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SPITTLE-INSECT VECTORS OF PIERCE'S DISEASE VIRUS

I. CHARACTERS, DISTRIBUTION, AND FOOD PLANTS

DWIGHT M. DELONG and HENRY H. P. SEVERIN

II. LIFE HISTORY AND VIRUS TRANSMISSION

HENRY H. P. SEVERIN

UNIVERSITY OF CALIFORNIA • BERKELEY, CALIFORNIA

SPITTLE-INSECT VECTORS OF PIERCE'S DISEASE VIRUS

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Distinguishing characters, especially genitalia, are given for the following species of Cercopidae:	
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<i>Aphrophora permutata</i> Uhler	
<i>Clastoptera brunnea</i> Ball	
<i>Philaenus leucophthalmus</i> (Linnaeus)	
The distribution of these four species is reported and their food and breeding plants in California are listed. Distinctive markings are described and illustrated for the following six color forms of <i>Philaenus leucophthalmus</i> , all occurring in California: var. <i>leucophthalmus</i> (Linnaeus); var. <i>pallidus</i> (Zetterstedt); var. <i>fabricii</i> Van Duzee; var. <i>marginellus</i> (Fabricius); var. <i>spumarius</i> (Fallen); and var. <i>impressus</i> n. var.	
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Under natural conditions in California, there are two generations a year for <i>Aphrophora permutata</i> Uhler and <i>Clastoptera brunnea</i> Ball, and one generation for six varieties of <i>Philaenus leucophthalmus</i> (Linnaeus). The molting of last-instar nymphs of <i>A. permutata</i> is described in detail.	
All of these spittle insects transmitted the virus of Pierce's disease of grapevines from diseased to healthy vines; their efficiencies (in single-insect tests) varied from 12 per cent for <i>Clastoptera brunnea</i> to 65 per cent for <i>Philaenus leucophthalmus</i> var. <i>leucophthalmus</i> . <i>P. leucophthalmus</i> and the two species of <i>Aphrophora</i> occasionally transmitted the virus from diseased grapevines to healthy alfalfa, and from alfalfa plants infected with alfalfa dwarf to healthy grapevines, but <i>C. brunnea</i> did not; and only <i>P. leucophthalmus</i> transmitted the virus from healthy to diseased alfalfa. Two varieties of <i>P. leucophthalmus</i> were the only ones among these insects found to be naturally infected. Grapevines proved to be an unfavorable food plant for all except <i>P. leucophthalmus</i> , and alfalfa was unfavorable for <i>Clastoptera brunnea</i> . None of these vectors have been collected on grapevines, nor in alfalfa fields in California, though <i>P. leucophthalmus</i> was once collected on volunteer alfalfa growing among weeds. Hence none of these insects appear to be of economic importance in spreading the virus to grapevines or alfalfa under natural conditions in California, except that <i>P. leucophthalmus</i> may possibly infect perennials, such as herbs, which may serve as reservoirs of the virus. The minimum latent period of the virus in adults of four varieties of <i>P. leucophthalmus</i> ranged from 2 to 7 hours. The virus was retained by <i>P. leucophthalmus</i> from 29 to 76 days.	

SPITTLE-INSECT VECTORS OF PIERCE'S DISEASE VIRUS

I. CHARACTERS, DISTRIBUTION, AND FOOD PLANTS¹

DWIGHT M. DELONG² and HENRY H. P. SEVERIN³

INTRODUCTION

THE CERCOPIDAE are a family of Homoptera commonly called the spittle insects or froghoppers. They are closely related to and easily confused with the Cicadellidae or leafhoppers on the one hand and the Fulgoridae or plant hoppers on the other. The Cercopidae can easily be distinguished from the Cicadellidae because the former have circlets of spines around the apex of the tibia, while the latter group has two rows of stout spines the entire length of the tibia. The Cercopidae differ from the Fulgoridae in the position of the antennae. In the Fulgoridae the antennae arise on the sides of the face beneath the eyes; in the Cercopidae they arise between the eyes on the genae.

At present six genera of Cercopidae—*Tomaspis* Amyot and Serville, *Lepyronia* Amyot and Serville, *Philaronia* Ball, *Aphrophora* Germar, *Clasoptera* Germar, and *Philaenus* Stål—are recognized as occurring in North America north of Mexico. Several members of the last three of these genera are shown in the companion paper of this issue (Severin, 1950)⁴ to be vectors of the virus of Pierce's disease of grapevines and alfalfa dwarf. These are the ones described in this paper. They are:

Aphrophora angulata Ball

Aphrophora permutata Uhler

Clasoptera brunnea Ball

Philaenus leucophthalmus (Linnaeus), varieties *leucophthalmus* (Linnaeus), *pallidus* (Zetterstedt), *fabricii* Van Duzee, *marginellus* (Fabricius), *spumarius* (Fallen), and *impressus* n. var.

¹ Received for publication May 18, 1948.

² Professor of Entomology, Ohio State University, Columbus, Ohio. R. V. Hershberger, Ohio State University, prepared the drawings.

³ Entomologist in the Experiment Station.

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

APHROPHORA ANGULATA

Characters. *Aphrophora angulata* Ball (fig. 1) is easily separated from all others of the genus by its broad elytra with the wide costal margins and two rather large but obscure pale spots. Its length is 10 mm.

The vertex (fig 1, *A*) is flat, scarcely longer in the middle than next to the eye. The median carina is weak on the tylus but is stronger on the posterior

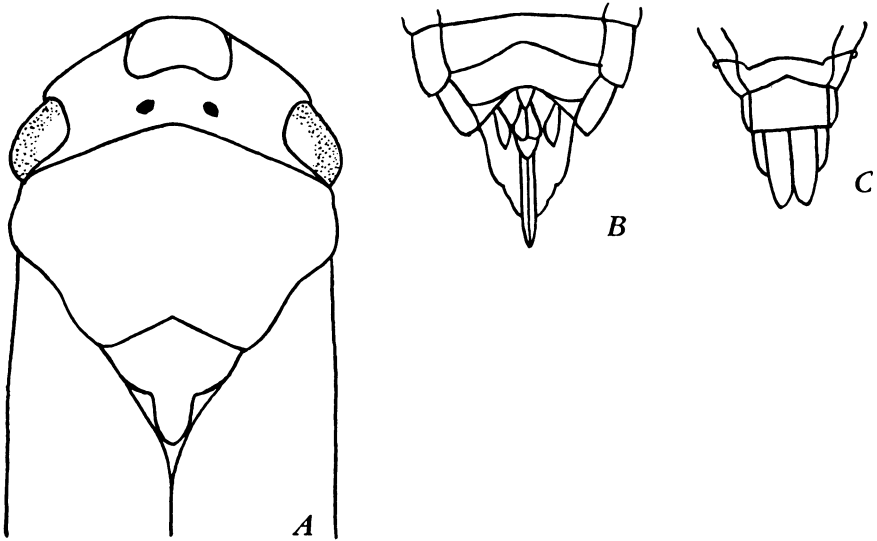


Fig. 1. *Aphrophora angulata* Ball: *A*, dorsal view of head, pronotum, and scutellum of female; *B*, ventral view of apical portion of female abdomen; *C*, ventral view of apical portion of male abdomen.

portion of the vertex. The margin is sharp as far as the tylus. The front is weakly inflated and forms an acute angle with the vertex. The median carina on the anterior depressed third of the pronotum is strong; the carina is weak on the elevated posterior portion. The anterior portion is finely punctate; the posterior portion is coarsely pitted. The elytra are quite broad at the middle and are roundedly angulate posteriorly. The anterior costal area is broadly flared.

