BULLETIN OF THE CALIFORNIA INSECT SURVEY

VOLUME 11

THE CEPHID STEM BORERS OF CALIFORNIA

(Hymenoptera: Cephidae)

BY

WOODROW W. MIDDLEKAUFF

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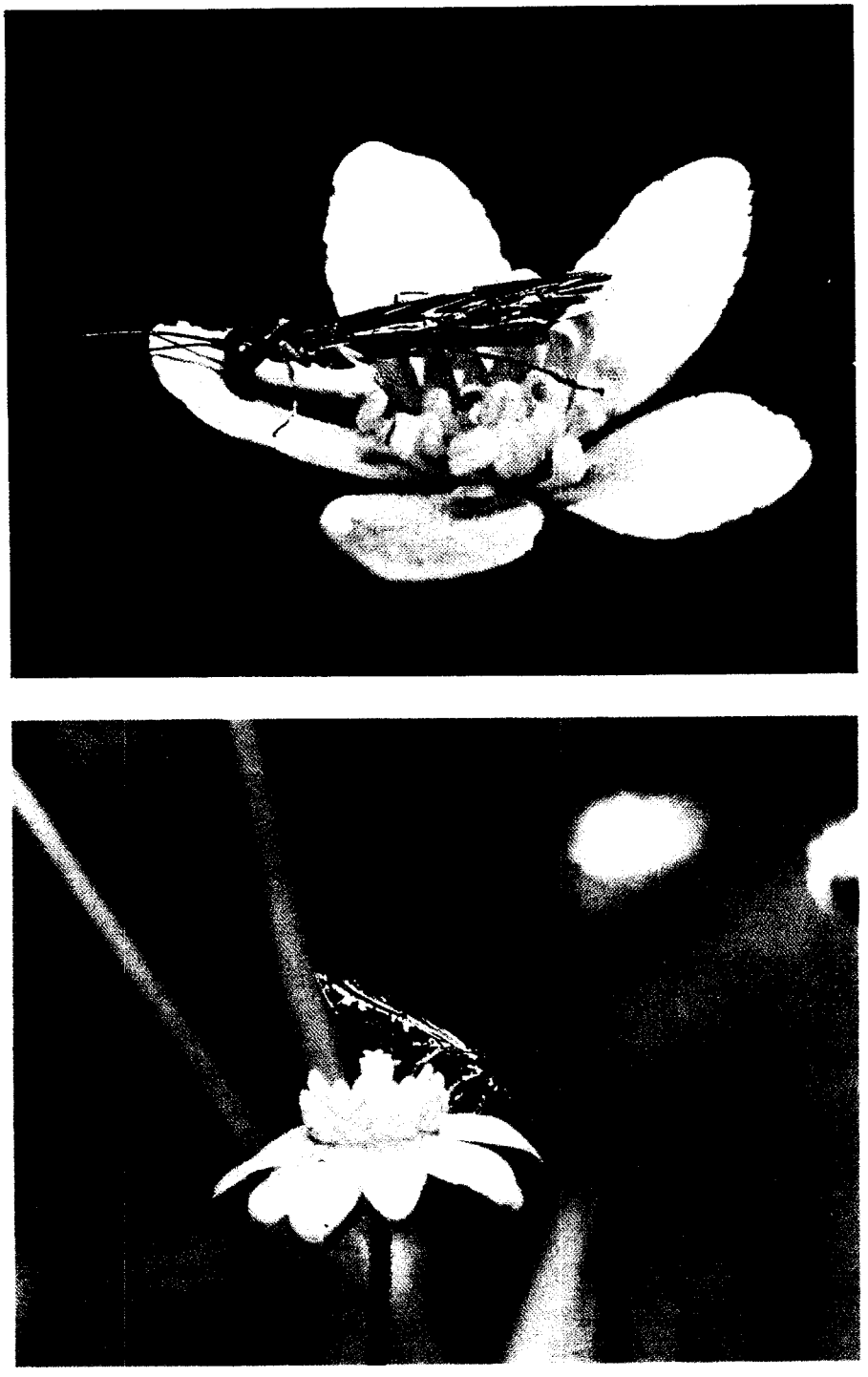

Cephus clavatus (Norton) on flowers of buttercup.
(Photo courtesy of David C. Rentz.)

