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HILGARDIA

*A Journal of Agricultural Science Published by
the California Agricultural Experiment Station*

VOLUME 19

APRIL, 1949

NUMBER 6

**CHARACTERS, DISTRIBUTION, AND FOOD PLANTS OF
LEAFHOPPER VECTORS OF VIRUS CAUSING
PIERCE'S DISEASE OF GRAPEVINES**

DWIGHT M. DELONG and HENRY H. P. SEVERIN

**LIFE HISTORY OF THE BLUE-GREEN SHARPSHOOTER,
NEOKOLLA CIRCELLATA**

HENRY H. P. SEVERIN

**TRANSMISSION OF THE VIRUS OF
PIERCE'S DISEASE OF GRAPEVINES BY LEAFHOPPERS**

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Characters, Distribution, and Food Plants of Leafhopper Vectors of Virus Causing Pierce's Disease of Grapevines 171

Distinguishing characters, especially genitalia, are given for the following vectors:

- Helochara delta* Oman
- Carneocephala fulgida* Nottingham
- Draeculacephala minerva* Ball
- Neokolla circellata* (Baker)
- Neokolla confluens* var. *pacifica* n. var.
- Neokolla severini* DeLong
- Pagaronia confusa* Oman
- Pagaronia 13-punctata* Ball
- Pagaronia triunata* Ball
- Friscanus friscanus* (Ball)

Differences in genitalia distinguish *Neokolla confluens* var. *pacifica* from *N. confluens*. All ten vectors occur in California; several of them have been reported only from this state. The usual food plants of most of them are grasses, though some have been collected on *Vinca* spp., some on various weeds, and *Neokolla circellata* on grapevine and other woody plants.

Life History of the Blue-Green Sharpshooter, *Neokolla circellata* 187

The female deposits a single egg in a slitlike egg chamber cut in the petiole or midrib of grapevine leaves. The egg period varies from 12 to 22 days during the spring in the greenhouse. Nymphs pass through 4 to 6 molts. The average duration of the nymphal stages was 46 to 53 days on grapevines, 58 to 66 days on common alfalfa. Under natural conditions the adults acquire the winged stage during the summer, winter over, and die in the spring. At Berkeley there is usually only one generation a year, but a partial second generation may occur.

Transmission of the Virus of Pierce's Disease of Grapevines by Leafhoppers 190

In single-insect transmission of virus from infected to healthy grapevines, the most efficient vectors tested were *Neokolla circellata* (65 per cent), *Carneocephala fulgida* (33 per cent), and *Helochara delta* (32 per cent). Lower percentages were obtained with *Draeculacephala minerva*, *Friscanus friscanus*, *N. severini*, and *Pagaronia confusa*. No infections were obtained with *P. triunata* or *N. confluens* var. *pacifica*. *N. circellata* was the only one of four species tested that gave a significant transmission of virus from infected grapevines to healthy alfalfa (35 per cent). In single-insect tests, no transmissions from infected to healthy alfalfa were obtained with five species, or from infected alfalfa to healthy grapevines with *P. confusa*. Some of the vectors that proved inefficient were short-lived when confined on grapevines and alfalfa in the greenhouse. Species of leafhoppers of the subfamily Anthysaninae, two species of fulgorids, and unidentified species of cicadas failed to transmit the virus. In transfers from infected to healthy grapevines, the minimum latent period was 2 hours in *Neokolla circellata* and *Carneocephala fulgida*, 7 hours in *Draeculacephala minerva*. In the greenhouse, some adults of the blue-green sharpshooter, reared on infected grapevines, retained the virus throughout adult life, in one case for 122 days.

CHARACTERS, DISTRIBUTION, AND FOOD PLANTS OF LEAFHOPPER VECTORS OF VIRUS CAUSING PIERCE'S DISEASE OF GRAPEVINES¹

DWIGHT M. DELONG² and HENRY H. P. SEVERIN³

INTRODUCTION

PIERCE'S DISEASE OF GRAPEVINES, now widespread and destructive in California vineyards, has been under study by a number of investigators at this experiment station since 1934. In 1936 the cause was found to be a virus, transmissible by grafts and cuttings (Hewitt, 1941).⁴ The virus was later reported (Hewitt, Houston, Frazier, and Freitag, 1946) to be identical with that causing alfalfa dwarf.

Leafhopper transmission of the virus was first demonstrated by Hewitt, Frazier, and Houston (1942) and by Houston, Frazier, and Hewitt (1942). Since then leafhoppers have been reported as vectors by Hewitt, Frazier, Jacob, and Freitag (1942); Frazier (1944); Frazier and Freitag (1946); and Hewitt, Houston, Frazier, and Freitag (1946). A total of fourteen species have been reported, as follows:

Carneocephala fulgida Nottingham
Carneocephala triggutata Nottingham
Cuerna occidentalis Oman and Beamer
Draeculacephala minerva Ball
Friscanus friscanus (Ball)
Helochara delta Oman
Neokolla circumcellata (Baker)

Neokolla confluens (Uhler)
Neokolla hieroglyphica (Say)
Neokolla severini DeLong⁵
Pagaronia confusa Oman
Pagaronia furcata Oman
Pagaronia 13-punctata Ball
Pagaronia triumata Ball

These leafhoppers, commonly called sharpshooters, all belong to the subfamily Tettigoniellinae (DeLong and Knull, 1945) [= Cicadellinae (Van Duzee, 1916, 1917a; DeLong and Caldwell, 1937) = Amblycephalinae (China, 1939; Medler, 1942)].

In an effort to learn more about the vectors and their relation to the disease, biological and transmission studies were begun in 1942 on nine of the species listed and on a variety of one other. The present paper describes distinctive characters to facilitate identification of vectors, summarizes geographic dis-

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⁴ See "Literature Cited" for citations, referred to in the text by author and date.

⁵ Until recently, misidentified as *Neokolla gothica*; see page 179.

tribution as given in the literature, and reports new localities and food plants observed in California.

Companion papers (Severin 1949*a, b*) report the life history of one species, *Neokolla circellata*, and transmission experiments with nine of the vectors described in this paper. Eight of the vectors described in the present paper are shown in color in the third paper of this issue.

