places, concealing itself between the bricks of chimneys or behind baseboards, frequently burrowing into the mortar of walls. It is particularly apt to abound in bakehouses. It is rarely very abundant but at times multiplies excessively and becomes a very serious nuisance. During cold weather or in cold rooms in winter, it remains torpid, but under the influence of warmth it becomes active and musical. It is easily kept in captivity as a pet, and will reward the possessor by furnishing an abundance of its peculiar melody, and in Spain it is often kept, it is reported, in cages, as we do singing birds. It is in the main nocturnal in its habits, coming out in the dusk of the evening and roaming about the house for whatever food materials it may discover. It feeds readily on bread crumbs or almost any food product to which it can get access, and is particularly attracted to liquids, in its eagerness to get at which it often meets death by drowning. It is a very pugnacious insect and will bite vigorously if captured, and is often predaceous or carnivorous, like most of its outdoor allies It is supposed to feed on various other house insects, such as the cockroach and is also probably canibalistic. A pair of native species kept in a cage by the writer, for a short period manifested the greatest friendliness, but the male shortly afterwards made a very substantial meal of his companion.

"These Crickets, in common with most other Orthoptera, will occasionally in pure wantonness seemingly, cut and injure fabrics, and are particularly apt to cut into wet clothing, evidently from their liking for moisture. Any of the common field grasshoppers or crickets, entering houses, are apt to try their sharp jaws on curtains, garments, etc., and Dr. J. A. Lintner records the case of a suit of clothing just from the tailor which was completely ruined in a night by common black field crickets (*Gryllus luctuosus*), which had entered an open window in some numbers. There is a popular superstition also to the effect that if a cricket be killed its relatives will promptly cut the garments of the offender.

"The house cricket may be readily destroyed by taking advantage of its liking for liquids, and any vessel containing beer or other liquid placed about will usually result in crickets being collected and drowned in numbers. It may also be destroyed by the distribution of uncooked vegetables, such as ground up carrots or potatoes, strongly poisoned with arsenic. In the use of poisoned baits in dwellings great care, however, should always be exercised."

Walker (1904, 252) records the taking of all stages of *G. domesticus* in late autumn in the basement of the General Hospital at Toronto, Ontario. They were "lurking in the chinks between the bricks of the wall and positively swarmed under loose bricks close to the furnace. Morse does not mention it from New England (1919a) though R. & H. (1915c) state that it has been recorded from Connecticut.

Subfamily VI. OECANTHINÆ.

The White Tree Crickets.

Slender bodied crickets of a pale color having the head elongate, horizontal or nearly so; vertex declivent, passing gradually

into the face; eyes large, ovate, lying obliquely behind the basal joint of antennæ; ocelli absent; antennæ more than twice as long as body, filiform, the two basal joints usually ornamented with black markings; pronotum longer than broad, somewhat narrowed in front; lower margins of lateral lobes with front and hind angles rounded; tegmina of males rather firm, rigid, semi-transparent, flat, much wider than the abdomen, their tips broadly rounded; of females narrow, membranous, wrapped closely about the body; wings usually longer than tegmina; legs very slender; fore and middle tibiæ unarmed, the former dilated near base and furnished each side with a large elongate-oval tympanum; all the femora unarmed beneath, the hind ones very slender; hind tibiæ usually armed above on each margin with a row of very numerous minute teeth and three to six longer spines, also with three pairs of subapical spurs; tarsi three-jointed, the basal joint longer than the others united. Subgenital plate of male scoop-shaped, its apex rounded. Ovipositor straight, shorter than hind femora, the tips of inner valves wedge-shaped, of outer ones armed with four short, rather blunt curved teeth.

All our species of *Oecanthus* are mainly arboreal, living on trees, vines, shrubbery and the taller herbaceous plants. They especially frequent the various species of golden-rod and wild sunflowers, and often three or four can be found on a single one of these plants. For the most part they remain quiescent during the day, but are quite active at night.

The first mention in this country of the peculiar mating habits of *Oecanthus* was made in my former work (1903, 452) as follows:

On September 18, 1898, I was in late afternoon in a wet prairie near Hammond, Indiana, where *O. fasciatus* was more than usually abundant on clumps of wild sunflower. A half dozen or more pairs were seen in copulation. In this act it seems that the female mounts the body of the male, the latter first raising the tegmina until they stand at an angle of about 45 degrees, so as to give the female access to a pair of glands which lie immediately beneath the base of wings. The female worked at these glands with her mandibles, the male meantime moving the inner wings gently sideways, in and out. After working over the glands for ten or fifteen minutes, the female would usually leave the body of the male and crawl onto an adjacent head of the sunflower. The male meantime kept the tegmina raised, seemingly in waiting for her return, which was always at the end of five or six min-

utes. During the process, no intromittent organ of the male was noticeable, nor was any union of the parts at the end of the abdomen seen. Is it possible that in the mating of these Oecanthids the female removes the semen from the glands whose openings are beneath the tegmina of the male and then fertilizes her ova?

Since then the mating habits of the different species of *Oecanthus* have been carefully studied and described by Hancock (1905, 1911) and Houghton (1909) and they are concisely stated by Fulton (1915, 3) as follows:

"The interest in these insects centers chiefly about their remarkable reproductive structures and instincts and their peculiar oviposition habits. The song of the male, which serves to attract the female, is produced by a minute rasp on the under side of the forewing which is scraped by a structure on the inner edge of the opposite wing. In producing the sound the wings are raised at right angles to the body and vibrated rapidly. When the wings are so raised, there is exposed on the metanotum a glandular hollow, the secretion of which is very attractive to the female. The latter climbs over the abdomen and feeds on the secretion. The male takes advantage of the position and inserts the barbed capillary tube of a spermatophore into the genital opening of the female and the sperms pass into the seminal receptacle. The spermatophore is formed in a peculiar pouch at the tip of the abdomen of the male by the hardening of a viscous liquid about a mass of sperms."