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THE CEPHID STEM BORERS OF CALIFORNIA (Hymenoptera: Cephidae)

BY

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INTRODUCTION

MEMBERS OF the sawfly family Cephidae are restricted to the Northern Hemisphere, except for two species from Madagascar in the unique subfamily Athetocephinae. It is a small family of about one hundred known species, divided into two subfamilies. three tribes, and eleven genera. The tribe Pachycephini is restricted to the Mediterranean area and the Eurasian steppes, the remaining two tribes, both in the subfamily Cephinae, are represented by species found in California.

Of the twelve North American species of Cephinae, five have been found in California. These are *Caenocephus aldrichi* Bradley, *Hartigia cressonii* (Kirby), *Janus rufiventris* (Cresson), *Cephus cinctus* Norton and *C. clavatus* (Norton). *Hartigia cowichana* Ries and *H. trimaculata* (Say) are found in nearby western states. The remaining five North American species occur in the eastern United States. Since there are so few species, all are discussed, with the western ones being treated more thoroughly.

Adults are slow-flying, slender insects, with long, cyclindrical or laterally compressed bodies. They are characterized by a number of unique morphological conditions not possessed by other sawflies. These include such conspicuous features as a maxapontal head, in which a hypostomal bridge separates the oral cavity from the occipital foramen; absence of cenchri; abdomen slightly constricted between first and second tergites and male genitalia lacking well differentiated claspers due to fusion of the harpes with their respective gonostipes.

A number of morphological similarities show that they are an annectent group between the siricid woodwasps and the most primitive family of the higher Hymenoptera, the Braconidae.

Larvae in the tribe Cephini are internal borers in stems of Gramineae, while those in the tribe Hartigiini bore in the twigs of Rosaceae or other arborescent plant families. They are white in color, lack abdominal prolegs, and possess only vestigial, unsegmented thoracic legs without tarsal claws. The abdomen terminates in a tubular prong or horn. They are single brooded (univoltine) and pass their resting stage in cocoons within the host plant. A number of species are of considerable economic importance.

ACKNOWLEDGMENTS

The cooperation of the following institutions and individuals in making specimens available for study is gratefully acknowledged. Abbreviations below are used throughout the text to indicate the present location of material seen or referred to in this study.

ANSP — Academy of Natural Sciences, Philadelphia.
BSNH — Boston Society of Natural History, Cambridge, Massachusetts.
CDA — California Department of Agriculture, Sacramento.
CU — Cornell University, Ithaca, New York.
CAS — California Academy of Sciences, San Francisco.
CIS — California Insect Survey, University of California.
CNC — Canadian National Collection, Ottawa.
UCD — University of California, Davis.
SJSC — San Jose State College, California.

SYSTEMATIC TREATMENT

KEY TO TRIBES AND GENERA OF CEPHIDAE IN NORTH AMERICA

(Adapted from Benson, 1951)

1. Antenna with segment 3 slightly longer than 4; flagellum either uniform or swelling very slightly after the 3rd segment, the following segments of almost equal thickness; claws bent almost at right angle, with inner tooth stout, and as long or longer than the end tooth (figs. 4, 5); hind basitarsus as long as the 3 following tarsal segments together. Larvae bore in woody plants or herbaceous Rosaceae, Tribe HARTIGIINI 2

   Antenna with segment 3 not longer than 4, and usually shorter; flagellum not swelling before the 6th segment, subclavate, with the subapical segments the thickest; claws only very slightly curved and with a small, slender, shorter inner tooth and no basal lobes (fig. 6); hind basitarsus not as long as the 3 following segments together. Larvae bore in Gramineae, Tribe CEPHINI 4

2. Hind tibia without pre-apical spines; antennal segment 3 longer than 4; left mandible with 2 parallel and equal inner teeth (fig. 3); hind wing with vein 3r-m absent; abdominal sterna of ♂ simple ..... *Caenocephus aldrichi* Bradley

   Hind tibia with 1 or 2 pre-apical spines; hind wings with vein 3r-m present (fig. 7) 3