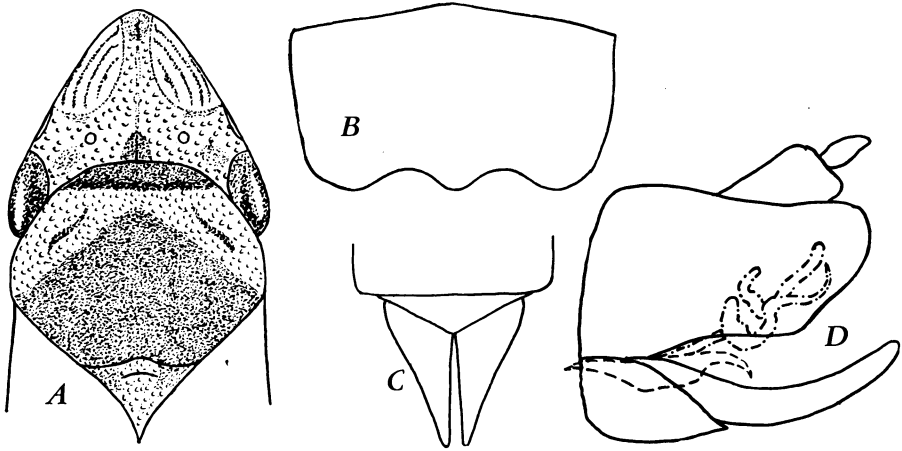


Fig. 1. *Helochara delta* Oman: A, dorsal view of head, pronotum, and scutellum; B, ventral view of female seventh sternite; C, ventral view of male valve and plates; D, lateral view of male genital structures.

HELOCHARA DELTA

Characters. *Helochara delta* Oman was described by Oman (1943) as distinct from *H. communis* Fitch, which it closely resembles in form, appearance, and genitalic structures. It is from 5 to 6 mm in length.

The vertex (fig. 1, A) is more produced than in *Helochara communis*; it is bluntly pointed and almost as long as the pronotum. The width of the vertex between the eyes is almost one fourth greater than its median length.

The color is dark green marked with paler green or yellowish green. The apex of the vertex and the four arcs on the anterolateral margin are black or dark brown. The face is pale dull green to brown.

The posterior margin of the female seventh sternite (fig. 1, B) is broadly concavely emarginate either side of a median produced portion, so that the segment appears trilobate. The male plates (fig. 1, C) are rather short, triangular with acute apices. The styles (fig. 1, D) are rather broad at the base, narrowed rather abruptly on the outer margin at about three fourths their length and produced to form an apical fingerlike process, which curves outward and is pointed on the outer margin at the apex. The aedeagus is about uniform in size throughout, and two pairs of lateral processes arise near the base. The pair at the basal end are short and extend dorsally. The other pair are narrow, curved across the aedeagus and usually extend to its apex.

Distribution and California Food Plants. *Helochara delta* is known from California only. Oman (1943) records the type locality of *Helochara delta*

from General Grant Park, California, elevation 6,500 feet, October 16, 1941. Other specimens are from Kenwood and Smith River, California.

N. W. Frazier collected a large population of *Helochara delta* on reed grasses (*Calamagrostis* sp.), rush grasses (*Juncus* sp.), and species of *Cyperus* growing in bogs at Kenwood, California, on September 25, 1943.

A mixed population of *Helochara delta* and *Carneocephala fulgida* was collected on Sudan grass (*Sorghum vulgare* var. *sudanense*), near Geyserville, Sonoma County, on September 6, 1946.

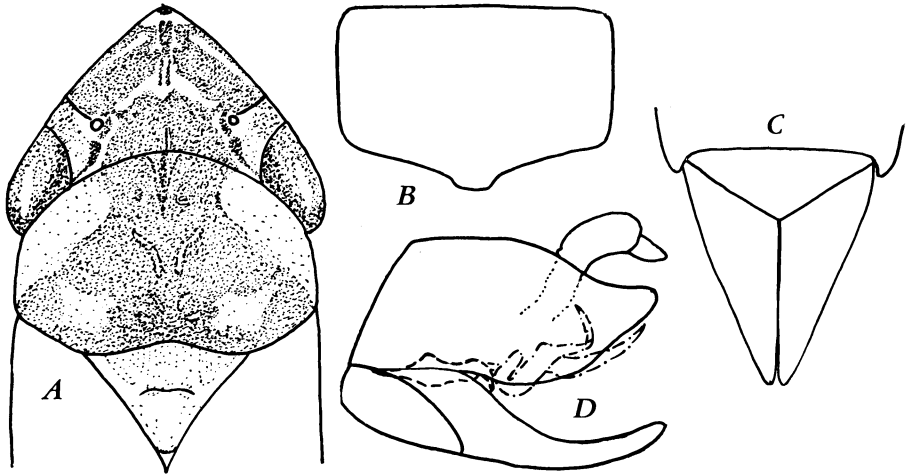


Fig. 2. Redheaded sharpshooter, *Carneocephala fulgida* Nottingham: *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of female seventh sternite; *C*, ventral view of male valve and plates; *D*, lateral view of male genital structures.

THE REDHEADED SHARPSHOOTER, CARNEOCEPHALA FULGIDA

Characters. In general appearance *Carneocephala fulgida* Nottingham closely resembles *C. flaviceps* (Riley) but is darker green and has a more pointed head. The male is smaller, 4.5 to 5.0 mm long, while the female is 5.5 to 6.0 mm long. The species was described by Nottingham in 1932.

The vertex (fig. 2, *A*) is rather flat and granulated. The width between the eyes is about one and one half times as great as the median length. The apex is pointed. The pronotum is about one third longer than the vertex.

The color of the vertex of the male is usually a little darker than that of the female. In each case the vertex is fulvous with paler spots. There is a pale spot at the apex, spots around the ocelli, a pale arc connecting them, and a spot anterior to the arc. There are pale bands along the anterior margin, and the posterior margin is greenish yellow. The pronotum and scutellum are yellowish green. The elytra are dark green with paler veins, and the apices are smoky. The face is pale brownish, mottled with paler spots.

The posterior margin of the female seventh sternite (fig. 2, *B*) is broadly and slightly produced at the middle and slightly sinuate on either side.

The male plates (fig. 2, *C*) are triangular, rather broad at the base, the apices acute and blunt, each with a fingerlike process. The styles are rather

short and tapered from the base to a pointed apex. In lateral view (fig. 2, *D*) the aedeagus is short and curved, with two pairs of lateral processes arising ventrally. The basal pair are shorter, the second pair longer; and the tips of the processes are curved dorsally and caudally.