"The female prepares for oviposition by chewing a small pit in the bark of the plant. The drilling is accomplished by quick downward thrusts of the ovipositor and a slower twisting motion. After the egg is deposited a quantity of mucilaginous substance is discharged into the hole, and with most species the female plugs up the opening with chewed bark or excrement."

"The songs of tree crickets form a considerable part of the insect sounds to be heard in late summer and autumn. The males generally place themselves in some hidden retreat among the leaves, with only their long antennæ projecting to warn them of approaching danger. They stop singing at the slightest jar of the ground or movement of the plants in which they are located, but at night a strong light can be thrown on them without appreciably disturbing them.

"In preparing to sing the male raises the fore wings or tegmina perpendicular to the body. This movement automatically unfolds them so that the inner portion, which normally lies over the back, and the inflexed outer portion, come to lie in the same plane when the wings are raised. The sound is produced by the fore wings vibrating rapidly in a transverse direction, so that the overlapping inner portions rub against each other.

"The mechanism which produces the sound is found near the base of the wing, the broad expanded distal part serving as a resonator to increase the volume of sound. A short but prominent transverse vein, about one-fourth way from the base, is modified beneath to form a minute, filiform rasp. It is from one to one and a half millimeters long according to species, and bears from 20 to 50 short teeth which are inclined slightly toward

the opposite wing. In all of many specimens examined the right wing laps over the left. The latter has a fine thickened ridge along the inner edge just opposite the file. This scrapes against the teeth of the file on the right wing and thus produces the sound vibrations. The underside of the left wing has a file practically identical to the other but this is apparently seldom, if ever, used."

The eggs of the white tree crickets are deposited either singly and irregularly in the bark of trees or shrubs, or singly but usually in more or less regular rows in the pith of twigs, berry canes, grape vines and weed stems. By these habits of oviposition they often cause much damage to the growing plants, which is in part offset by their habits of feeding upon aphids and perhaps the young of other injurious insects.

In addition to the works above cited treating especially of the mating habits the principal literature treating of our North American species of the subfamily is as follows: Fitch, 1856; Saussure, 1874, 456—464, 1878, 591—597; Riley, 1881; Blatchley, 1903; Forbes, 1905; Fulton, 1915; R. & H., 1916. Kirby (1906, 62) recognized 34 genera of Oecanthinæ. Of these but two are represented in the eastern United States.

KEY TO EASTERN GENERA OF ŒCANTHINÆ.

a. Hind tibiæ armed above with both spines and small teeth; base of thorax not suddenly dilated; wings but little if any longer than tegmina. I. OECANTHUS.

aa. Hind tibiæ not armed above and with only two very small spurs each side at apex; base of thorax suddenly strongly dilated to form a distinct border; wings nearly twice as long as tegmina. II. NEOXABEA.

I. OECANTHUS Serville, 1831, 134. (Gr., "to inhabit" + "flower.")

The principal characters of the genus are given under the subfamily heading and in the above key. In addition they have the fourth segment of maxillary palpi nearly as long as third; tegmina of female regularly reticulated with the oblique longitudinal vein plainly visible; tegmina of male with humeral angle distinct and mediastinal vein weakly bowed; hind tarsi imperfectly 4-jointed, the suture between the third and fourth segments visible, but the fourth one immovable; the first or basal segment much longer than the others united, and armed each side with a single apical spur; anal cerci straight, slender, tapering, bristly, nearly as long as abdomen.

The name *Oecanthus,* signifying "I dwell in the flowers," does not truly represent the habits of the insects as they are more often found upon the twigs and foliage than in the flowers them-

selves. Kirby (1906, 72) recognized 27 species of the genus, 16 of them from America. Of these six species and one color variety occur in our territory. Hart (1892) first showed that the form and arrangement of the black markings on the basal joints of antennæ of *Oecanthus* furnish reliable characters for determining the species, and these markings have since been used as the principal differential character in all keys.

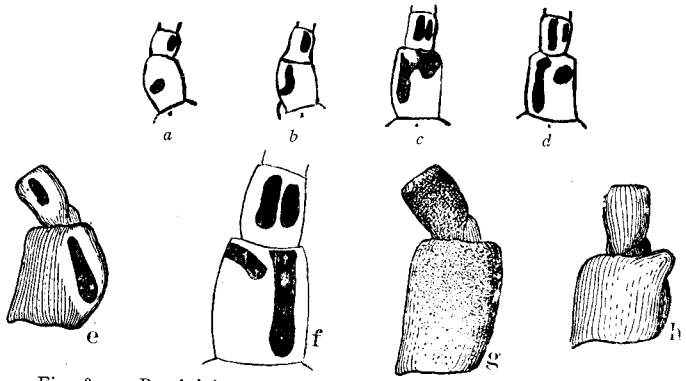

Fig. 240. Basal joints of antennæ of *Oecanthus* and *Neoxabea* showing the black markings. *a, O. niveus; b, angustipennis; c, nigricornis; d, quadripunctatus; e, exclamationis; f, pini; g, latipennis; h, N. bipunctatus.* (After Lugger & Fulton.)

KEY TO EASTERN SPECIES OF ŒCANTHUS.[84]

a. Antennæ with one or more black spots on under side of the first two basal segments; tegmina of male less than half as broad as long, their greatest width not over 6 mm.; front of head and base of antennæ never pinkish.

b. First and second basal segments of antennæ each with a single black mark.

c. Black marks on both segments in the form of small round spots (Fig. 240, *a.*) 335. NIVEUS.

cc. Basal segment with an elongate black mark.

d. Mark on basal segment j-shaped, hooked at base (Fig. 240, *b.*) 336. ANGUSTIPENNIS.

dd. Mark on basal segment club-shaped, not hooked (Fig. 240, *e.*) 337. EXCLAMATIONIS.

bb. First and second segments each with two black marks or wholly black.

e. Head and thorax pale yellowish-green or black or marked with both colors.

f. Marks on basal segment broad, often confluent (Fig. 240, *c*); antennæ usually in great part black; head and thorax either black or trifasciate with black; lower surface of abdomen in part black. 338. NIGRICORNIS.