3. Hind tibia with 2 pre-apical spines; claws with an acute basal lobe (fig. 4); maxillary palpus longer than front tibia and with segment 4 at least 1½ times as long as 6; segment 6 emerges from base of 5; left mandible without a middle tooth between the 2 main teeth (fig. 3). Larvae bore in twigs of trees and shrubs ..... *Janus*

   Hind tibia with 1 pre-apical spine; claws without an acute basal lobe (figs. 5, 6); maxillary palpus shorter than front tibia and with segment 4 scarcely longer than 6, which emerges from near the apex of 5. Larvae bore in twigs of rosaceous shrubs..... *Hartigia*

4. Saw sheath broadening slightly toward apex, where it is broader than apex of tibia; ♂ with a deep setiferous pit on sternites VII and VIII..... *Trachelus tabidus* (Fabricius)

   Saw sheath tapering evenly behind, where it is narrower than apex of tibia; ♂ without deep pits on sternites VII and VIII (figs. 10, 11)..... *Cephus*

Tribe HARTIGIINI
Genus *Caenocephus* Konow, 1896

Only two species are known, one Nearctic and one Palearctic.

Caenocephus aldrichi Bradley

(Figs. 3, 5; Map 1)

Caenocephus aldrichi **Bradley, 1905, Canad. Ent., 37:363. Type ♀ (Juliaetta, Idaho; CU).**

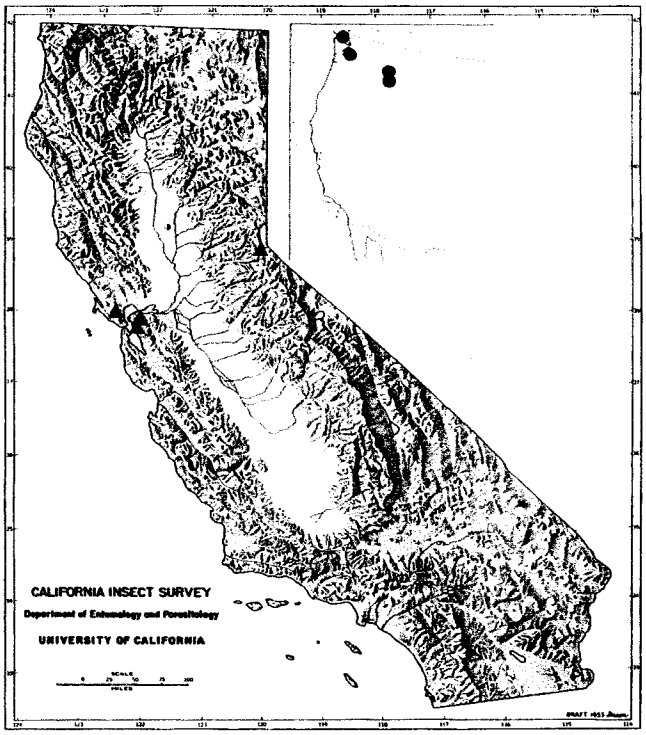
Caenocephus konowi **Bradley, 1905, Canad. Ent., 37:363.**

Geographic range.—British Columbia, California, Idaho, Washington (see map 1).

California records.—ALAMEDA Co.: Berkeley, ♀, V-5-34 (CIS). CONTRA COSTA Co.: Orinda, ♀, V-24-51, collected from *Conium maculatum* L. (G. Loshbaugh, CIS); EL DORADO Co.: Echo Lake, ♂, 7400 ft. elev. (W. W. Middlekauff, CIS). MARIN Co.: 2 miles W Fairfax, ♀, V-13-66 (J. Powell, CIS).

Host.—Uncertain. ?*Conium maculatum* L.

Life history.—Unknown.



Map 1. California distribution of *Caenocephus aldrichi* Bradley. Inset map shows distribution in North America.

Discussion.—This distinctive species is uncommon in collections, and nothing is known about its biology. The Loshbaugh specimen was swept from poison hemlock.

It is the only species in the genus known from North America. Ries (1937) placed *konowi* Bradley in synonymy when he stated that it was the male of *aldrichi* Bradley.

It undoubtedly occurs in Oregon, but to date has not been recorded from there.