Geographical Distribution and California Food Plants. Records indicate that the redheaded sharpshooter is known only from California. Nottingham (1932) notes the following localities for it: Lemon Cove, July 24, 1929 (R. H. Beamer); Winters, August 6, 1929 (R. H. Beamer); Sacramento, August 7, 1929 (L. D. Anderson); and Spreckels, May 14, 1929 (G. E. Bensel).

According to Hewitt, Frazier, Jacob, and Freitag (1942), *Carneocephala fulgida* has in general been found under the same conditions as described for *Draeculacephala minerva* but favors open and exposed soils which support low, sparsely growing grasses and weeds. This leafhopper is commonly found on puncture vine (*Tribulus terrestris*) and cocklebur (*Xanthium canadense*).

Carneocephala fulgida was collected on grasses and weeds growing in the dry stream bed of the Russian River near Larkmead. An enormous population of nymphs and adults occurred on Sudan grass (*Sorghum vulgare* var. *sudanense*) near Geyserville, Sonoma County, on September 6, 1946.

THE GREEN SHARPSHOOTER, DRAECULACEPHALA MINERVA

Characters. The green sharpshooter, *Draeculacephala minerva* Ball, was described by Ball in 1927. It is the common western species of dark green and yellow grass leafhopper. The male is 6 to 7 mm. in length, the female 7 to 9 mm.

The vertex (fig. 3, *A*) is bluntly angled. In both sexes its width between the eyes at the base is a little greater than its median length. The margins are convexly rounded to a blunt-pointed apex.

The color of the vertex, the anterior half of the pronotum, and the scutellum is yellow. There is a conspicuous brown spot on the apex of the vertex and a black impressed line from the margin to the ocellus. Along the margin on either side there are three conspicuous parallel brown arcs. The posterior half of the pronotum is dark green. The elytra are dark green with pale veins.

The posterior margin of the female seventh sternite (fig. 3, *B*) is broadly, angularly notched on either side of the middle to form a broad, bluntly angled, produced, median tooth, and lateral angles which are slightly produced.

The male plates (fig. 3, *C*) are elongate, triangular, exceeded in length by the pygofers. The aedeagus (fig. 3, *D*, *E*, *F*) possesses a ventro-anterior portion from which a pair of processes extend dorsally. The dorso-posterior portion has a pair of long processes at the base which are vermiculate and longer than the aedeagus, extending dorsally and caudally. The ventral process is deeply constricted near the base, then curved to form a rounded spoon-shaped portion with the apex, which is broadly rounded.

Geographical Distribution and California Food Plants. This species is western and southwestern in distribution. It has been collected in California, Oregon, Nevada, Utah, Arizona, New Mexico, Texas, Mexico, Guatemala, and the Canal Zone.

Ball (1927) gives the following localities for the green sharpshooter in California: Stanford, June 21, 1908 (Ball); San Jose (King); and Chino (Ball and Titus).

According to Hewitt, Frazier, Jacob, and Freitag (1942), the green sharpshooter is widely distributed in California. It is commonly found in moist situations, as in marshes and bogs, along streams and ditches, and in wet areas created by irrigation practices. Well-irrigated alfalfa fields which have a thinning stand of plants contain certain plants that provide situations for

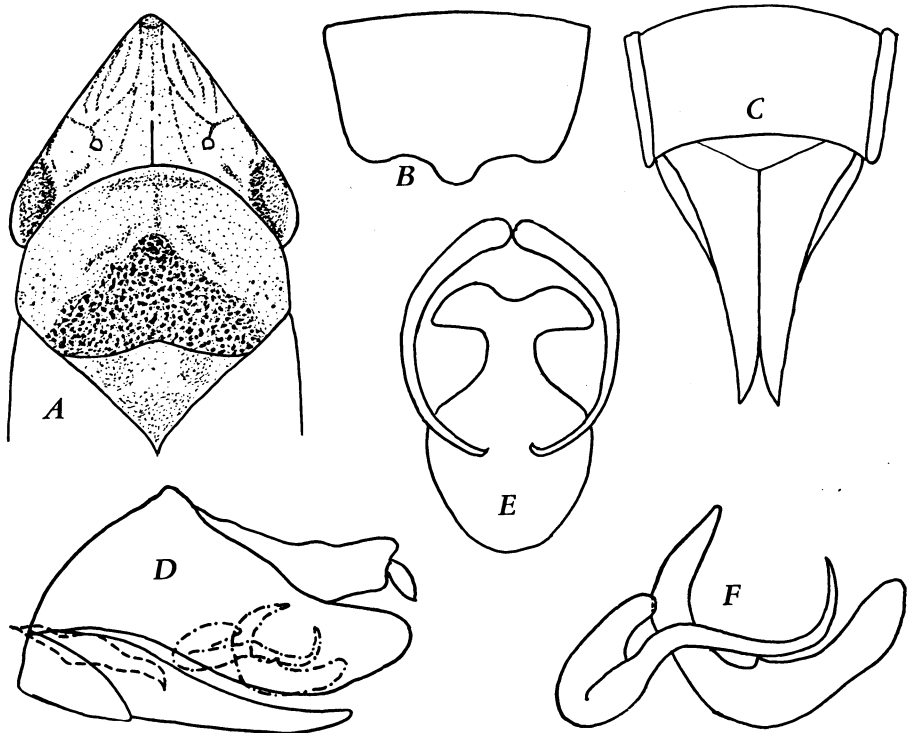


Fig. 3. Green sharpshooter, *Draeculacephala minerva* Ball: A, dorsal view of head, pronotum, and scutellum; B, ventral view of female seventh sternite; C, ventral view of male plates; D, lateral view of male genital structures; E, ventral view of male aedeagus; F, lateral view of male aedeagus.

large numbers of this leafhopper. Populations of this leafhopper have also been observed in young grain fields, in orchard covercrops, in uncultivated areas around buildings, on lawns, along roadsides, railroad right-of-ways, irrigation ditches, and canals, and in permanent pastures. Grasses afford preferred food and breeding plants, Bermuda grass (*Cynodon dactylon*) being especially favored. The leafhopper is common on puncture vine (*Tribulus terrestris*) and on cocklebur (*Xanthium canadense*).