[84] I have not included *O. forbesi* Titus (Can. Ent. XXXIV, 260) as it was probably described from a specimen with malformed palpi. Hart (Ms.) states that the unique male type without the palpi is in the collection at Urbana, Ill., and looks to him "like an ordinary *4-punctatus.*" As far as I can ascertain only the one specimen is known.

ff. Marks on basal joint usually narrow, parallel, distinct (Fig. 240, *d*); head, thorax and abdomen wholly pale greenish-yellow. 338a. QUADRIPUNCTATUS.

ee. Head, thorax and antennæ reddish-brown; wings in life with conspicuous green veins; black marks on basal antennal segment broad, rarely confluent (Fig. 240, *f*.) 339. PINI.

aa. Antennæ without black marks on basal segment (Fig. 240, *g*); tegmina of male more than half as broad as long, their greatest width more than 6.5 mm.; head and basal joints of antennæ usually suffused with pinkish. 340. LATIPENNIS.

335. OECANTHUS NIVEUS (DeGeer), 1773, 522. Snowy Tree Cricket.

Form moderately slender. Ivory white, more or less tinged, especially in female, with a very pale green; top of head and basal segments of antennæ usually suffused with pale orange-yellow; black spots on both basal segments round. Pronotum almost as broad as long. Tegmina of male broader than in any species except *latipennis*. Wings but slightly exceeding tegmina, male, surpassing them about 4 mm., female. Ovipositor short, straight, tipped with black. Length of body, ♂ and ♀, 12—14.5; of tegmina, ♂, 13—14, ♀, 12—13; of hind femora, ♂, 8.5—9, ♀, 9—10; of ovipositor, 5.5 mm. Greatest width of tegmina, ♂, 5.5—6 mm. (Fig. 241.)

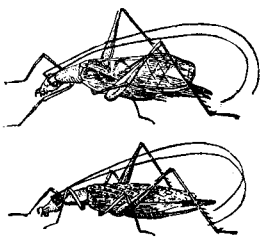

Fig. 241. Male and female. (After Beutenmuller.)

While the snowy tree cricket occurs in all parts of Indiana, it appears to be less common in the State than either *O. angustipennis* or *quadripunctatus*, and much of the published literature relating to it has doubtless been of these and other species. Like the other members of its genus *niveus* reaches maturity in southern Indiana about July 1st, and in the central part a fortnight later, and exists in that stage until after heavy frosts. The females appear to be more plentiful than the males, the latter being more often heard than seen. During the day they keep themselves hidden among the foliage and flowers of various plants, but as night approaches they come forth and the male begins his incessant, shrill, chirping note, which he continues with little or no intermission till the approach of morning warns him to desist.

The range of *niveus* is said by Fulton (1915) to be wider than that of any other *Oecanthus*, extending from New England and Ontario to Minnesota and Utah, south and southwest to Georgia, Texas, Cuba and Mexico. It is not recorded from Florida and R. & H. (1916, 296) state that Thompson's Mills, Ga. and Cranberry, N. Car. are the only reliable definite records from the southeastern United States.

Fulton (loc. cit.) says that *O. niveus* "is a tree- and bush-inhabiting form. It is found most abundantly in apple orchards and is more or less common in plantings of other fruit trees and in raspberry plantations, shrubberies, vines and bushy fence rows. Among forest trees it is less common, although a few can often be heard singing in such places, especially along the edge of a wood. In general this species prefers a cultivated region to a wilderness. However, in orchards that are regularly sprayed with arsenicals, the crickets do not become very abundant."

Morse (1919a) states that *niveus* is common throughout southern New England in shrubbery near houses, orchards and gardens from late August till October. Walker (1904, 253) says that *niveus* is very common in the cultivated parts of Ontario and that of native trees he had found it most partial to butternut, where the females are found on the trunk and lower branches, but the males higher up and more difficult to obtain. He adds: "*O. niveus* is generally held responsible for a great deal of mischief done to raspberry and blackberry canes by the females in laying their eggs. It is my belief that most of this damage, at least in this locality, is done by *O. fasciatus* and *quadripunctatus* which abound on raspberry bushes, while *niveus* is seldom if ever found on them." This belief, as will be noted below, has been since proven to be correct.

The first definite account of the song and habits of *niveus* is that of Fitch (1856, 406) in part as follows:

"In the southern part of New York the song of the snowy tree cricket begins to be heard as early as the first of August. Perched among the thick foliage of a grapevine or other shrubbery, some feet up from the ground, and remaining in the same spot day after day, its song begins soon after sunset and before the duskiness of twilight arrives. It is distinctly heard at a distance of several rods, and the songster is always farther off than is supposed. Though dozens of other crickets and katydids are shrilling on every side at the same time, the peculiar note of this cricket is at once distinguished from all the rest, consisting of repetitions of a single syllable, slowly uttered, in a monotonous, melancholy tone, with a slight pause between. The children regard the cricket as no votary of the temperance cause; they understand its song to consist of the words *treat—treat—treat—treat*, which words, slowly uttered, do so closely resemble its notes that they will at once recall them to the recollection of almost every reader. And the song is thus continued without the slightest variation and without any cessation, I think, the whole night through. I, however, have sometimes heard it at the first commencement of its evening serenade uttering three syllables resembling the words *treat, treat, two; treat, treat, two*—as though the songster was supplicating a libation for his voiceless mate as well as himself, a longer pause following each

third note. This prelude is probably performed in limbering or otherwise adjusting his organs, preparatory to performing the regular carol, which is struck into in a few moments."[85]

Houghton (1904, 1909a) and Parrott and Fulton (1914) have shown that *O. nigricornis* and not *O. niveus* is the tree cricket that does so much damage by ovipositing in rows in raspberry canes and that *niveus* deposits the eggs singly in apple, plum, elm and other trees, though sometimes singly in the raspberry canes. The method of ovipositing by *niveus* is thus described by Parrott & Fulton:

