from the eastern states can be distinguished readily by the purplish red color on the head between the eyes and antennae. In states west of the Mississippi many individuals exhibit this color very faintly. *O. californicus* from Banks, Idaho and Fort Collins, Colorado are all much paler than typical specimens from the Pacific Coast, but two specimens from Ashland, Oregon, are as pale as any. Many of these pale specimens show a distinct reddish tinge between the eyes and there is little to distinguish them from *O. latipennis* except the smaller size, stouter pronotum (Fig. 8, G, H), the relative size of tegmina and pronotum (L/w) and the presence, at least in some specimens, of the dark line on the basal antennal segments. The distal segment of the maxillary palp has a hollow on one side in dry specimens which in *O. californicus* usually covers the distal half or three-fifths of the segment, while in *O. latipennis* it is only one-third or two-fifths as long as the segment. It is possible that the two species may intergrade in the southern states east of the Rocky mountains. Considering the brush-loving habits of both species, one would not expect to find either of them inhabiting the great plains, except possibly along the large river valleys.

Life Stages of *O. Californicus*

Corvallis, Oregon. Egg (Fig. 7, D)—Whitish in color, semi-translucent, shining; elongate cylindrical, slightly curved; with an opaque white cap at micropyle end, made up of numerous minute projections arranged in regular transverse rows. Projections on side of cap above the first few rows are expanded transversely at the tip, measuring .020 to .024 mm. in length, .020 tangential diameter at tip and .008 radial diameter (Fig. 7, F, G). Projections merge by gradual stages from this type on the side to smaller cylindrical ones at the apex, .010 mm. long by .007 mm. in diameter (Fig. 7, H, I). Measurements of 50 eggs give the following dimensions (in millimeters): length 2.37 to 3.05, average 2.73; width .39 to .52, average .43; cap length .19 to .33, average .25; cap width .33 to .42, average .37.

Nymph. First Instar (Fig. 8, B). Ground color translucent whitish with broad dorsal band of dull purplish pink (Persian lilac or light vinaceous lilac of Ridgway), enclosing a narrower stripe of medium gray in which lies a narrow pale mid-dorsal line. Head with space between antennae entirely pink as far back as a curved transverse pale line, in which the pale mid-dorsal line terminates. Posterior half of inner edge of eye bordered by a black line which extends back on occiput, giving off a branch on the inner side just back of the eye. Pink band on pronotum bounded laterally on anterior half by narrow gray lines. Gray band dark on both ends of pronotum and on posterior edge of each succeeding segment, where each segment bears a pair of prominent black bristles. Cerci whitish with a patch of gray on inner side near the base, bounded by a narrow pink area. Hind femora with faint gray traces of the dark dashes which appear later. Antennae pale with faint gray annulations at distal ends of segments 3.4, 6, and 9. Length of newly hatched nymph 3 mm., antennae 7.5 mm.

Second Instar (Fig. 8, C). Ground color yellowish white. Pink color very pale on head and pronotum. Gray band fainter and more diffused, covered with fine stipples or dots at bases of minute bristles. Pale mid-dorsal line more broken; at hind border of each abdominal segment it expands into a prominent white spot, bounded on each side by a dark gray spot. Pink band on abdomen deepest on lateral edges, bounded by clear pale ivory, below which sides are mottled with faint brownish blotches.

Third Instar (Fig. 8, D). Mid-dorsal area darkened by numerous small bristle dots only. Head with wide dark area in middle of occiput, paralleled on each side by two dark lines, the outer one meeting the inner edge of the eye. Median pink zone very faint except the lateral borders, which curve outwardly on anterior half of segments and inwardly on posterior half. Otherwise as in second instar.

Fourth Instar (Fig. 8, E). Characterized by further reduction of the pink coloration, now confined mainly to a narrow line bordering a pale yellowish or pinkish dorsal band on the abdomen. The small bristle dots have increased in number in each stage and taken on a brown color so that the whole insect has a distinct brownish tone. Dots largest and most numerous bordering the pale mid-dorsal line. Hind border of each abdominal segment with a white median spot, with black spots on each side; much larger on the first segment. Antennae pale brown near base, in some with dark line on first segment. Wing pads folded up on the sides reaching to second abdominal segment; marked with brown streaks. Dashes on hind femora dark brown.

Fifth Instar (Fig. 8, F). Ground color ivory yellow, stippled with brown dots, more or less over entire body, but most numerous along the mid-dorsal area.

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