The color is pale grayish brown, the vertex and anterior half of the pronotum are lighter. There is a distinct spot on the costa at the middle, broadening and usually fading toward the inner side of the disk. At the base there is an obscure spot on the costal margin and another deeper-brown obscure marginal spot at the apex.

The female last ventral segment (fig. 1, *B*) is weakly convex. The pygofers are exceeded by the ovipositor one fourth their length.

The male plates (fig. 1, *C*) are very short and are fused; their length is

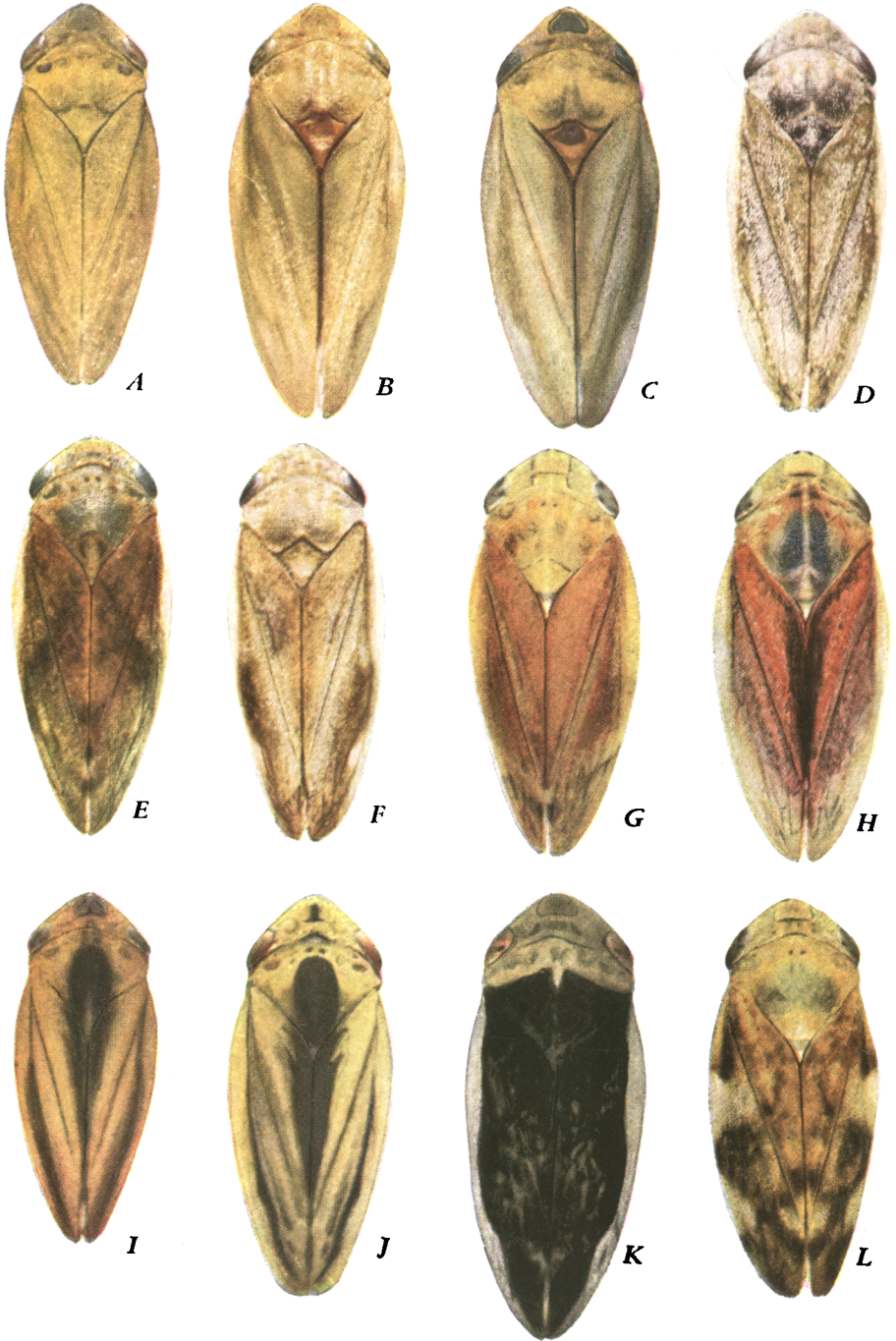


Plate 1. Color patterns of adults in four varieties of *Philaenus leucophthalmus* (Linnaeus): *A, E, F, G*, males, *B, C, D, H*, females, var. *leucophthalmus* (Linnaeus); *I*, male, *J*, female, var. *fabricii* Van Duzee; *K*, female, var. *marginellus* (Fabricius); *L*, female, var. *spumarius* (Fallen).