"The female selects a suitable spot on a tree or bush and prepares to oviposit by first chewing a small hole in the bark, choosing the upper side of a branch in preference to the lower side, and working with the head uppermost when on a sloping or vertical surface. Upon the completion of the cavity she then walks forward a little, arches her back so as to bring the ovipositor about perpendicular to the branch and begins moving it up and down until she strikes the hole. She then starts to drill by giving the ovipositor quick thrusts and at the same time slowly turning it around by twisting the abdomen 30 or 40 degrees to each side. As the ovipositor is forced in it takes a more or less oblique course, according to the thickness of the bark, so that the egg usually comes to lie nearly parallel to the surface. It generally takes from six to seven minutes to force the ovipositor to its base the first time, but in some cases it takes much longer, depending on the resistance of the bark. After the operation this organ is pulled nearly out and drilled in again several times, each effort taking about one and a half or two minutes. When the hole is sufficiently reamed out and the ovipositor drilled in for the last time the female forces out a drop of excrement and, by stretching out the tip of the abdomen, fastens it to the bark just below the hole. The egg is then forced down and the ovipositor is slowly withdrawn. The female pauses with only the tip remaining in the hole and deposits some mucilaginous substance. She then removes the ovipositor, moves a slight distance backward, seizes the drop of excrement in her mouth and places it over the opening; then spends several minutes packing it in and smoothing it out so that the wound is neatly capped. The whole process of depositing an egg, from starting to drill until the hole for the reception of the egg is sealed, may consume from twenty minutes to three-quarters of an hour.

"In trees having a rather soft, fleshy bark, such as apple and plum, *niveus* prefers to oviposit in fairly large branches from one to three inches in diameter. The eggs may be placed in almost any area in the bark, but a favorite location is in a lenticel where the initial drilling is more easily accomplished. In bushes and trees in which the large branches have a tough bark the eggs are commonly laid in the smaller branches in thick places in the bark on each side of the base of a small twig or bud. In raspberry canes, where the eggs are sometimes fairly common, oviposition usually occurs in the fleshy area at the side of the bud in the axils of the

[85]Other interesting accounts of the song of *O. niveus* are given by McNeill (1891), Scudder (1893), Shull (1907) and Allard (1911.)

leaves, and we have never found more than one egg on each side of a bud. However, the egg never extends through the woody layer into the pith, as is the case with *nigricornis*."

Whatever injury *O. niveus* may do in ovipositing is, in part at least, offset by its carnivorous propensities, as the young which hatch in May or early June, feed, until they reach maturity, largely upon the various species of aphids or plant lice which infest the shrubbery they frequent. Walsh (1867, 54) was the first entomologist to call attention to this carnivorous habit, but it seems little attention was given to the matter until Murtfeldt (1889) gave an interesting account of some experiments and observations concerning this habit from which the following extract is taken:

"Some leaves of plum infested with a delicate species of yellow aphis were put into a jar with the young of *Oecanthus niveus*, but attracted no immediate attention. As twilight deepened, however, the crickets awakened to greater activity. By holding the jar against the light of the window, or bringing it suddenly into the lamplight, the little nocturnal hunters might be seen hurrying with a furtive, darting movement, over the leaves and stems, the head bent down, the antennæ stretched forward, and every sense apparently on the alert. Then the aphids provided for their food would be caught up one after another with eagerness and devoured with violent action of the mouth parts, the antennæ meanwhile playing up and down in evident expression of satisfaction. Unless I had provided very liberally not an aphis would be found in the jar the next morning and the sluggish crickets would have every appearance of plethora."

336. OECANTHUS ANGUSTIPENNIS Fitch, 1856, 413. Narrow-winged Tree Cricket.

Form very slender. Pale greenish-white; vertex and base of antennæ often yellowish; each of the first two basal joints of antennæ with a black mark, that on the first one elongate and hooked inward at base; the one on second joint oblong, slightly curved; tegmina of male translucent with a greenish tinge. Head smaller and pronotum slightly longer and narrower in front than in *niveus*. Tegmina of male narrower than in any other species except *quadripunctatus*. Wings slightly surpassing tegmina in length. Length of body, ♂, 12—14, ♀, 11.5—13; of pronotum, 2.8; of tegmina, ♂, 10—12, ♀, 12; of wings, 13.5; of hind femora, 8.5; of ovipositor, 5.5 mm.

The narrow-winged tree cricket does not appear to be a common insect in Indiana, having so far been taken only in Vigo, Putnam, Lawrence, Floyd and Crawford counties. It frequents the borders of groves and especially ironweeds in open pastures and reaches maturity about July 15.

About Dunedin, Fla. I have taken adults of *angustipennis* by beating and sweeping in October, December, January and March, and it has been sent in as taken at porch light in May and June.

It appears to be much less common in that State than *quadripunctatus,* having been recorded only from Gainesville, Monticello, LaGrange and Lakeland. At LaGrange it was collected by Davis (1914) "among the golden rods and other low plants by the side of the road; also on small oaks and other trees. The song is loud, about three or four seconds long, with an equal interval of rest."

The known range of *O. angustipennis* extends from New England west to Minnesota and Nebraska and south and southwest to Georgia, Dunedin, Fla., Mississippi and, according to Allard, Texas. In New England it is definitely known, says Morse, only from near Boston and at various points in Connecticut, where it "frequents orchards, fruit trees and even low thickets of sweet fern." Beutenmüller (1894, 270) says that about New York City it is "not as common as *niveus* and inhabits the higher parts of different kinds of forest and fruit trees. The note is fainter than that of *niveus* and may be represented by *reeeeeee,* lasting about five seconds, and terminating abruptly, with an equal interval of rest. It usually sings at night only, but sometimes also late in the afternoon in shady places, and on cloudy days." Fox (Ms.) reports it from Clarksville, Tenn. and Hubbell from Washtenaw Co., Mich. In Nebraska Bruner found it "pretty well distributed over the eastern part of the State."