The source of supply of *Draeculacephala minerva* for experimental purposes was on grasses in a depleted alfalfa field near Milpitas, Santa Clara County, and along the margins of a bog at Sharp Park, San Mateo County.

The leafhopper was collected in many other localities in the coastal fog belt, and in the Salinas, San Joaquin, Sacramento, and Napa valleys.

THE BLUE-GREEN SHARPSHOOTER, *NEOKOLLA CIRCELLATA*

Characters. The blue-green sharpshooter, *Neokolla circellata* (Baker), was described by Baker in 1898 as a member of *Tettigonia*. *T. circellata* was a manuscript name used by Uhler but not published. For many years this species was placed as a synonym of *Tettigonia atropunctata* Signoret but has recently been recognized as an apparently good species. The length is 6 to 7 mm.

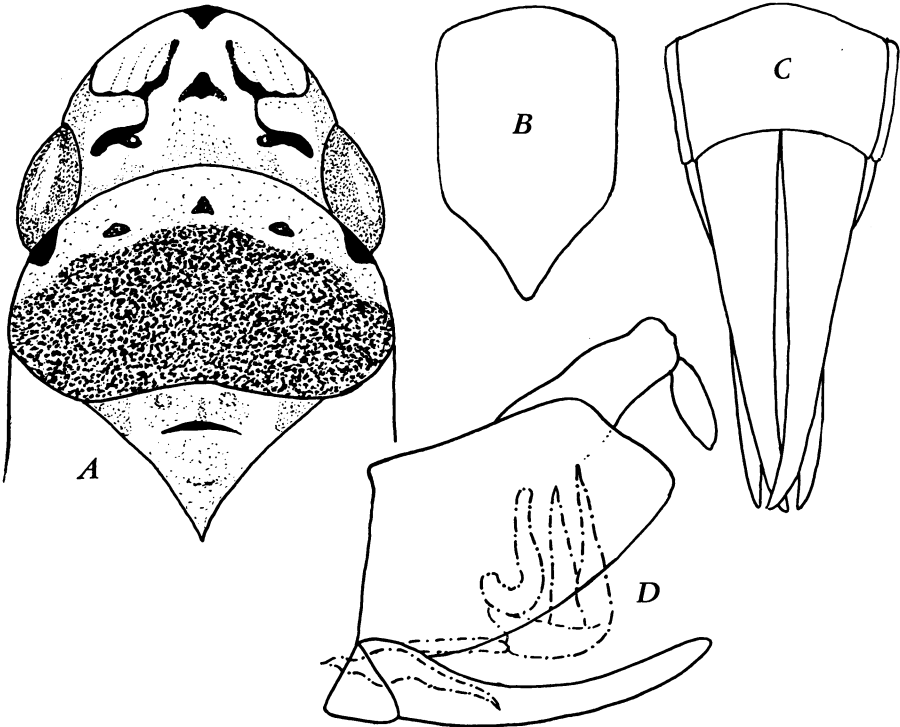


Fig. 4. Blue-green sharpshooter, *Neokolla circellata* (Baker): *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of female seventh sternite; *C*, ventral view of male valve and plates; *D*, lateral view of male genital structures.

The vertex (fig. 4, *A*) is blunt, with the sides convexly rounded. It is about one and one third times as wide between the eyes as the median length.

The vertex is yellow in color with a black spot at the apex. There is a spot at the middle, an oblique dash against each ocellus on the outside, and a curved black line on each side along the line of the frontal suture. The pronotum is pale on the anterior half; the posterior half is darker with a series of spots on the anterior portion. The elytra are blue.

The posterior margin of the female seventh sternite (fig. 4, *B*) is strongly, angularly produced. The median line is keeled; the apex appears pointed because of this keel.

The male plates (fig. 4, *C*) are long and slender, about four times as long as the basal width. The styles are rather long, narrowed on the apical half to a pointed apex, which curves outward. The aedeagus in lateral view (fig. 4, *D*) is composed of three erect processes. The apical one is the longest and is sharp-pointed at the apex. The process adjacent to it is a little shorter and is sharp-pointed. The basal process has a shorter anterior and a longer posterior portion, both of which are blunt.

Geographical Distribution and California Food Plants. The blue-green sharpshooter is known to occur in Arizona and California.

Baker (1898) records the species from Los Angeles (Koebele).

Hewitt, Frazier, Jacob, and Freitag (1942) state that it is often very common and abundant in the coastal fog belt, especially in canyons and along streams and in valleys. In the San Joaquin Valley it is sometimes found in large numbers, but usually fairly closely confined to stream banks.

This sharpshooter is found on many host plants, but prefers vines, shrubs, trees, and perennial herbs (Hewitt, Frazier, Jacob, and Freitag, 1942). Wild grapevines, wild blackberry, elderberry, and willow are especially common host plants. Grasses and weeds are less commonly infested.

In Berkeley this species frequently completes the nymphal stages on deciduous plants such as Japanese or Boston ivy (*Parthenocissus tricuspidata*), and the adults fly to other food plants during the autumn. Near Larkmead, when the leaves of grapevines began to dry and drop, the adults were abundant on Persian walnut (*Juglans regia*) partly surrounding a vineyard. This sharpshooter completes its nymphal stages on the following plants (those plants which serve only as food plants during the winter are not listed):

Apocynaceae:

Vinea major, large periwinkle

Araliaceae:

Hedera canariensis, ivy

Compositae:

Artemisia vulgaris, California mugwort

Geraniaceae:

Pelargonium capitatum

Pelargonium domesticum, Lady

Washington geranium

Pelargonium hortorum, fish geranium

Pelargonium peltatum, ivy geranium

Labiatae:

Salvia leucantha

Leguminosae:

Acacia longifolia, Sydney golden wattle

Myoporaceae:

Myoporum laetum

Myrtaceae:

Eugenia paniculata var. *australis*

(*E. myrtifolia*)

Onagraceae:

Fuchsia hybrida

Plumbaginaceae:

Limonium perezii (*Statice perezii*)

Pittosporaceae:

Pittosporum eugenioides, tarata

Rubiaceae:

Coprosma baueri

Saxifragaceae:

Francoa sonchifolia

Solanaceae:

Cestrum purpureum (*C. elegans*)

Vitaceae:

Parthenocissus tricuspidata

NEOKOLLA CONFLUENS VAR. PACIFICA N. VAR.