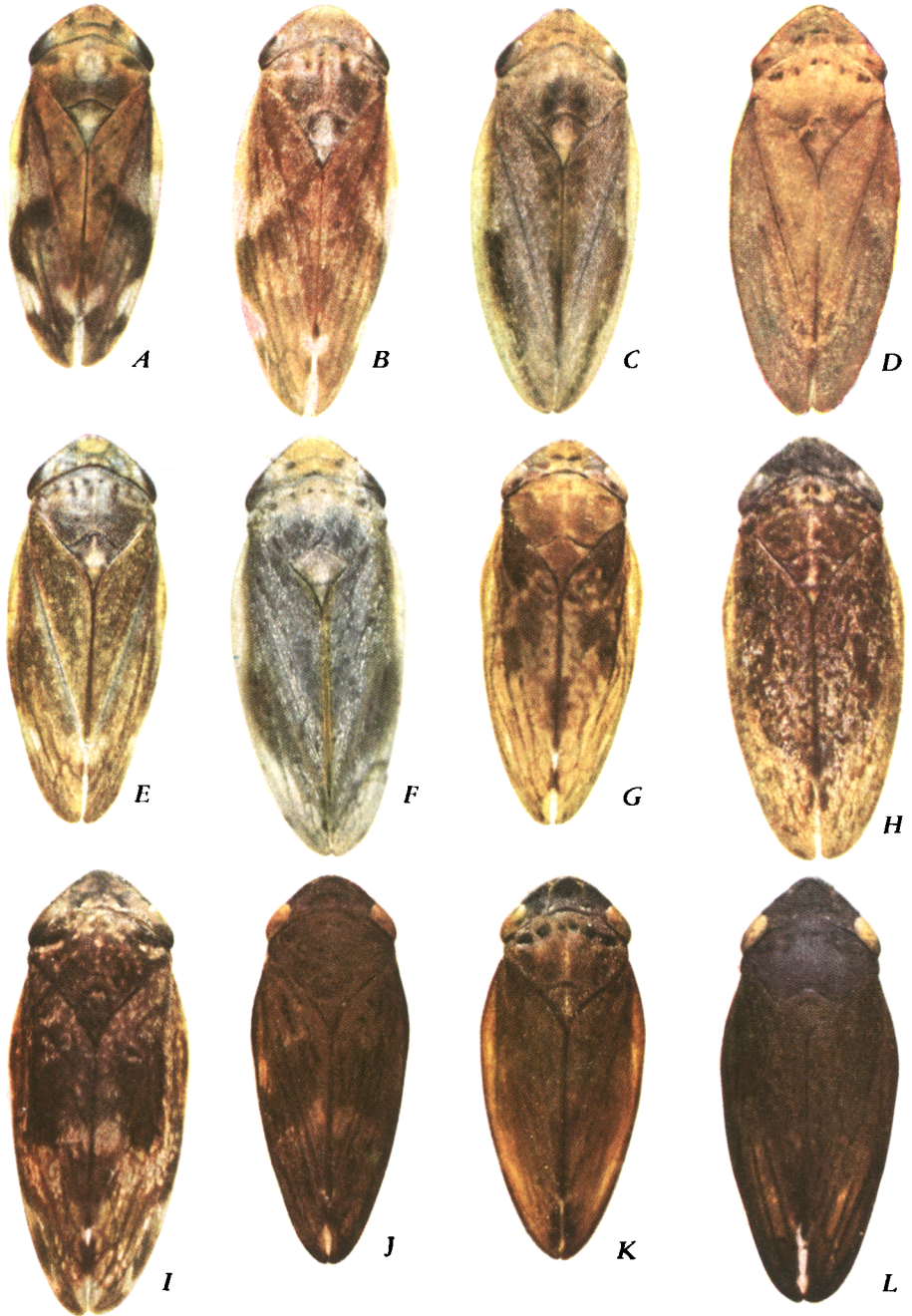


Plate 2. Color patterns of adults of *Philaenus leucophthalmus* var. *pallidus* (Zetterstedt): A, B, E, G, J, K, males; C, D, F, H, I, L, females.

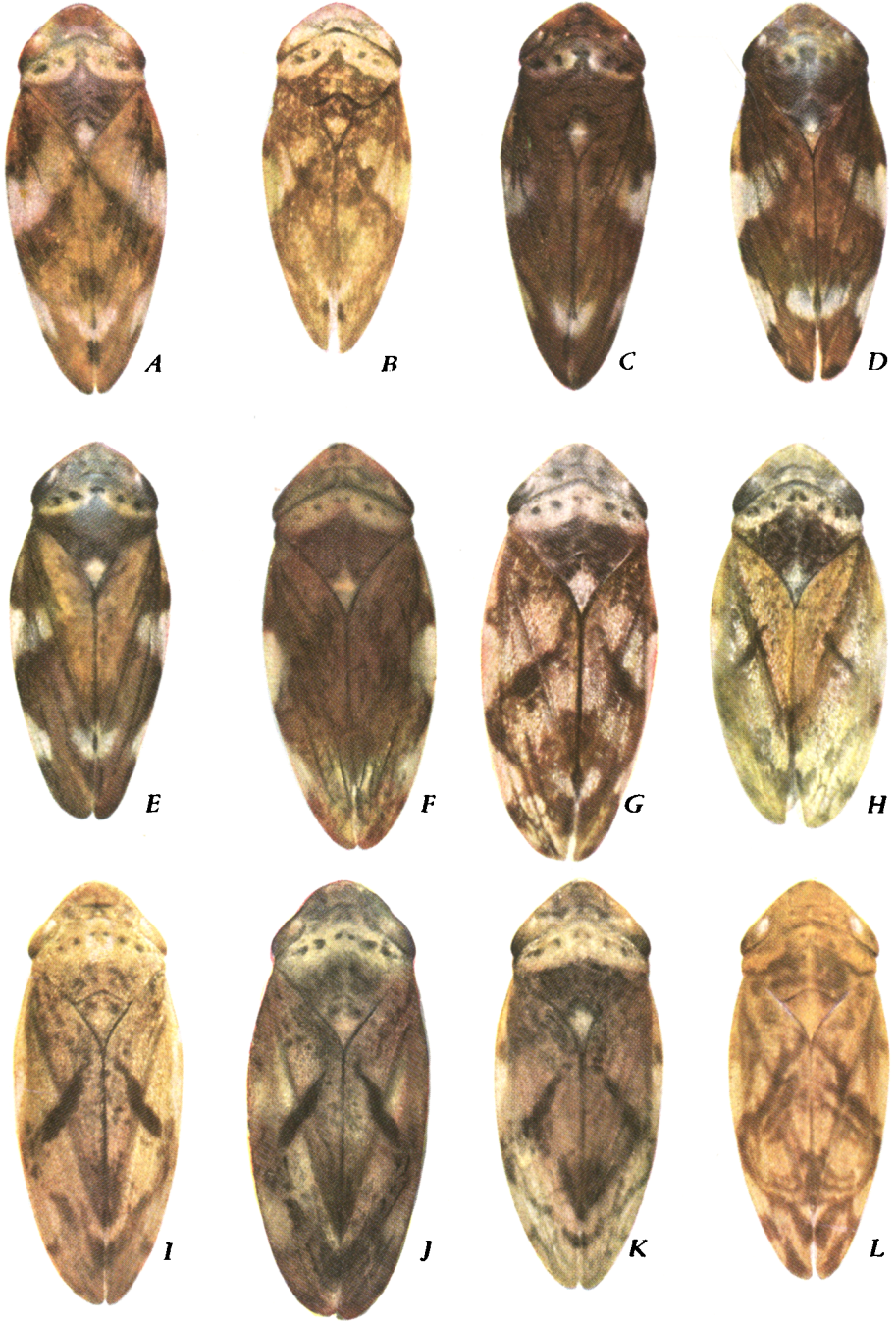


Plate 3. Color patterns of adults of *Philaenus leucophthalmus* var. *impressus* n. var.:
A, C, D, E, males; B, F, G, H, I, J, K, L, females.