Fulton (1915, 27, 29) says of *angustipennis*:

"It is often found in company with *niveus* and is generally abundant in apple orchards. It is more strictly arboreal than the latter species, and seems to be confined to woody plants, either trees or large bushes. About Geneva, N. Y., it has never been taken on raspberry, grape or weeds of any kind. Among forest trees it is more common than *niveus*. Many specimens have been collected from scrub and post oaks on Long Island, and from alder in a swamp near Geneva. The song of this species is not so loud as that made by *niveus* and is of a more mournful quality. It is, like that, intermittent, but can be readily distinguished by its longer notes and rests and its nonrythmical character. Each trill continues from one to five seconds. The periods of rest vary more and may be from one to eight seconds or longer. On trees where *angustipennis* occurs in equal abundance with *niveus*, its song is nearly drowned out by the synchronous beat of the latter species and only by listening intently can it be detected. So far as observed it sings throughout the night and remains silent during the day."

Allard (1910b) wrote of the song of *angustipennis* in north Georgia as follows:

"It sings on cloudy afternoons, though its song is best heard after sunset. As the shadows become deeper in the oak trees and the breezes have ceased, a faint, brief high-pitchd *pr-e-e-e* is heard. This is soon repeated by others in different keys at brief intervals. The notes of this cricket, to me, inspire a weird pathos, unlike any

other insect music. The phrase *pr-e-e-e* does not sustain the same uniform pitch, but dies away in a slightly lower key, a change which is hardly noticeable to the untrained ear. Each note is a mysterious, momentary wail amidst the shadowy foliage of the oaks, and seems like the voice of a complaining spirit interrupting the serenity of the night."

337. OECANTHUS EXCLAMATIONIS Davis, 1907, 173. Davis's Tree Cricket.

Somewhat larger and stouter than *angustipennis*. Pale greenish-white; occiput and vertex pale to orange yellow; first antennal segment swollen in front, the protuberance with a black club-shaped mark, second segment with a short dash directly above, the two marks together appearing like an inverted exclamation point. Pronotum slightly shorter and wider than in *angustipennis*, the lower portion of lateral lobes more flattened. Tegmina of male slightly longer and broader. Wings more strongly protruding, exceeding tips of cerci. Length of body, ♂ and ♀ 12—15; of tegmina, ♂ and ♀, 13—14; of ovipositor, 5 mm. Width of tegmina, ♂, 5—5.5 mm.

Central Park and Staten Island, N. Y., August (*Davis*). Not yet identified from Indiana, though it doubtless occurs in the State, as the known range extends from Connecticut west to Cedar Point, Ohio and Hollister, Mo. and southwest to Clarksville and Johnson City, Tenn. About New York City Davis finds it mainly on the post-oak, *Quercus minor* (Marsh) and other species of oak, often in company with *O. angustipennis* to which it is very closely related.

Fulton (1915, 31) states that "The song of *exclamationis* is intermittent and non-rhythmical and most resembles the song of *angustipennis*. The beginning of each note is comparatively weak, but the sound increases in volume and slightly in pitch and continues uniformly until it abruptly ends. In quality it most resembles the distant singing of the common toad." Females kept in captivity deposited many eggs in the bark of oak branches between half an inch and an inch in diameter. The habits of oviposition are very similar to those of *O. niveus* as the female "would fasten a drop of excrement to the bark before depositing the egg and after pulling out the ovipositor would pick the pellet up and force it into the hole. She would then chew off small pieces of bark and add them to the plug, and spend five or ten minutes putting on the finishing touches."

338. OECANTHUS NIGRICORNIS F. Walker, 1869, 93. Black-horned Tree Cricket.

Size medium and form robust for the genus. Greenish-yellow; head and pronotum either wholly black or with three more or less distinct lengthwise black stripes; legs yellowish with a blackish tinge or wholly black;

tibiæ and tarsi black; abdomen black beneath, yellowish-green above. Antennæ longer than in any other species, often two and a half times the length of body, either wholly black or with two black marks on each of the two basal segments; the inner mark on the first one twice the length of the other, the two often merged above. Tegmina slightly narrower than those of *niveus*. Wings equalling or slightly surpassing the tegmina. Apical spurs of hind tibiæ stronger and more acute than

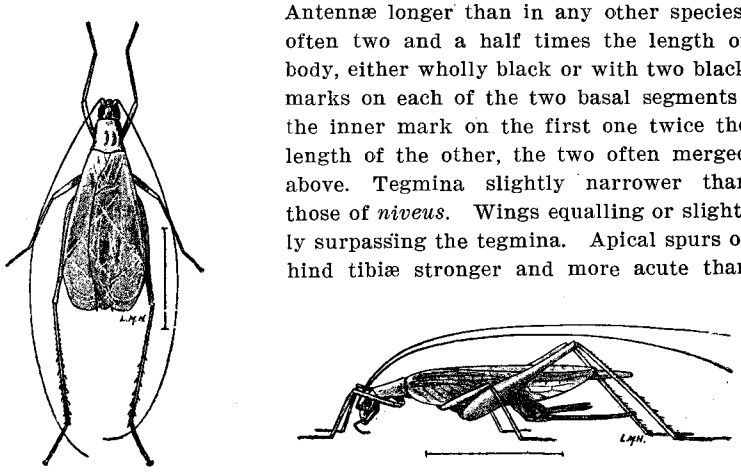

Fig. 242. *Oecanthus nigricornis* Walker. *a*, male; *b*, female.

in allied species. Ovipositor with apical third slightly but distinctly upcurved. Length of body, ♂ and ♀, 12—14; of pronotum, 3; of tegmina, 10—12; of inner wings, 12.5—13.2; of hind femora, 9.2—10; of ovipositor, 5.7 mm. Width of tegmina, ♂, 4.5—5 mm. (Fig. 242.)

This is the *O. fasciatus* Fitch of most American authors, myself (1903, 450) included, Fitch having wrongly identified De Geer's *Nemobius fasciatus* as the present insect. The next older name has therefore been given it in recent years. Scudder (1862, 431) was very caustic in his remarks about Fitch's misidentification, but himself on the next page wrongly made Fitch's *fasciatus* a synonym of *O. niveus* and later in both his catalogues used *O. fasciatus* as the name of the cricket.