Characters. *Neokolla confluens* var. *pacifica* resembles *confluens* in general form and appearance, but the genitalia of the male are different. The length is 6.5 to 7.0 mm.

The vertex (fig. 5, *A*) is bluntly produced, almost twice as broad between the eyes as the median length. The pronotum is about one half longer than the vertex.

The color is gray to cream. The vertex is marked with a heavy black elongated bar extending from either side of the pale apex to near the eye (fig. 5, *A*). The portion next to the eyes is narrowed and is in line with a small spot between its terminus and the eye. There is a heavy bent band either side extending from the base anteriorly through the ocellus, then curved inwardly extending almost to the middle line where it turns abruptly caudally and extends almost to the base. These marks form a median white band from the apex to the base. There is a longitudinal bar which is between the eye and the ocellus. The pronotum is mottled with small darker spots. The scutellum is mostly black with two median anterior pale circular spots, each of which contains a black dot at the center. There is a medium elongate white spot

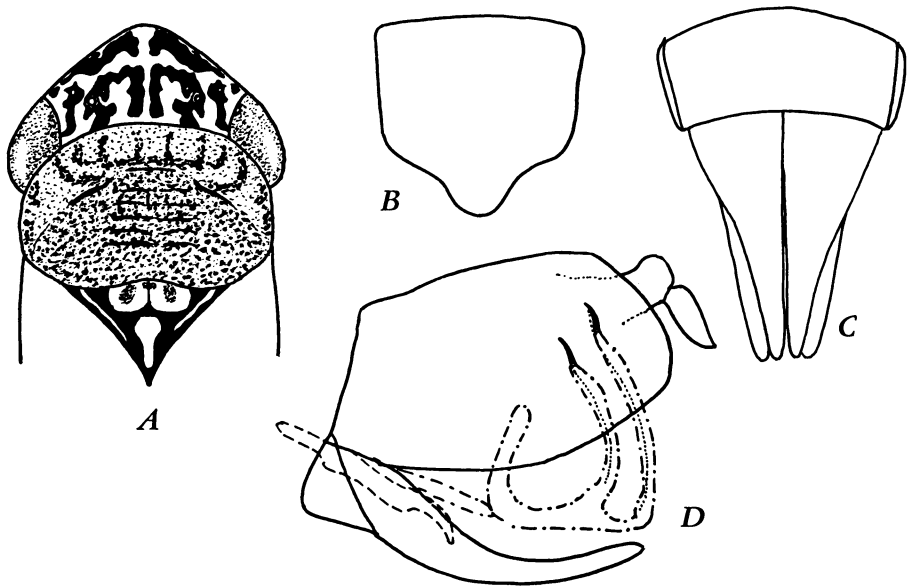


Fig. 5. *Neokolla confuens* var. *pacifica* n. var.: *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of female seventh sternite; *C*, ventral view of male valve and plates; *D*, lateral view of male genital structures.

between these and the apex, and a narrow pale diagonal line extending from each basal angle more than half way to the apex just inside the lateral margins.

The posterior margin of the female seventh sternite (fig. 5, *B*) is convexly rounded on the lateral angles, then concavely sloping to form a produced median blunt apex.

The male plates (fig. 5, *C*) are elongate, triangular, each almost three times as long as its basal width, and concavely tapered to a blunt apex. The styles are gradually narrowed from a rather broad base to a narrow apex, which is truncate with a projecting tooth on the outer apical margin. The aedeagus (fig. 5, *D*) is curved upward at the base and has two long, dorsally directed processes, one at the apex of the ventral portion and the other at about the middle of the ventral portion. These are slender and are enlarged and convexly curved on the caudal margin just before the narrow acutely pointed tip.

Geographical Distribution and California Food Plants. This variety is known to occur in California and probably in southern Idaho.

During the past four summers, *Neokolla confluens* var. *pacifica* was collected, on rare occasions, on common periwinkle or running myrtle (*Vinca minor*) growing along the banks of the Russian River near Larkmead.

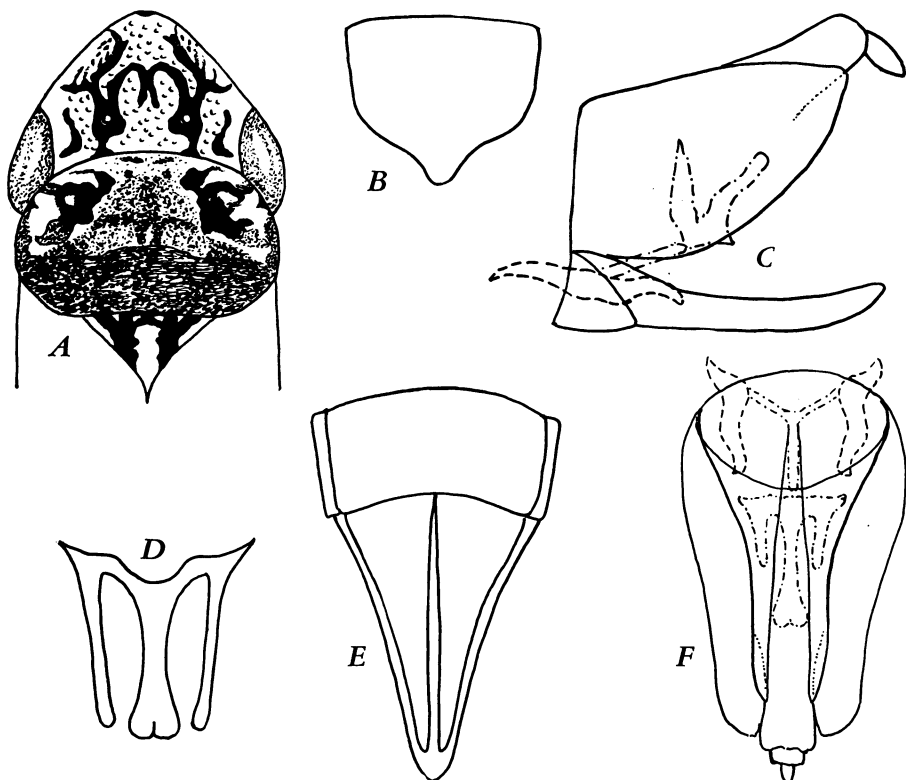


Fig. 6. *Neokolla severini* DeLong: *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of female seventh sternite; *C*, lateral view of male genital structures; *D*, caudal view of male aedeagus; *E*, ventral view of male valve and plates; *F*, ventral view of male genital structures. (*A*, *C*, *D*, and *F* from DeLong, 1948.)