Genus *Hartigia* Schiödte, 1838

Thirteen Holarctic species are described in this genus. Three of these are known from North America, two of which, *cressonii* (Kirby) and *trimaculata* (Say), are important economic pests.

KEY TO NORTH AMERICAN SPECIES OF HARTIGIA

Females

1. Antenna with segments 6–12 orange; abdomen with sclerotized portions of segments 1 and 5 entirely black; segments 6 and 9 entirely yellow; segments 2, 3, and 4 in part or entirely yellow, and segments 7 and 8 black or only partly marked with yellow..... *cressonii* (Kirby)

Antenna black; abdominal segments not colored as above 2

2. Abdomen with tergites 3 and 4 and tibiae and tarsi, orange .....*cowichana* Ries

Abdomen with tergite 3 black; tergite 4 with yellow or whitish spots or bands; tibiae and tarsi dusky brown *trimaculata* (Say)

Males

1. Tibiae and tarsi orange; abdomen mostly black with tergite IV entirely orange .....*cowichana* Ries

Tibiae and tarsi brown or blackish; abdomen black, or black marked with yellow or white 2

2. Tibiae and tarsi entirely yellow-brown ..... *cressonii* (Kirby)

Inner side of fore tibiae yellow; remainder of tibiae, and tarsi brown .....*trimaculata* (Say)

Hartigia cowichana Ries

Hartigia cowichana Ries, 1937, Ent. News, 48:82. Type ♀ (Victoria, British Columbia; CNC).

Geographic range.—British Columbia, Oregon*, Washington.

California records.—This species has not been reported from California.

Host.—Rose.

Life history.—Unknown.

Discussion.—This uncommon species has been reported previously only in British Columbia and Washington. A poorly preserved female in the California Insect Survey was collected on the Sprague River in Oregon, 12 miles E of Chiloquin, July 13, 1951, by B. Malkin. It is the first specimen reported from Oregon.

Hartigia cressonii (Kirby)

(Figs. 8, 12; Map 2)

Cephus abdominalis Cresson (not Latreille, 1816), 1880, Trans. Amer. Ent. Soc., 8:33. Type ♀ (Nevada, ANSP). Preoccupied.

Cephus cressonii Kirby, 1882, List Hym. Brit. Mus., 1 (Add.): 403.

Astatus abdominalis, Konow, 1898, Ent. Nachr., 24:77.

Hartigia abdominalis, Essig, 1912, Mon. Bull. Calif. Comm. Hort., I:889-901.

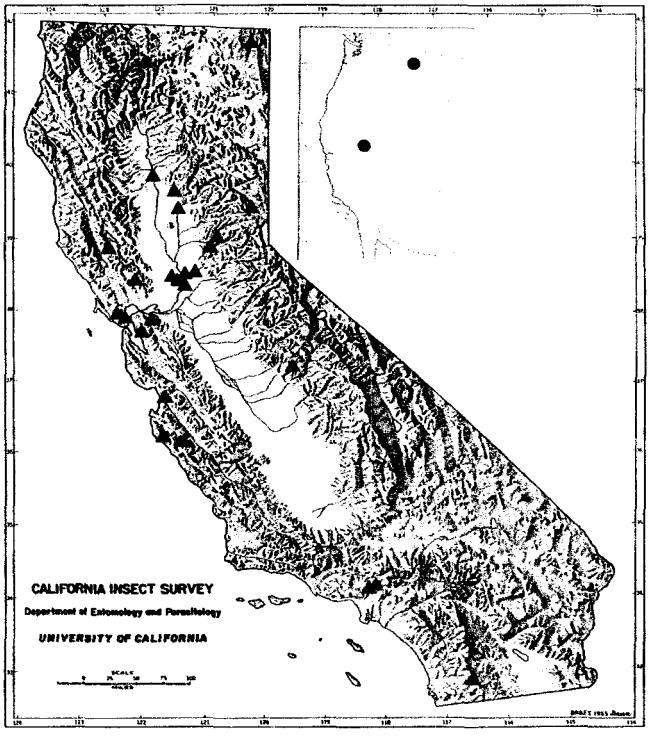
Hartigia cressoni, Essig, 1913, Mon. Bull. Calif. Comm. Hort., II:279-280.