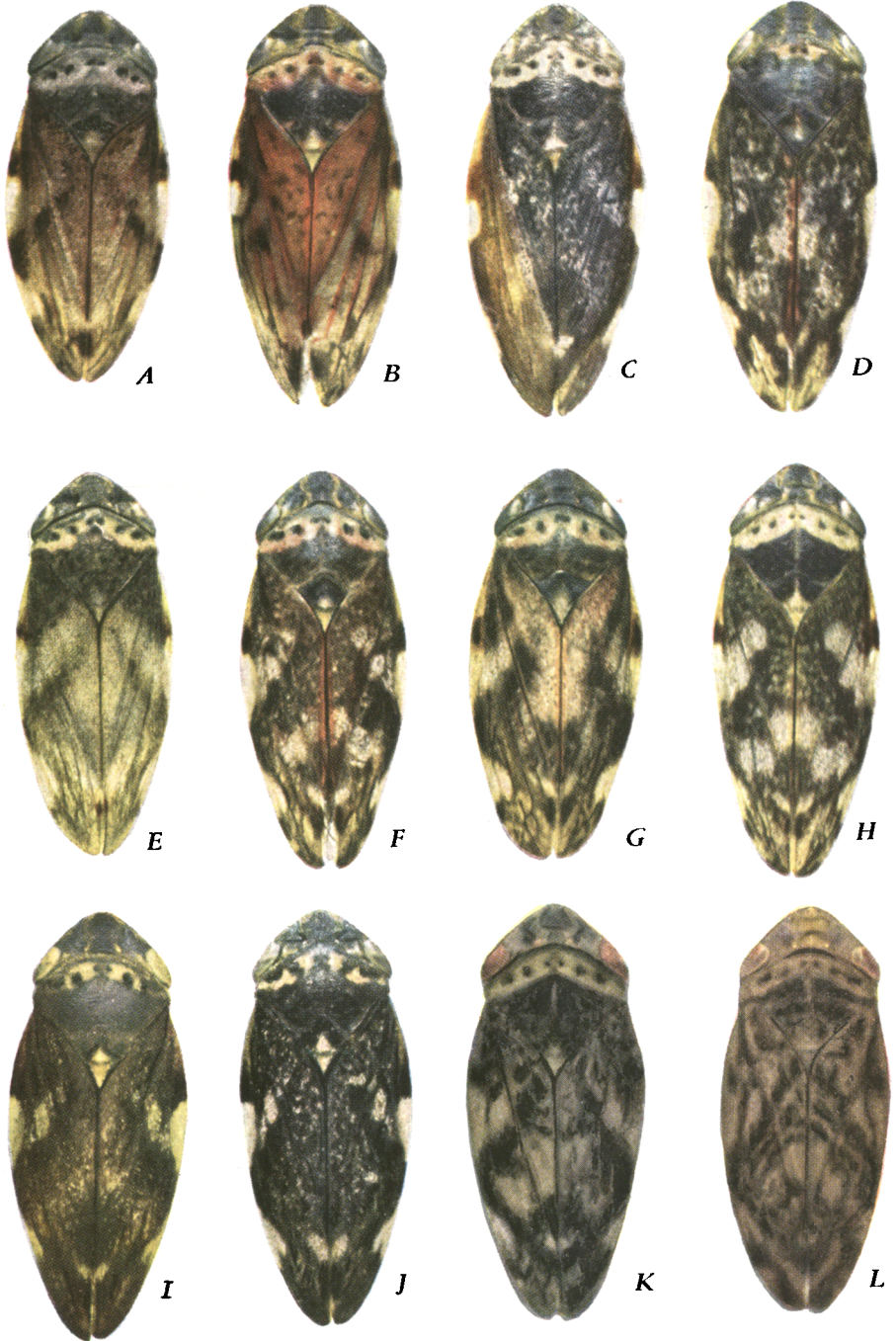


Plate 4. Color patterns of adults of *Philaenus leucophthalmus* var. *impressus* n. var., females.

greater than the width. The male apex (also shown in fig. 1, *C*) is broadly truncate and has a median notch, on either side of which it is slightly emarginate to the produced lateral angles.

Distribution in General. This species was originally described from California by Ball (1898) and has since been taken in many localities in this state. It has not been recorded in other areas.

Distribution and Food and Breeding Plants in California. The food and breeding plants on which nymphs and adults of *Aphrophora angulata* were collected in California, and the locality records and dates of collection, are as follows:

Boraginaceae:

Amsinckia intermedia, annual; San Mateo County: Atherton, April 24, 1947

Compositae:

Achillea millefolium, common yarrow or milfoil, perennial herb; San Mateo County: Atherton, April 27, 1947

Artemisia vulgaris, California mugwort, perennial; San Mateo County: Atherton, April 24, 1947

Cirsium lanceolatum, bull thistle, biennial; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Madia elegans, common madia, annual; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946

Silybum marianum, milk thistle, annual or biennial herb; San Mateo County: Atherton, April 24, 1947

Gramineae:

Avena fatua, wild oat, annual; San Mateo County: Atherton, April 24, 1947

Labiatae:

Stachys ajugoides, herb; San Mateo County: Atherton, May 2, 1947; Alameda County: Berkeley (Strawberry Canyon), May 14, 1947

Stachys bullata, herb; San Mateo County: Atherton, May 2, 1947

Leguminosae:

Medicago hispida, bur clover, annual; San Mateo County: Atherton, April 24, 1947

Melilotus indica, yellow melilot, annual herb; Alameda County: Berkeley hills, April 28, 1947

Vicia americana, American vetch, perennial; San Mateo County: Atherton, April 24, 1947

Liliaceae:

Chlorogalum pomeridianum, soap plant, bulbous herb; Alameda County: Berkeley (Strawberry Canyon), May 2, 1946

Polygonaceae:

Rumex conglomeratus, green dock, perennial; Alameda County: Berkeley (Strawberry Canyon), April 18, 1946

Portulacaceae:

Montia perfoliata, miner's lettuce, annual; San Mateo County: Atherton, April 24, 1947

Ranunculaceae:

Ranunculus californicus, California buttercup, perennial; San Mateo County: Atherton, April 24, 1947

Rosaceae:

Rubus procerus, Himalaya-berry, shrub; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Rubiaceae:

Galium aparine, goose grass, annual; Alameda County: Berkeley hills, May 5, 1946

Umbelliferae:

Sanicula liberta (*S. crassicaulis*), gamble weed, perennial; San Mateo County: Atherton, April 24, 1947

APHROPHORA PERMUTATA

Characters. The color of *Aphrophora permutata* Uhler (fig. 2) is variable, but the two oblique dark-margined, light bands on the elytra and the long fingerlike male plates will distinguish this species from its close relatives. Its length is 9 to 12 mm.

The vertex (fig. 2, *A*) is about one fourth longer in the middle than at the eye and is sloping or transversely depressed. The anterior margin is rather thick. The front is moderately inflated and produced anteriorly, forming a right angle with the vertex. The disk of the pronotum is elevated and the portion before the middle is somewhat depressed.