R. Flock collected this variety at Covina (San Dimas Canyon), Los Angeles County, on *Adenostoma*; at Peralta, Orange County; and at Rivera, Los Angeles County.

NEOKOLLA SEVERINI

Characters. *Neokolla severini* DeLong was described in 1948. It had previously been confused with *N. gothica*, which it resembles in color and general appearance. The species occurring in California had been identified as *N. gothica* for many years, but can be distinguished from the latter by the smaller size (5.5 to 6.0 mm long), shorter head, and different male genital structures.

The vertex (fig. 6, *A*) is produced, bluntly angled, one third wider between the eyes than the median length, and shorter than the pronotum.

The color is somewhat variable. The vertex ground color is grayish, often tinted with red. There is a black spot at the apex (fig. 6, *A*). There is an area on each margin about halfway between the apex and the eye separated from the disk by a black line, which encloses several dark arc-like lines. A black line extends from the inner basal margin of this area to the ocellus, which is enclosed in a black ring. A black line extends forward from the ocellus, curves on the disk to meet the curved line from the opposite side, from which point they are directed basally for a short distance as contiguous lines. There is also a black dash near the base on either side between the ocellus and the eye. The anterior third of the pronotum is pale with black markings. The posterior two thirds is black. The scutellum is gray, often tinted with red, with black lines extending from about the middle of either side to the pronotum. The elytra are usually dark with a few pale markings, and the veins are inconspicuous, often obscured. The face is pale with traces of faint arcs.

The posterior margin of the female seventh sternite (fig. 6, *B*) is strongly angularly produced to a blunt apex. The entire segment is long. The male plates (fig. 6, *E*) are elongate and concavely narrowed on the inner margins to form narrow, rather blunt apices. The plates are about four times as long as the width of each at the base. The styles are rather short, broad at the base, and curved inward to form a blunt apex. The aedeagus is simple and in caudal view (fig. 6, *D*) has an apex which is slightly enlarged and notched at the middle to form two rounded apical lobes. There are two dorsally directed processes at the base (fig. 6, *C*).

Geographical Distribution and California Food Plants. The records at hand indicate that *Neokolla severini* occurs in California and is the common species in Arizona. The species was collected by Severin in small numbers on common periwinkle or running myrtle (*Vinca minor*) growing along the banks of the Russian River near Larkmead. Most of the adults used in testing the efficiency of this vector in transmitting the virus causing Pierce's disease of grapevines (Severin, 1949b) were reared on large periwinkle (*Vinca major*) by J. H. Freitag.

R. Flock collected *Neokolla severini* at Riverside, Riverside County, on *Ribes* and *Lonicera hispidula* (*L. subspicata*); Berkeley, Alameda County; Covina (San Dimas Canyon), Los Angeles County; East Highlands, San Bernardino County, on *Eriodictyon*; in the San Bernardino Mountains on *Artemisia vulgaris*; and in the San Jacinto Mountains on *Ceanothus*.

PAGARONIA CONFUSA

Characters. *Pagaronia confusa* Oman was described by Oman in 1938. Previously it had been confused with *P. 13-punctata*, which it closely resembles in coloration. It can be separated from *P. 13-punctata* by the broader male plates and the straight lateral processes of the aedeagus (compare fig. 7, *C, D*, and fig. 8, *B, C*). *P. confusa* is 8.0 to 9.5 mm long.

The vertex of *Pagaronia confusa* (fig. 7, *A*) is a little more pointed than in *P. 13-punctata* (fig. 8, *A*). The length of the vertex on the median line is slightly less than its width between the eyes.

The general color is pale green. It may have the 13 black spots on the head and pronotum as are found on *Pagaronia 13-punctata*, but the spots below

the ocelli and the lateral spots on the pronotum are usually absent (Oman, 1938).

The posterior margin of the female seventh sternite (fig. 7, *B*) is slightly produced and faintly notched at the middle.

The male plates (fig. 7, *D*) are rather slender, broadened at the base, and tapered to bluntly rounded tips. The aedeagus is long, slender, and produced dorsally, and bears a pair of rather long, straight, slender processes at the apex which extend ventrally and laterally (fig. 7, *C*). The pygofer does not bear apical processes.

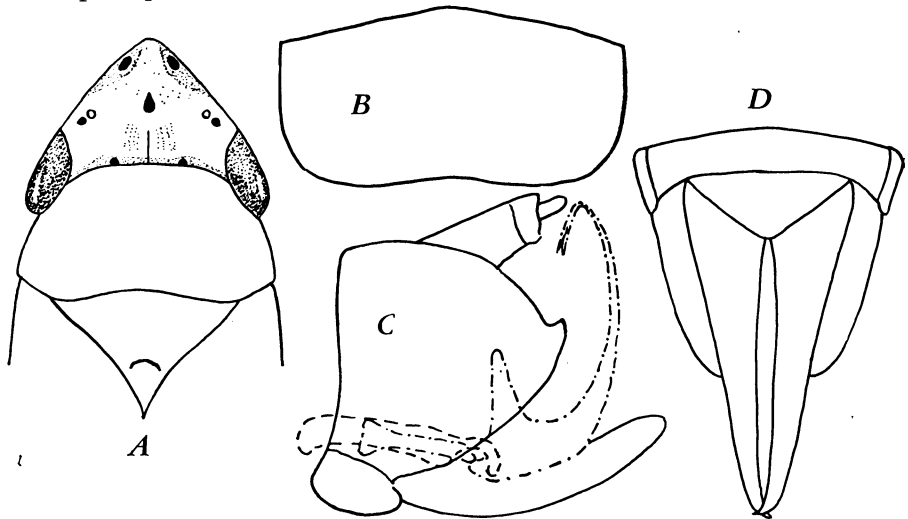


Fig. 7. *Pagaronia confusa* Oman: *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of female seventh sternite; *C*, ventral view of male valve and plates; *D*, lateral view of male genital structures.

Geographical Distribution and California Food Plants. This species was described from specimens collected at Mount Diablo, California, and has not been collected in other states.

In addition to the type locality, Oman (1938) records the following localities: San Rafael (Oman), Sausalito (Thompson), and Palo Alto (Baker) in California; and Reno (?), Nevada (Brown).