Eumetabolus cressoni, Klima, 1937, Hym. Cat., pt. 2:27.

Hartigia cressonii, Ries, 1937, Trans. Amer. Ent. Soc., 63:316-319.

Geographic range.—California, Montana*, Nevada (map 2).

*New state record.



Map 2. California distribution of *Hartigia cressonii* (Kirby). Inset map shows distribution in the United States.

California records.—Alameda Co.: Oakland, ♂, ♀, V-30-37 (E. S. Ross, CAS). Butte Co.: Oroville, 2♀, III-4-26, bred from blackberry (H. H. Keifer, CAS). Contra Costa Co.: Concord, ♀, V-7-59 (D. Thomas, CAS). El Dorado Co.: Snowline, ♀, VI-30-48 (UCD). Lake Co.: Kelseyville, ♂, V-16-56 (J. C. Downey, UCD). Madera Co.: 3 miles W Bass Lake, ♀, VI-1-46 (H. Chandler, CAS). Marin Co.: Fairfax, ♀, IV-25-26 (C. L. Fox, CAS). Mill Valley, ♀, III-1-26 (E. P. Van Duzee, CAS). Modoc Co.: Davis Creek, ♀, VII-14-22 (C. L. Fox, CAS). Monterey Co.: Arroyo Seco, ♂, V-16-58 (E. G. Linsley, CIS). Big Sur, ♂, IV-7-39 (E. C. Van Dyke, CAS). Watsonville, ♀, VI-11-39 (F. E. Blaisdell, CAS). Napa Co.: Canyon, ♀, V-22-49 (R. C. Bechtel, UCD). 7 miles E Conn Dam, ♀, VI-12-64 (Paul Welles, CIS). 10 miles NW Napa, ♀, IV-15-66 (R. P. Allen, CDA). Nevada Co.: Boca, ♂, VI-28-54 (R. M. Bohart, CIS). Placer Co.: Auburn, ♀, VIII-3-17 (CIS). Plumas Co.: La Porte, ♀, IX-23-51 (E. R. Jaycox, UCD). Portola, ♀, V-5-60 (M. Wasbauer, CDA). Sacramento Co.: Carmichael, ♀, IV-2-60 (R. F. Wilkey, CDA); ♀, VI-1-57 (R. E. Darby, UCD). Elk Grove, ♂, V-1-52 (J. K. Hester, CIS). Folsom, ♀, V-31-38 (G. Tomich, CIS); ♂, V-14-54 (A. D. Telford, CIS). Sacramento, ♀, IV-1931, reared from blackberry (H. H. Keifer, CDA); ♀, IV-14-61 (T. R. Haig, CDA). San Diego Co.: near Buckman Springs, Pine Valley, ♂, V-7-53 (F. X. Williams, CIS). San Joaquin Co.: Tracy, ♂, ♀, IV-22-62 (W. H. Tyson, SJSC). Santa Clara Co.: Silver Creek Hills, ♀, V-1961 (W. H. Tyson, WHT). Sierra Co.: Sierraville, ♂, VI-2-54 (R. M. Bohart, CIS). Siskiyou Co.: Mt. Shasta City, ♀, VI-23-58 (J. Powell, CIS). Stanislaus Co.: La Grange, ♀, V-30-57 (R. P. Allen, CIS). Tehama Co.: Red Bluff, ♀, IV-26-38 (H. P. Chandler, CAS). Tuolumne Co.: Strawberry, ♂, 2♀, VI-18-53 (J. Rozen, CIS); ♀, VI-22-57 (John M. Burns, CIS). Yolo Co.: Clarksburg, ♀, VI-7-33 (CIS). Davis, ♀, VI-18-27 (F. H. Wymore, CIS); ♀, V-30-55 (A. T. McClay, UCD). Elkhorn Ferry, ♀, V-10-51 (E. I. Schlinger, CIS).

Hosts.—Raspberries, blackberries, loganberries, roses.

Economic importance.—The first biological study on this species was by Essig (1912) in California, where the insect was doing considerable damage to young growing canes of raspberry in the central and northern foothill counties. He reported it infesting both wild and cultivated blackberries, loganberries, raspberries, and roses.