This striped tree cricket is the most common *Oecanthus* in Indiana. In August and September, nearly every stalk of goldenrod and wild sunflower along roadsides, in open fields or in fence corners, will have from one to a half dozen of these insects upon its flowers or branches. It is also especially abundant upon the tall weeds and bushes along the borders of lakes and ponds, and in sloughs and damp ravines.

The note of *fasciatus* is a shrill continuous *whi-r-r-r-r* which is kept up for several minutes with the intervals of irregular length. It is continued for most of the night and on cloudy days. When the sun is shining brightly it usually begins about mid-afternoon and continues with but little pause until the dawn of the next day, unless the caller is, in the meantime, successful in wooing with his music one of the opposite sex within reaching distance.

The known range of typical *O. nigricornis* is a wide one extending from New England and Ontario west across the continent and southwest to North Carolina, Texas and Arizona. It is not as yet recorded from Georgia or Florida and numerous records under the name of *fasciatus* are not to be relied upon. It occurs in numbers throughout New England and Walker (1904, 254) records it as "by far the commonest tree cricket in Ontario, and during August and September it abounds on shrubs and tall herbs, especially golden-rod, and is particularly plentiful on low grounds. Partially cleared bush lands supporting a rank growth of raspberry bushes, golden rod, boneset and other tall herbaceous plants are favorite haunts. It is so common on raspberry bushes that there is little doubt that the female is responsible for much damage to the canes, though I have no proof of this assumption. I have found it in cultivated raspberry bushes in gardens, but it is more partial to wild districts."

It is now known that *O. nigricornis* and its variety *quadripunctatus* are the tree crickets which do much harm by ovipositing in the tender canes or shoots of various cultivated fruits, as the raspberry, blackberry, grape, plum, peach, etc.; no less than 321 eggs, by actual count, having been found in a raspberry cane 22 inches in length. So partial is it to the stems of raspberry and blackberry as receptacles for its eggs that in some localities scarcely a cane escapes without being more or less damaged. The eggs are laid in autumn, and at first the injury is shown only by a slight roughness of the bark, but afterwards the cane or branch frequently dies above the puncture, or is so much injured as to be broken off by the first high wind. If the injured and broken canes containing the eggs be collected and burned in early spring the number of insects for that season will be materially lessened.

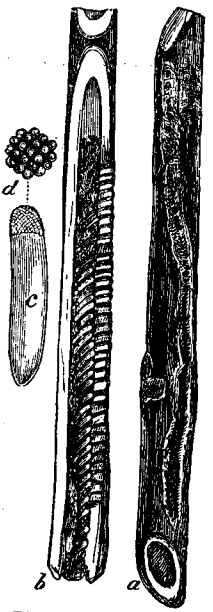

Fig. 243. Eggs of Tree Cricket in raspberry cane. (*a*) Cane, showing puncture. (*b*) Cane split to show eggs. (*c*) Egg enlarged. (*d*) Cap of egg enlarged. (After Riley.)

Bruner (1895, 112) has written of the habits of oviposition of *niveus* with which he confused those of *nigricornis* in other plants as follows:

"In addition to cultivated fruits the snowy tree cricket also deposits its eggs in the stems of a large variety of other plants and trees—the main

requirements being a soft fibre and pithy interior to the twigs selected. Among the trees the white willow suffers most. I have seen hedges of this tree so completely utilized that scarcely a twig escaped being deposited into. Other species of willow, cottonwood, elm, maple, box elder, cherry, dog-wood, black locust, sycamore, ash, honey-locust, and in fact almost all kinds of trees, are sometimes attacked. Elder is a great favorite, too. After these come weeds, as the artichoke, sunflower, golden-rod, ambrosia, and many others. All of these latter being annuals, or dying to the ground each year, whether attacked by the cricket or not, the conclusion is plain. All the cricket requires is a receptacle for her eggs. It matters but little whether a dead or a living plant furnishes that oondition.

"While woody plants are known to be very commonly used as receptacles for the eggs of this cricket, it is by far the most numerous upon such weeds as those mentioned above during its entire career; but more particularly so during its latter days when looking after the perpetuation of its kind."

The mating habits, oviposition and song of *O. nigricornis* have been fully described by Hancock, Houghton and Jensen in the works previously cited. Allard (1911) says that in New England "It dwells among weeds, grass and golden-rods nearly everywhere in fields and pastures. Its song is a steady, quavering, sustained trill. The trill of some individuals is strong, deep and rich-toned, recalling the mellow trill of *O. latipennis*. The pitch and volume of sound vary noticeably with different individuals."

338a. OECANTHUS NIGRICORNIS QUADRIPUNCTATUS Beutenmuller, 1894a, 250. Four-spotted Tree Cricket.

Size and form of *nigricornis*. Pale yellowish-green; antennæ pale brown, the two basal segments pale green with two black marks on each; those on second segment oblong, parallel, the inner about double the length of outer; the inner mark on lower or basal segment two-thirds the length of segment, its upper end curved outward but not united with the outer mark, which is short and almost round (Fig. 240, *d.*) Tegmina of male translucent with greenish-yellow veins, the wings protruding slightly beyond their tips. Legs dull greenish-yellow, the tarsi often in part fuscous. Ovipositor brownish with black tip. Length of body, ♂ and ♀, 11.5—14; of pronotum, 2.4—2.6; of tegmina, 10—12; of wings, 12.5—13.5; of hind femora, 8—8.5; of ovipositor, 5.5 mm. Width of tegmina, ♂, 4.5—4.7 mm.

In central and southern Indiana this tree cricket is almost as common as *nigricornis* but in the northern part of the State it appears to occur in fewer numbers. It frequents shrubbery and weeds in gardens, along roadsides and borders of cultivated fields, and is often found in company with *nigricornis*. An adult female was taken in Crawford County on June 28, an early date for a tree cricket in Indiana.

In Florida I have found *quadripunctatus* the most common of

the tree crickets in late fall and winter, specimens having been taken at Sanford, Cape Sable, Sarasota and Dunedin. About Dunedin it occurs on the tall grasses and weeds growing about low places in the pine woods and is also often swept from huckleberry bushes and other low shrubs; adults having been taken during every month from October to April. It has before been recorded from numerous localities in the State as far south as Ft. Myers.