A mixed population of *Pagaronia confusa* and *P. triunata* was collected abundantly by Severin on American vetch (*Vicia americana*) on May 15, 1946, near Atherton, San Mateo County. Adults were also collected on California mugwort (*Artemisia vulgaris*) on May 17, 1946, in Strawberry Canyon, Berkeley, Alameda County.

PAGARONIA 13-PUNCTATA

Characters. *Pagaronia 13-punctata* Ball was described by Ball (1902) and was redescribed as var. *octopunctata* by Kirkaldy (1909). It is 8.0 to 9.5 mm long.

The width of vertex (fig. 8, *A*) between the eyes is slightly greater than its median length.

The color is pale green to yellow. The 13 black spots on well marked specimens are arranged thus: one just below the vertex margin, a pair near the apex above the margin, one anterior to the ocelli on the median line, one below and one behind each ocellus, a pair of smaller ones, often obscure, on the suture just below the ocelli (Ball, 1902), a pair on the posterior margin of the vertex, and three forming a transverse row on the disk of the pronotum. Seven spots on the dorsal side of the head and three on the pronotum are shown in figure 8, *A*. According to Oman (1938), the three pronotal spots, the median spot anterior to the ocelli, and the spots below the ocelli may be inconspicuous or absent.

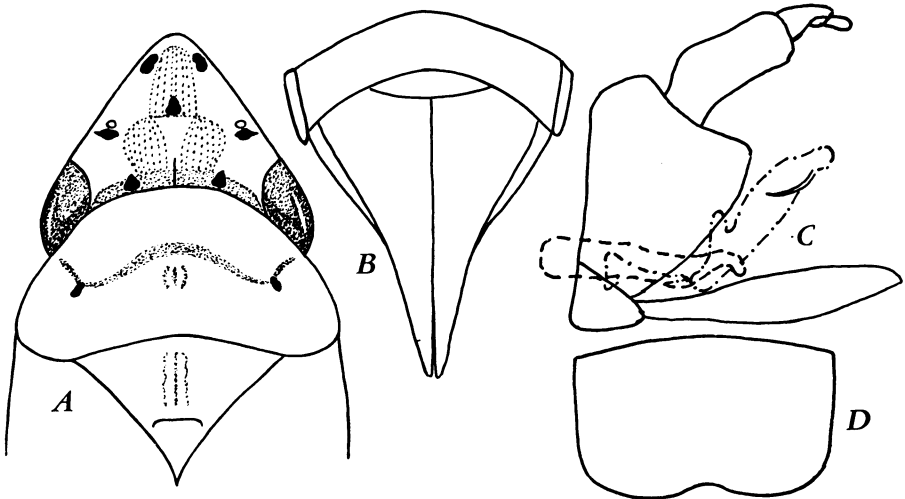


Fig. 8. *Pagaronia 13-punctata* Ball: *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of male valve and plates; *C*, lateral view of male genital structures; *D*, ventral view of female seventh sternite.

The posterior margin of the female seventh sternite (fig. 8, *D*) is produced and shallowly notched at the middle.

The male plates (fig. 8, *B*) are elongate, slender, blunt at the apex, and almost three times as long as the basal width. The aedeagus (fig. 8, *C*) is stout, extends dorsally, and has a pair of processes at the tip which are tapered toward the apex, extending ventrally and curved laterally at their apices. The pygofer is plain without spines.

Geographical Distribution and California Food Plants. This species is recorded from California only. It is apparently confined to Santa Barbara, Los Angeles, and Orange counties, if we may judge from the known records.

According to Oman (1938) the types of *Pagaronia 13-punctata* Ball are from Los Angeles County (Coquillett and Koebele), Pasadena (Fall), and Marin County (Fuchs). "It is probable that the specimens from Marin County are not *P. 13-punctata* but *P. confusa*." Other localities in which this species was taken are Lancaster (Uhler collection), Mint Canyon, and above Mint Canyon (Oman). Mint Canyon is between Saugus and Palmdale. These records indicate a rather limited distribution in the low hills near Los Angeles.

A single male of *Pagaronia 13-punctata* was collected in California, Santa Barbara foothills (June, 1907) by W. W. Giffard; this was redescribed as var. *octopunctata* by Kirkaldy (1909).

Pagaronia 13-punctata was collected by R. C. Dickson commonly on California mugwort (*Artemisia vulgaris*), at Peralta in Santa Ana Canyon, Orange County, on June 7, 1945; and by R. A. Flock in the same locality and in the San Bernardino Mountains, at 4,500 feet.

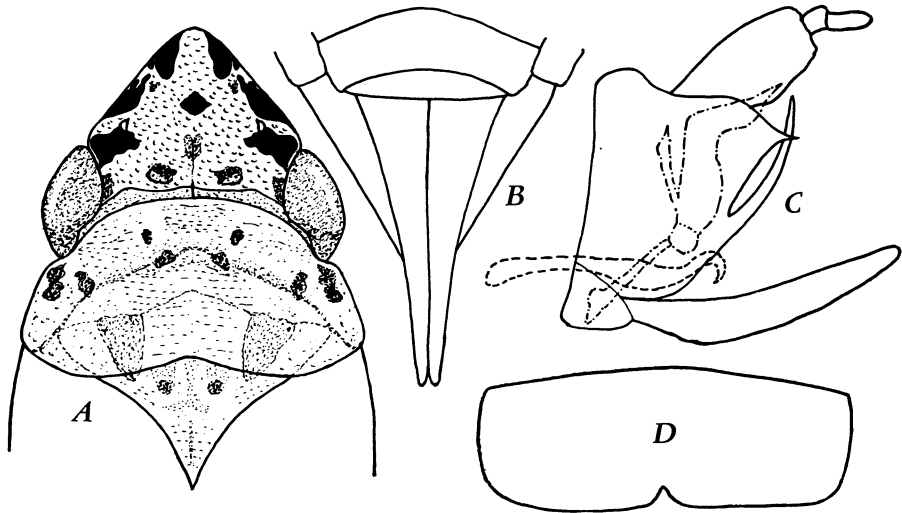


Fig. 9. *Pagaronia triunata* Ball: A, dorsal view of head, pronotum, and scutellum; B, ventral view of male valve and plates; C, lateral view of male genital structures; D, ventral view of female seventh sternite.