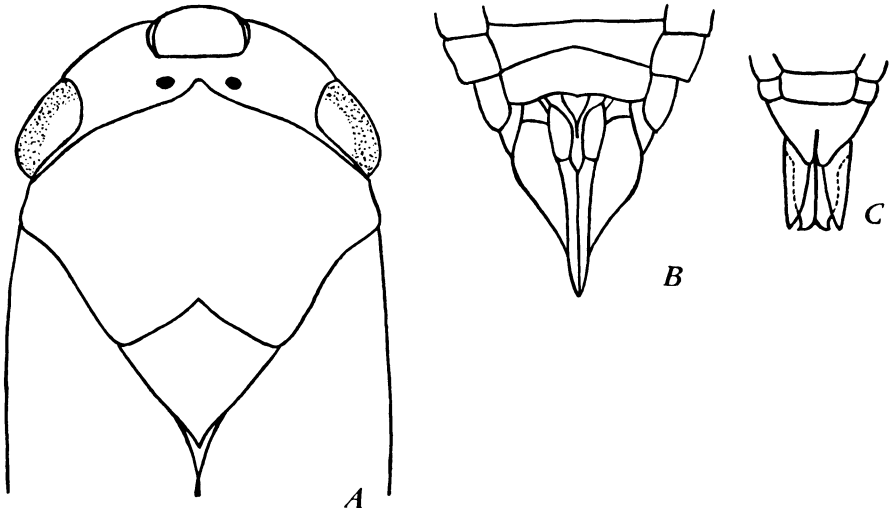


Fig. 2. *Aphrophora permutata* Uhler: *A*, dorsal view of head, pronotum, and scutellum of female; *B*, ventral view of apical portion of female abdomen; *C*, ventral view of apical portion of male abdomen.

The color is variable from brownish yellow to rusty brown. The vertex is tawny with darker punctures and light carina. The pronotum is grayish with tawny or brownish punctures. The grayish-brown elytra have coarse darker punctures and are crossed with two oblique dark-margined light bands. One band extends from the scutellum to the center of the corium, the other from in front of the apex of the clavus transversely onto the corium, then obliquely back to the costa.

The female pygofers and ovipositor (fig. 2, *B*) are short and compact and thickly set with coarse hairs. The male plates (fig. 2, *C*) are long and finger-like, and taper to narrow apices which are slightly divergent.

Distribution in General. This species was described from specimens collected in Colorado, Utah, and California by Uhler (1876). It has since been recorded for British Columbia, Washington, Oregon, Idaho, Montana, New Mexico. It is probably the most common western species of this genus.

Distribution and Food and Breeding Plants in California. *Aphrophora permutata* occurs not only in the fog belt but also on wild vegetation and ornamentals in grape- and alfalfa-growing districts in the interior regions of the state. In addition to the following food and breeding plants in various localities in California, it has been taken in many localities of the pine areas of the Sierra Nevada.

Anacardiaceae:

Rhus diversiloba, poison oak, shrub; Alameda County: Berkeley hills, April 28, 1946

Compositae:

Anaphalis margaritacea, pearl everlasting, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Artemisia vulgaris, California mugwort, perennial; Alameda County; Berkeley (Strawberry Canyon), April 18, 1947

Chrysanthemum sp., perennial; Alameda County: Berkeley, April 20, 1946; Yolo County: Davis, April 28, 1946, B. R. Houston

Crepis capillaris, smooth hawkbeard, annual or biennial; Alameda County: Berkeley (campus, University of California), April 18, 25, 1947

Hypochoeris glabra, smooth cats-ear, annual; San Mateo County: Atherton, April 29, 1946

Hypochoeris radicata, hairy cats-ear, annual; San Mateo County: Atherton, April 29, 1946

Picris echioides, bristly ox-tongue, biennial; San Mateo County: Sharp Park, February 25, 26, March up to the middle of April, 1947, 1948; Alameda County: Berkeley (Strawberry Canyon), April 14, 1946; (campus, University of California), April 26, 1946; Niles, April 29, 1946

Sonchus asper, prickly sow-thistle, annual; Alameda County: Berkeley (campus, University of California), April 20, 1946, April 25, 1947

Sonchus oleraceus, common sow-thistle, annual; San Mateo County, April 29, 1946

Taraxacum officinale (*T. vulgare*), common dandelion, perennial herb; Alameda County: Berkeley (Strawberry Canyon), April 28, 1947

Cruciferae:

Raphanus sativus, wild radish, annual; Alameda County: Berkeley (campus, University of California), May 2, 1946

Cucurbitaceae:

Echinocystis fabacea, common man-root, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1947

Dipsaceae:

Dipsacus fullonum, fullers teasel, biennial herb; Alameda County: Berkeley (Strawberry Canyon), April 18, 1947

Geraniaceae:

Erodium botrys, annual; San Mateo County: Atherton, April 29, 1946

Erodium moschatum, white-stem filaree, annual; Alameda County: Berkeley (campus, University of California), May 2, 1946

Geranium dissectum, common geranium, annual; Alameda County: Berkeley (campus, University of California), May 2, 1946

Leguminosae:

Lupinus pachylobus, annual; San Mateo County: Atherton, April 29, 1946

Medicago hispida, bur clover, annual; San Mateo County: Atherton, May 2, 1946; Alameda County: Berkeley (campus, University of California), April 25, 1947

Melilotus indica, yellow melilot, biennial herb; Alameda County: Berkeley (Strawberry Canyon), April 18, 1947

Vicia americana, American vetch, perennial; Alameda County: Berkeley (campus, University of California), April 24, 1946

Malvaceae:

Malva parviflora, cheese-weed, annual or biennial; Alameda County: Berkeley (campus, University of California), April 29, 1946

Liliaceae:

Chlorogalum pomeridianum, soap plant, bulbous herb; Alameda County: Berkeley (Strawberry Canyon), April 18, May 2, 14, 1946

Pinaceae:

Pinus halepensis, Aleppo pine; San Mateo County: Sharp Park, June 28, July 25, 1945; July 8, 15, 23, 1946

Pinus radiata, Monterey pine; San Mateo County: Sharp Park, June 28, July 25, 1945; July 8, 15, 23, 1946

Pinus sp., Napa County, 3 miles east of St. Helena, two males, August 30, 1945

Polygonaceae:

Rumex conglomeratus, green dock, perennial; Alameda County: Berkeley (Strawberry Canyon), April 18, May 14, 1946

Rumex crispus, curly dock, perennial; Alameda County: Berkeley (campus, University of California), April 25, 1947

Portulacaceae:

Montia perfoliata, miner's lettuce, annual; San Mateo County: Atherton, May 2, 1946

Primulaceae:

Anagallis arvensis, poor man's weatherglass, annual; Alameda County: Berkeley (campus, University of California), April 28, 1946

Rosaceae:

Rubus procerus, Himalaya-berry, shrub; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Rubus vitifolius, California blackberry, perennial bush; Alameda County: Berkeley (Strawberry Canyon), May 5, 14, 1946; April 28, 1947; Sonoma County: Sebastopol, April 25, 1947, D. D. Jensen

Umbelliferae:

Sanicula liberta (*S. crassicaulis*), gamble weed, perennial; Alameda County: Berkeley (Strawberry Canyon), May 5, 14, 1946; April 28, 1947

Urticaceae:

Urtica californica, coast nettle, herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946

CLASTOPTERA BRUNNEA

Ball (1919) originally described *Clastoptera brunnea* (fig. 3) as *C. lineaticollis* var. *brunnea* and gave a brief description of the color pattern.