By some authors, notably Fulton and R. & H., *quadripunctatus* is regarded as a distinct species, but numerous specimens at hand show that intermediates occur. It is often found in numbers on the same clumps of weeds or bushes in company with *nigricornis*. Walker (1904, 255) says: "I believe this form to be merely a pale variety of *O. fasciatus* as I have a series of intergrades and am unable to draw a definite line to separate the two." Caudell is quoted by Houghton (1909a, 114) as stating that specimens bred from the same egg clusters sent in by Houghton represented both *nigricornis* and *quadripunctatus* and that he considered the latter only a variety of the former. Houghton quotes other evidence to show that Caudell's opinion is correct.

On the other hand R. & H. (1916) regard them as distinct, stating that in addition to color differences *nigricornis* has a heavier and wider pronotum and a depression between the eyes not "at all or rarely weakly indicated in *quadripunctatus*." Fulton (1915) separates them in his key only by color characters, but states that they have "constant differences in habits," *quadripunctatus* occurring in larger numbers in upland fields abounding in medium sized weeds such as aster, sweet clover, daisy, golden-rod, ragweed, and especially the wild carrot or Queen Ann's lace. Quite often in a field of this character where *quadripunctatus* is prevalent, the brushy fence rows surrounding the area will be inhabited by *nigricornis*. In general *nigricornis* prefers larger plants and more dense growth than *quadripunctatus*, and its habitat is more varied, it being usually found in tall, rank growths of weeds, such as in swamps and river bottoms, in brush or second growth, in fence rows grown up with bushes, briers and vines, in raspberry plantings, vineyards, nurseries and even occasionally in orchards."

As noted above specimens are at hand showing not only all intergradations in color from almost black *nigricornis* to the palest of *quadripunctatus*, but also in the form of the thorax and depression on head mentioned by R. & H. Moreover, Fulton states

that the "song of *nigricornis* so closely resembles that of *quadripunctatus* that it is very dififcult to distinguish the two," and Allard (1911) says that he "has been unable to find any constant differences which serve to distinguish the trills of these two species." I therefore regard *quadripunctatus* as only a color variety of *nigricornis,* gradually replacing the latter southward and wholly so in Florida. In Indiana, as perhaps elsewhere as far as can be judged from the records, the typical form *nigricornis* is more abundant in the cooler and moister regions and the variety in warmer and drier localities.

The range of *O. n. quadripunctatus* as given by Fulton is almost exactly that of *nigricornis,* Florida, Colorado and Utah being added to the list of states mentioned and California not given. R. & H. (1916) record it from many localities from Virginia southwestward to Ft. Myers, Fla., and state that it is "the most abundant species of *Oecanthus* in the eastern United States." Morse says that it is widely distributed and locally abundant in southern New England and extends as far north as Brunswick, Maine. Lugger recognized two forms of *nigricornis* as occurring in Minnesota but evidently was not aware of Beutenmüller's name for the pale one. I once found it abundant on the north shore of the Niagara River opposite Buffalo, N. Y., where it was the only *Oecanthus* seen in early September. Specimens are also at hand from Sherborn, Mass., North Madison, Conn., Mobile, Ala. and Agricultural College, Miss.

339. OECANTHUS PINI Beutenmuller, 1894b, 56. Pine Tree Cricket.

Size medium, form rather robust. Head and pronotum nearly uniform dull reddish-brown, the latter with a paler stripe each side; antennæ dull brown, the two basal segments paler, the first with an elongate black spot along inner edge and a small oblique one near apex; second with two oblong, parallel black spots; tegmina of male transparent greenish-yellow with green veins; those of female greenish-yellow, pale yellow along the fold, tinged with brown near base; legs dull brown, hind femora green; tarsi piceous; body beneath brown with sides yellowish-green. Ovipositor dull brown, the tip black. Disk of thorax subquadrate. Wings scarcely surpassing tegmina, male, a little longer, female. Length of body, ♂ and ♀, 12—15; of tegmina, 11—13; of ovipositor, 6 mm. Width of tegmina, ♂, 4.5—5 mm.

Delaware County, Penn., Sept. 29 (*Hebard*). Described from Windham County, Conn. and ranges from Gloucester, Mass. west to Bloomsburg, Pa. and southwest to Raleigh, N. Car. Hart (1907, 235) has recorded it from northwestern Illinois but (Ms.) reports that his specimens were not from pine and their identification uncertain.

Beutenmüller (loc. cit.) says of it: "Resembles *O. fasciatus* but readily distinguished by the grass green venation. The insect lives only on pine trees and usually on the higher branches. Its song is a continuous soft and metallic *reeeeee* with numerous undulations. When many individuals are heard together their stridulation sounds not unlike the distant jingling of sleigh-bells." Fulton and Davis found it in numbers on the pitch pine, *Pinus rigida* Mill. near Central Park, Long Island, and Davis on the Jersey or scrub pine, *P. virginiana* Mill. at Bloomsburg, Pa. Fulton (1915, 41) states that the female deposits the eggs about 3 mm. apart in regular rows in pine bark.

340. OECANTHUS LATIPENNIS Riley, 1881, 61. Broad-winged Tree Cricket.

Size large for the genus. Greenish-white, male, pale yellowish-green, female; occiput and eight or ten basal joints of antennæ pinkish, the former sometimes with four faint dusky streaks; pronotum often with a median dusky stripe, darkest in front; tegmina and wings of female often dusky at tips; legs white, knees yellowish; hind femora with a small dark spot near tip. Tegmina of male wider than in any other species. Wings much shorter than tegmina, male, surpassing their tips, female. Length of body, ♂ and ♀, 13—17; of pronotum, 3—3.3; of tegmina, ♂, 13—16, ♀, 13—14.5; of wings, ♂, 12, ♀, 15—17; of hind femora, ♂ and ♀, 10; of ovipositor, 6.5 mm. Width of tegmina, ♂, 6.5—8 mm.