PAGARONIA TRIUNATA

Characters. *Pagaronia triunata* Ball was originally described by Ball (1902) as a variety of *P. 13-punctata*. It has since been raised to specific status. The irregular black markings on the head and the slender elongated male plates are distinctive. The length of the male is 7.7 mm, that of the female 9.2 mm.

The width of the vertex (fig. 9, A) between the eyes is a little greater than the median length.

The color is pale dirty yellow. There is a median black spot just beneath the apex of the vertex. Between each eye and the ocellus there is a small black spot, and in front of each ocellus a large irregular black spot which frequently appears bilobate. There is also a small median black spot anterior to the ocelli, an elongate curved spot each side at the base, and a small spot near the base next to each eye. There are black or fuscous markings in the form of spots on the anterior lateral portions of the pronotum. The scutellum contains a pair of minute black or fuscous spots just back of the median anterior margin. The elytra of the male are marked with reddish or reddish-brown cells; those of the female are paler.

The posterior margin of the female seventh sternite (fig. 9, *D*) is slightly produced and has a slight median notch.

The male plates (fig. 9, *B*) are long, slender, nearly parallel-margined, and three times as long as their combined basal width. The apices are bluntly pointed. The aedeagus (fig. 9, *C*) is rather thick, extends dorsally, then is bent caudally. The apex is sharply pointed on the dorsal margin. In dorsal view the apex is bifurcate. The male pygofer is set with two pairs of slender processes. The dorsal pair are short and directed caudally, the ventral pair are long and extend dorsally and slightly caudally almost to the dorsal margin of the pygofer.

Geographical Distribution and California Food Plants. *Pagaronia triunata* is known only from California. The type specimens were collected by Coquillett in Santa Clara County, California. Ball (1902) took the species at Salinas, California.

In addition Oman (1938) records the following localities in California: Santa Cruz Mountains (Koebele), Alameda (Van Dyke), Honda (Oman), and specimens in the Uhler collection labeled "Congr.," which presumably means Congress Junction or Congress Springs, both in Santa Clara County.

Pagaronia triunata was collected abundantly on grasses growing below pine and oak trees on April 29, May 2, and May 8, 1946, near Atherton, San Mateo County; but not a single specimen was taken on grapevines in a near-by vineyard. After the grasses became dry a few adults were taken on pine trees and on *Acacia baileyana*; they were abundant on American vetch (*Vicia americana*) on May 15, 1947.

FRISCANUS FRISCANUS

Characters. *Friscanus friscanus* (Ball) was described by Ball (1909) as belonging to *Errhomenellus*. Later Van Duzee (1917*b*) described it under the name *Memnonia simplex*. When the group was revised by Oman in 1938, he erected the genus *Friscanus* to include *friscanus*, the genotype.

The female is 5.8 to 6.0 mm long, the male much shorter, 3.8 to 4.0 mm.

The vertex (fig. 10, *A*) is bluntly produced and angled. The width between the eyes is about equal to the median length.

The female is almost uniformly pale green. The male is the same shade, but with a pair of rather heavy longitudinal black stripes across the vertex and pronotum; these stripes are curved and often fused anteriorly. These are sometimes represented by two pairs of spots on the vertex, and fainter markings on the pronotum. The basal angles of the scutellum may be black. Black areas may occur on the claval, apical, and costal cells of the forewings. Black spots are frequent on the dorsum of the abdomen and the tips of the plates.

The posterior margin of the female seventh sternite (fig. 10, *B*) is weakly produced and slightly notched at the middle.

The male plates (fig. 10, *C*) are long and slender, tapering to slightly rounded tips and curved upward posteriorly. The aedeagus (fig. 10, *D*) is rather thick basally. The terminal portion is narrow, pointed, and bent dorsally. The pygofer bears a pair of rather long, slender, pointed, fingerlike processes which arise on the ventral portion and extend dorsally and slightly caudally along the posterior margin of the pygofer.

Geographical Distribution and California Food Plants. *Friscanus friscanus* is found rather abundantly in the area around San Francisco but is apparently not widely distributed even in California, and is not known outside this state. The type locality of *Friscanus friscanus* is San Francisco (Ball, 1909). Oman (1938) made extensive collections of this leafhopper from San Francisco or from localities along the coast a short distance south of San Francisco. Nymphs and adults were abundant on *Lupinus arboreus* in June.

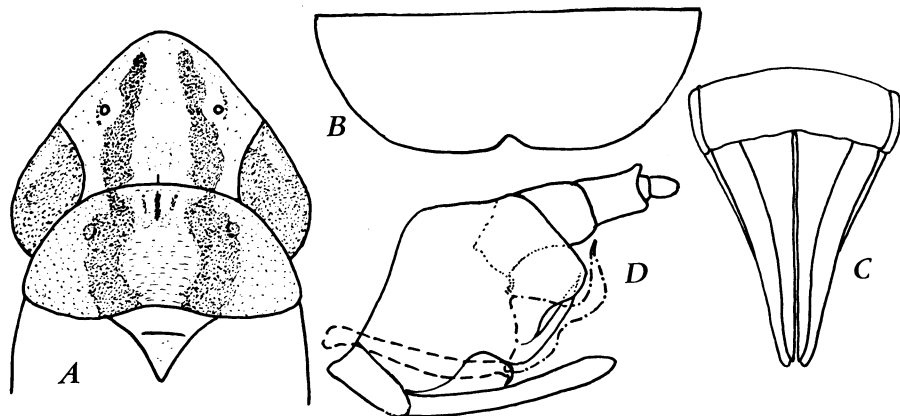


Fig. 10. *Friscanus friscanus* (Ball): A, dorsal view of head, pronotum, and scutellum; B, ventral view of female seventh sternite; C, ventral view of male valve and plates; D, lateral view of male genital structures.

W. W. Giffard collected one male and seven female examples taken at Lands End and Golden Gate Park, San Francisco, in June and July, and in San Mateo County in June (Van Duzee, 1917b).

During the past five years this leafhopper has been collected by Severin on tree lupine (*Lupinus arboreus*) growing along the roadsides near the coast in San Francisco County, and in canyons and exposed slopes of the Montara Mountains in San Mateo County during May and June. During the summer the leafhoppers fly to other plants, and an occasional adult was taken on California sagebrush (*Artemisia californica*).

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