Doering (1928) gave specific ranking to this species and gave a detailed description of the color, structural details, and external and internal genitalia.

Characters. The members of the genus *Clastoptera* are small and globose. The males of *C. brunnea* may be black or dark gray with dark markings. The females are yellow to brown with dark-brown transverse lines on the vertex and pronotum. The female is 3.45 to 3.75 mm long, the male, 3.0 to 3.3 mm.

The vertex (fig. 3, A) is slightly carinated on the anterior margin. The ocelli are nearer the anterior margin of the vertex than the pronotum and the distance between the two ocelli is less than the distance between each ocellus and the eye. The front is extended beyond the vertex from one half of two thirds the length of the vertex. The postclypeus is moderately inflated, its length is approximately three times the length of the anteclypeus. The pronotum, with its anterior margin roundedly produced, is crossed by six to eight distinct, slightly depressed dark bands, which are interrupted before the lateral margins. The scutellum is about twice as wide as it is long. The elytra are about two and one half times as long as they are wide, with the

base of the costal margin slightly flaring. They appear parallel-margined as far as the apical fourth, where they curve sharply to form the apex.

In color the front is yellow, bordered anteriorly with brown. The vertex is yellow with an anterior black border usually reaching the ocelli. The face is either entirely shining black or may have faint markings in the form of 6 or 7 pairs of yellow arcs. The mandibular sclerites are sometimes yellow. The scutellum is yellow with a brown band across the middle, and two large triangular brown spots between this band and the base of the scutellum. The

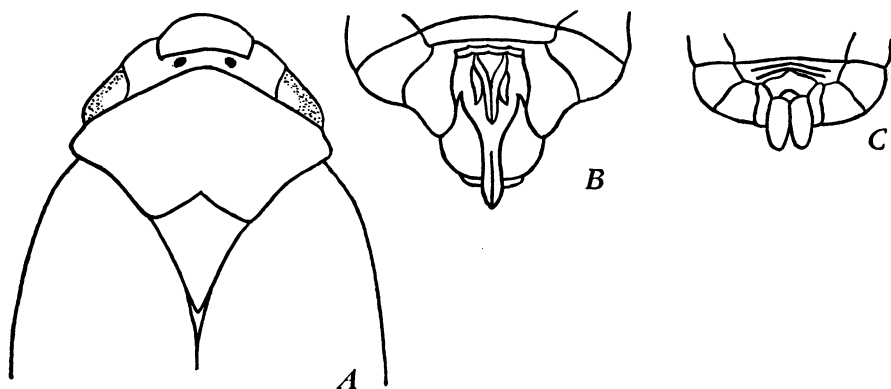


Fig. 3. *Clastophora brunnea* (Ball): A, dorsal view of head, pronotum, and scutellum; B, ventral view of apical abdomen; C, ventral view of apical portion of male abdomen.

elytra are yellow, the clavus bronze fuscous, and the corium fuscous. Posterior to a distinct yellow spot midway on the costal margin is a darker brownish oblique area. There is a small dark spot on the costal margin at the apex.

The female pygofer (fig. 3, B) is slightly wider than long. The male plates (fig. 3, C) are broad at the base; the inner margins are rounded to blunt apices. The styles are one fourth to one fifth longer than the plates.

Distribution in General. The distribution includes Oregon, California, Colorado, Nevada, North Dakota, Utah, and British Columbia.

Distribution and Food and Breeding Plants in California. *Clastophora brunnea* has been taken on the following food and breeding plants:

Compositae:

Artemisia californica, California mugwort, evergreen shrub; San Mateo County: Montara, June 28, July 25, 1945; July 16, 23, August 29, 1946

Baccharis pilularis, coyote brush or chaparral broom, shrub; San Mateo County: Montara, June 12, 1945; Crystal Springs Reservoir, May 8, 15, 31, June 17, 1946; Alameda County: Berkeley (Strawberry Canyon), May 17, 1946; Marin County: Mare Island, June 28, July 25, 1946

Baccharis viminea, mule fat, shrub; Marin County: Mare Island, July 25, 29, September 6, 12, October 10, 1946

Grindelia camporum, gum plant, perennial herb; Marin County: Mare Island, July 25, 29, September 6, 12, 1946

PHILAENUS LEUCOPHTHALMUS

Characters. *Philaenus leucophthalmus* (Linnaeus) (fig. 4) is so variable in color that those showing various color patterns are separated under different varietal names (page 354). But in form, including genitalia, these varieties are alike.

The species is broad and short, with a length of 5.5 to 6.5 mm.

The vertex (fig. 4, *A*) is short, twice as wide as the median length, sloping, and with the anterior margin obtusely angled. It is slightly more than one half the length of the pronotum. The tylus is more than one half the length of the vertex and broader than it is long. The ocelli are close to the posterior

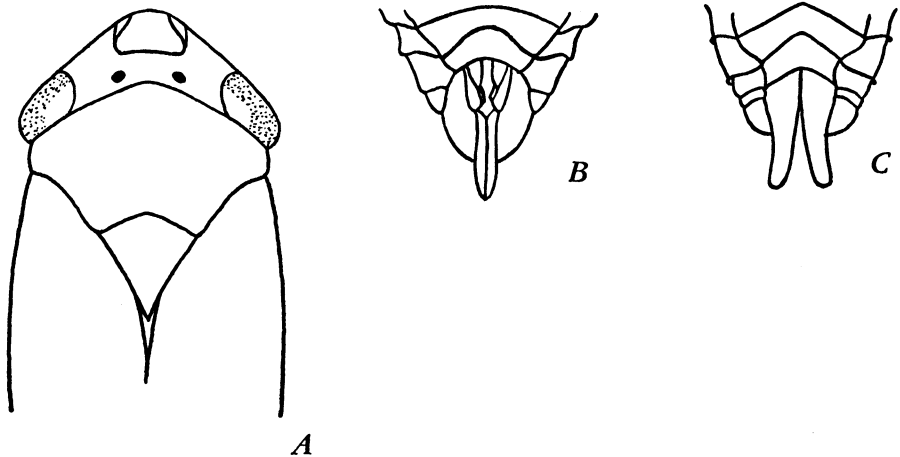


Fig. 4. *Philaenus leucophthalmus* (Linnaeus): *A*, dorsal view of head, pronotum, and scutellum; *B*, ventral view of apical portion of female abdomen; *C*, ventral view of apical portion of male abdomen.

margin and are about equidistant from each other and from the eyes. The pronotum is roundedly angled in front and deeply pitted back of the margin. The elytra are broad, with the costal margin strongly convex, being reflexed before the middle to form a flaring margin.