This, our largest species of *Oecanthus,* occurs throughout southern Indiana but has not as yet been taken in the northern half of the State. It is found mostly on shrubs and vines along fence rows, roadsides, and especially in thickets along the borders of streams and with us appears to be most abundant in October, though adults have been taken the last of August.

The known range of *O. latipennis* is southern extending from Long Island and New Jersey west to Missouri and Nebraska and south and southwest to Georgia and Alabama. Fulton mentions it from Michigan and Lugger, without definite locality, in his Minnesota work. Riley records a male from Columbia, Texas, but afterward states that it had black marks on antennæ, which would preclude its being *latipennis.*

The eggs of the broad-winged tree cricket are usually laid in the pith of the smaller twigs of shrubs and vines, preferably in the slender twigs of the wild and cultivated grapes. Riley (loc. cit.) has described the method of oviposition as follows:

"The jaws are first used to slightly tear the outer bark. With the antennæ stretched straight forward and the abdomen bent up so as to bring the ovipositor at right angles with the cane, the female then commences drilling, working the abdomen convulsively up and down about twice each second. The eggs are laid lengthwise in the pith, but always in

two sets, one on each side of the hole. The number varies according to the size of the cane, and the distance between the holes is also variable. The hole is usually filled up with a white mucous secretion, though there is very little of it about the eggs. This secretion also doubtless serves to facilitate the drilling. The same female will lay over 200 eggs, and will sometimes puncture the same cane at intervals of one-third of an inch for one and a half feet or more."

The day note of the male of *latipennis* is louder than that of any other species. I have heard it when 60 feet distant; have traced it up, and found the musician beneath a leaf or on a post in the angle of a rail fence, industriously sounding his cymbals. The note is kept up for 20 to 30 seconds, and is then succeeded by a pause of about five seconds, when it is begun once more. Riley has written of it, probably of the night song: "The shrill of *latipennis* is continuous and recalls the trilling of a high-pitched dog-whistle in the distance. The key varies, however, and is sometimes much less high and more musical than at others. The commingled shrill of this species recalls also the distant croaking of frogs in spring. The broad wings are thoroughly elevated during the act, or even bent forward, and the vibration is so rapid that there appears to be no motion."

Fulton (1915) states that the song of *latipennis* is a loud clear whistle with a musical ringing quality. The eggs are usually laid in grapevines, though sometimes in large stalks of golden-rod growing near the vines. A single hole in the outer woody layer of the stem serves for the deposition of from four to twelve eggs which are placed side by side in the pith in two groups, one above and one below the opening. "The size of the pith determines the number of eggs. The grapevine has a small pith and will hold only two or three eggs on a side, while in the golden-rod as many as six can be found in a single cluster."

II. NEOXABEA Kirby, 1906, 76. (Gr., "near" + Xabea.)

The principal characters separating this genus from *Oecanthus* are given in the generic key. In addition they have the maxillary palpi with third and fifth segments subequal, each twice as long as fourth; tegmina of female irregularly reticulated, the oblique longitudinal veins not conspicuous; male tegmina with mediastinal vein strongly curved, the humeral angle wanting; first joint of hind tarsi unarmed, the tarsi clearly but three-jointed, the second joint very short; anal cerci stout, strongly sinuate, only half as long as abdomen. But one species is known.

341. NEOXABEA BIPUNCTATA (DeGeer), 1773, 523. Two-spotted Tree Cricket.

Pale pinkish-brown; tegmina of female with two pairs of rather large blackish spots, one near base, the other at middle. Antennæ pale yellow, the basal segments without black marks, the first segment slightly prolonged at its upper inner angle, forming an acute blackish tooth (Fig. 240, *h*); legs pale with a pinkish tinge. Head strongly depressed between the eyes. Pronotum nearly one-half longer than wide; subcylindrical with sides subparallel to near basal fifth, then suddenly expanded to form a much wider strongly pitted basal margin, this separated from the disk proper by a distinct cross-suture. Wings very long, protruding like tails beyond the abdomen. Length of body, ♂ and ♀, 13—16; of pronotum, 3.3; of tegmina, 11—13; of wings, 20; of hind femora, 9—10; of ovipositor, 6 mm. Width of tegmina, ♂, 4.5 mm.

This long-winged tree cricket appears to be very scarce, not only in Indiana, but usually wherever found. Here it has been taken only in Vigo and Marion counties, Aug. 3—27. Its known range is southern and a very wide one, extending in the United States from Connecticut west to Illinois and Kansas and south and southwest to North Carolina, Georgia and Mississippi. It is also recorded by Saussure and others from Mexico and Central America. DeGeer's type was from Pennsylvania. Morse (1919a) records it from New Canaan, Portland and New Haven, Conn., Aug. 14—Sept. 11; Smith (1910) from various points in New Jersey and Fulton (1915) from Ohio and Kansas. Near Cedar Point, Ohio, it was found by King on oak, willow and wild grape vines along the forest border or standing isolated at the edge of open sandy areas. R. & H. (1916, 300) mention it as "extremely retiring, living only in the densest tangles of heavy forest undergrowth, where solitary examples can be found only after long continued and vigorous beating."

Allard (1910b) describing its habits in north Georgia says:

"This cricket prefers the dense leaf-canopy of grape-vines, and usually begins to sing at nightfall. It is an intermittent triller, and its low, deep, mellow trills, *tr-r-r-r*, continued only a few seconds, are separated by short intervals. Its notes are deeper, stronger, and richer than those of *Oecanthus angustipennis*. In tone quality they more nearly approach the song of *Oecanthus latipennis*. This cricket is not uncommon at Thompson's Mills, but usually congregates in small communities wherever conditions are favorable, generally in wild grape-vines by the roadside or in low trees near dwellings."

The genus *Xabea* Riley (nec. Walker) of my former work (1903, 453) and of most American writers, was replaced by *Neoxabea* by Kirby, who gave as synonyms of *N. bipunctata* (DeG.) the *Oecanthus punctulatus* Fitch (1856, 415) and *O. formosus* Walker (1869, 94).