The female pygofers (fig. 4, *B*) are broader than they are long, and the ovipositor is short. The male plates (fig. 4, *C*) are broad at the base and tapered to long fingerlike processes.

Distribution in General. This species apparently occurs throughout the United States.

Davis and Mitchell (1946) record 58 species of plants on which nymphs of *Philaenus spumarius* (Linnaeus) were collected at Kilauea, Hawaii National Park.

Distribution and Food and Breeding Plants in California. One or more of the six varieties of the meadow spittle insect, *Philaenus leucophthalmus*, were taken on the following food and breeding plants in California.

Anacardiaceae:

Rhus diversiloba, poison oak, shrub; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946

Apocynaceae:

Vinca major, evergreen herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946

Araceae:

Zantedeschia aethiopica, calla of gardeners; perennial, rhizomatous herbs; San Francisco County: San Francisco, May 8, 1947

Araliaceae:

Hedera canariensis, common ivy, shrub; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946, May 2, 1947

Hedera helix, English ivy, shrub; San Francisco County: San Francisco, April 22, 1947

Boraginaceae:

Heliotropium arborescens (*H. peruvianum*), common heliotrope, herb; San Francisco County: San Francisco, May 8, 1947

Myosotis scorpioides, true forget-me-not, perennial; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947; San Francisco County: San Francisco, May 8, 1947

Campanulaceae:

Campanula persicifolia, perennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946, May 2, 5, 1947; San Francisco County: San Francisco, May 8, 1947

Caprifoliaceae:

Sambucus caerulea (*S. glauca*), blue elderberry, deciduous shrub; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946

Caryophyllaceae:

Dianthus barbatus, sweet william, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 5, 1947

Dianthus caryophyllus, carnation, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Dianthus plumarius, common grass or garden pink, perennial herb; Alameda County: Berkeley, May 8, 1946; Strawberry Canyon, May 5, 1947; San Francisco County: San Francisco, May 8, 1947

Saponaria officinalis, bouncing Bet, perennial herb; Alameda County: Berkeley, May 8, 1946

Stellaria media, chickweed, annual; Alameda County: Berkeley (Strawberry Canyon), April 18, May 2, 5, 1947

Cistaceae:

Helianthemum nummularium (*H. chamaecistus*), sun-rose, subshrub; Alameda County: Berkeley (Strawberry Canyon), May 2, 5, 1947

Commelinaceae:

Tradescantia fluminensis, wandering Jew, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946

Compositae:

Anaphalis margaritacea, pearl everlasting, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Artemisia vulgaris, California mugwort, perennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946, April 28, 1947

Baccharis pilularis, coyote brush or chaparral broom, shrub; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946

Carduus pycnocephalus (*C. tenuiflorus*), biennial herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946

Chrysanthemum maximum, shasta daisy, short-lived perennial, sometimes treated as a biennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1947

Cirsium lanceolatum, bull thistle, biennial; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947

Cynara scolymus, artichoke, perennial; San Francisco County: San Francisco, April 22, 1947

Dahlia sp., perennial; San Francisco County: San Francisco, May 8, 1947

- Felicia petiolata*, subshrub; Alameda County: Berkeley (Strawberry Canyon), May 5, 1947
- Gaeania rigens*, perennial herb; San Francisco County: San Francisco, May 8, 1947
- Hypochoeris glabra*, smooth cats-ear, annual; Alameda County: Berkeley, May 14, 1946
- Madia elegans*, common madia, annual; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Pieris echinoides*, bristly ox-tongue, biennial; San Francisco County: San Francisco, April 22, 1947; Alameda County: Berkeley (Strawberry Canyon), May 14, 1947
- Rudbeckia laciniata* var. *hortensia*, golden glow, perennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946
- Sonchus asper*, prickly sow-thistle, annual; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946; San Francisco County: San Francisco, April 22, 1947
- Sonchus oleraceus*, common sow-thistle, annual; San Francisco County: San Francisco, April 22, 1947
- Tanacetum vulgare*, common tansy, perennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946
- Taraxacum officinale* (*T. vulgare*), common dandelion, perennial herb; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946; San Francisco County: San Francisco, April 22, 1947
- Tragopogon porrifolius*, salsify, biennial; San Francisco County: San Francisco, April 22, 1947
- Convolvulaceae:
- Convolvulus arvensis*, bindweed or orchard morning-glory, perennial; San Francisco County: San Francisco, April 22, 1947
- Ipomoea muricata* (*Convolvulus muricatus*), perennial herb; Alameda County: Berkeley, May 8, 1946
- Cruciferae:
- Cheiranthus cheiri*, wallflower, perennial; San Francisco County: San Francisco, May 8, 1947
- Mathiola incana*, stock or gilliflower, biennial or perennial; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947
- Raphanus sativus*, wild radish, annual; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947
- Cucurbitaceae:
- Echinocystis fabacea*, common man-root; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Geraniaceae:
- Pelargonium domesticum*, Lady Washington geranium, perennial; San Francisco County: San Francisco, April 29, 1946, April 22, 1947; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947
- Pelargonium graveolens*, rose geranium, perennial; San Francisco County: San Francisco, May 8, 1947
- Pelargonium hortorum*, fish geranium, perennial; San Francisco County: San Francisco, May 8, 1947
- Pelargonium peltatum*, ivy geranium, perennial; San Francisco County: San Francisco, May 8, 1947
- Gramineae:
- Elymus saxatile*, perennial; Alameda County: Berkeley (Strawberry Canyon), May 17, 1946
- Hordeum murinum*, farmer's foxtail or wall barley, annual; San Francisco County: San Francisco, April 22, 1947
- Hypericaceae:
- Hypericum moserianum*, gold-flower, subshrub; Alameda County: Berkeley, May 8, 1947
- Iridaceae:
- Gladiolus* sp., perennial; Alameda County: Berkeley (Strawberry Canyon), April 18, 1947; San Francisco County: San Francisco, April 22, May 5, 1947
- Labiatae:
- Majorana hortensis*, sweet marjoram, perennial herb or subbrush; San Francisco County: San Francisco, July 5, 1944

- Origanum vulgare*, wild marjoram, aromatic herb; San Francisco County: San Francisco, July 5, 1944
- Mentha spicata*, spearmint, perennial; Alameda County: Berkeley, May 2, 1946
- Nepeta mussinii*, perennial; Alameda County: Berkeley, May 2, 1946
- Rosmarinus officinalis*, rosemary, shrub; San Francisco County: San Francisco, July 5, 1944
- Salvia coccinea*, Texas sage, subshrub; Alameda County: Berkeley, April 25, 1947
- Salvia officinalis*, narrow-leaf or garden sage, subshrub; San Francisco County: San Francisco, July 5, 1944
- Stachys ajugoides*, herb; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947
- Stachys bullata*, herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Thymus vulgaris*, common thyme, subshrub; San Francisco County: San Francisco, July 5, 1944
- Leguminosae:
- Medicago sativa*, alfalfa, perennial; Alameda County: Berkeley (Strawberry Canyon), May 14, 1947
- Melilotus indica*, yellow melilot, biennial herb; Alameda County: Berkeley (Strawberry Canyon), April 18, 1947
- Liliaceae:
- Chlorogalum pomeridianum*, soap plant, bulbous herb; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Malvaceae:
- Althaea rosea*, hollyhoek, biennial; San Francisco County: San Francisco, April 22, 1947; Alameda County: Berkeley (Strawberry Canyon), May 2, 1947
- Malva parviflora*, cheese-weed, annual or biennial; San Francisco County: San Francisco, April 22, 1947
- Myrtaceae:
- Leptospermum laevigatum*, Australian tea-tree, shrub; San Francisco County: San Francisco, April 29, 1946
- Onagraceae:
- Fuchsia triphylla*, shrub; San Francisco County: San Francisco, May 8, 1947
- Papaveraceae:
- Eschscholtzia californica*, California poppy, perennial; San Francisco County: San Francisco, May 8, 1947
- Papaver orientale*, Oriental poppy, perennial; San Francisco County: San Francisco, April 22, 1947
- Papaver rhoeas*, corn poppy, annual; San Francisco County: San Francisco, May 8, 1947
- Plantaginaceae:
- Plantago lanceolata*, ribwort or English plantain, perennial; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946; April 28, 1947
- Polygonaceae:
- Rumex acetosella*, sheep sorrel, perennial; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Rumex conglomeratus*, green dock, perennial; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946
- Rumex crispus*, curly dock, perennial; San Francisco County: San Francisco, April 22, 1947
- Ranunculaceae:
- Aquilegia chrysantha*, golden columbine, perennial; Alameda County: Berkeley (Strawberry Canyon), May 5, 1947
- Ranunculus repens* var. *pleniflorus*, double-flowered creeping buttercup, perennial; Alameda County: Berkeley, May 8, 1947
- Rosaceae:
- Chaenomeles lagenaria*, Japanese quince, shrub; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946
- Fragaria chiloensis*, strawberry, perennial; San Francisco County: San Francisco, May 2, 1947

- Prunus armeniaca*, common apricot, tree; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946
- Prunus* sp., plum, tree; Alameda County: Berkeley (Strawberry Canyon), May 2, 5, 1947
- Rubus parviflorus*, thimble-berry, perennial bush; Alameda County: Berkeley (Strawberry Canyon), May 2, 5, 1947
- Rubus procerus*, Himalaya-berry, shrub; Alameda County: Berkeley (Strawberry Canyon), May 2, 5, 1947
- Rubus vitifolius*, California blackberry, perennial bush; Alameda County: Berkeley (Strawberry Canyon), April 18, 28, 1947
- Rubiaceae:
- Galium aparine*, goose grass, annual; Alameda County: Berkeley hills, May 5, 1946; Berkeley (Strawberry Canyon), May 2, 1947
- Galium verum*, yellow bedstraw, perennial; Alameda County: Berkeley, May 8, 1947
- Saxifragaceae:
- Heuchera sanguinea*, coral-bells, perennial; San Francisco County: San Francisco, April 22, 1947; Alameda County: Berkeley (Strawberry Canyon), May 7, 1947
- Hydrangea paniculata* var. *grandiflora*, peegee hydrangea, shrub; San Francisco County: San Francisco, May 8, 1947
- Ribes sativum*, common or garden currant, shrub; Alameda County: Berkeley (Strawberry Canyon), May 5, 1947
- Scrophulariaceae:
- Scrophularia californica*, perennial herb; San Francisco County: San Francisco, May 8, 1947
- Solanaceae:
- Cestrum purpureum* (*C. elegans*), shrub; San Francisco County: San Francisco, May 2, 1947
- Umbelliferae:
- Apium graveolens* var. *dulce*, celery, biennial, perhaps sometimes perennial; San Francisco County: San Francisco, April 22, 1947
- Conium maculatum*, poison-hemlock, biennial; Alameda County: Berkeley (Strawberry Canyon), May 13, 1946
- Daucus carota* var. *sativa*, cultivated carrot, annual or biennial; San Francisco County: San Francisco, April 22, 1947
- Petroselinum crispum* (*P. hortense*), parsley, biennial or short-lived perennial; San Francisco County: San Francisco, April 22, 1947
- Sanicula liberta* (*S. crassicaulis*), gamble weed, perennial; Alameda County: Berkeley (Strawberry Canyon), May 14, 1946, April 28, 1947
- Valerianaceae:
- Centranthus ruber*, red valerian or Jupiters-beard, perennial; San Francisco County: San Francisco, May 8, 1947
- Verbenaceae:
- Verbena rigida* (*V. venosa*), herbaceous perennial; San Francisco County: San Francisco, May 8, 1947
- Violaceae:
- Viola odorata*, sweet, garden, or florists violet, perennial herb; San Francisco County: San Francisco, April 22, 1947

Color Forms. The different color forms of *Philaenus leucophthalmus* (Linnaeus) represented in California which have been concerned with virus transmission are:

Var. *leucophthalmus* (Linnaeus) (plate 1, A-H): This color form is uniformly dark brown or blackish, often with small areas of yellow on the vertex and elytra.

Var. *pallidus* (Zetterstedt) (plate 2, A-L): This varietal form is paler but rather uniform in color, either yellowish or yellowish brown.

Var. *fabricii* Van Duzee (plate 1, *I-J*): This color variety is rather distinctly marked with longitudinal stripes. There is a brown stripe on the inner margins of the elytra and on the corium. There is a broad yellow stripe on the claval suture.

Var. *marginellus* (Fabricius) (plate 1, *K*): This color form is usually distinctly marked. The vertex and anterior half of pronotum are yellow, the posterior half of pronotum dark brown to black, and the elytra dark brown or black with the costal margins pale yellow.

Var. *spumarius* (Fallen) (plate 1, *L*): In this variety the intensity of color may range from yellowish to brown but in every case there are two white spots on the costal margin which may vary from quite small marginal spots to elongated spots extending across the elytra.

Var. *impressus* n. var. (plates 3, 4): In this color form both the intensity of pigment and its distribution may vary greatly. However, all specimens have a row of four impressed dark pigment spots arranged transversely across the anterior pale portion of the pronotum. As a rule the vertex is dark, the anterior portion of the pronotum is light, and the posterior portion of pronotum and the scutellum are dark brown. The elytra are usually dark brown with pale costal spots or oblique pale bands.

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