Life history notes.—According to Essig (1912), the glossy, pearly white, oval, flattened eggs are about 1.5 mm long and about two-thirds as wide at their greatest breadth. The female places the eggs in a slit just beneath the epidermis of the young canes usually near the second or third leaf axil. Oviposition occurs from the beginning until about the middle of May. An area surrounding the oviposition puncture becomes discolored and easily visible. No data are available on the incubation period.

The young larva feeds near the point of hatching until it is about 6 mm long. It then begins a spiral tunnel downward in the cambium for 25–30 mm, then penetrates the pith and tunnels upward to the tip of the young shoot which soon withers and dies. As soon as the shoot dies the larva again starts downward, mining the center of the pith. This downward course may stop within 50 or 60 cm of the ground or continue into the roots. Active, feeding larvae may be found as late as October. As with many other sawflies the larva overwinters, and pupates several weeks prior to emergence as an adult.

The mature larva measures about 22 mm in length, is whitish in color, cylindrical, and somewhat enlarged dorsally and laterally in the thoracic region. The head is pale, measuring 1.87 mm in length and 1.66 mm in breadth. The mandibles, their articulations, and the labrum are sclerotized and darkened. The antennae are 5-segmented. The thorax has three pairs of medium-sized, fleshy, mamma-like, lightly sclerotized legs. The pleura, pro-, and metathorax have dorsal sclerotized spots. Abdominal segments, each with three annuli, have the pleurae moderately prominent. The segments are yellowish and glossy with lightly sclerotized circles on segment 8 and larger and more heavily sclerotized circles on segment 9. Prolegs are absent. The dorsal anal lobe terminates in a prong. The anal plate, lateral area of dorsal anal lobe and ventral lobe are hairy, sclero-

tized, and yellow. The ventral anal lobe has palpiform appendages at the posterior lateral extremities (fig. 12).

Adults appear as early as March, become most abundant in May and June and may linger into July or early August. The latest record known is a male from Sierraville collected on August 2. Contrary to Essig (1912) there is no evidence of a second brood.

Discussion.—The female of this species is easily distinguished from the other members of the genus by the extensive amount of yellow on the abdomen and the yellow-orange median portion of the antennae. The male is often difficult to distinguish from those of *trimaculata*, but may be recognized by the yellow sixth and ninth tergites, the yellow markings on the second, third and fourth tergites, and the entirely yellow-brown tibia and tarsi.

The name *abdominalis*, first given to this insect by Cresson in 1880, was changed in 1882 to *cressonii* by Kirby. He found Cresson's *abdominalis* was preoccupied by Latreille in 1816, who had used it for a European species which later became a synonym of *Cephus pygmaeus* (L.).

A male specimen in the California Academy of Sciences, collected June 24, 1930, by B. Malkin at Thomson Falls, Montana, is a new state record.

Hartigia trimaculata (Say)

Cephus trimaculatus Say, 1824, *In* Keating, Narr. Long's 2nd Exped. St. Peter's Riv., 2:313. Type ♀ (Pennsylvania; destroyed).
Cephus mexicanus Guérin, 1845, Iconogr. Regn. Animal. Ins., III:403.
Phylloecus trimaculatus, Norton, 1869, Trans. Amer. Ent. Soc., 2:345.
Phylloecus bicinctus Provancher, 1875, Nat. Canad., 7:375.
Cephus bifasciatus Cresson, 1880, Trans. Amer. Ent. Soc., 8:33.
Cephus fasciatus Cresson, 1880, Trans. Amer. Ent. Soc., 8:33.
Cephus bicinctus, Norton, 1880, Trans. Amer. Ent. Soc., 8:47.
Syrista trimaculatus, Konow, 1898, Ent. Nachr., 24:76.
Macrocephus bicintus, Konow, 1898, Ent. Nachr., 24:76.
Macrocephus fasciatus, Konow, 1898, Ent. Nachr., 24:77.
Adirus trimaculatus, Konow, 1899, Ent. Nachr., 25:74.
Aridus trimaculatus, Smith, 1900, Ins. N. Jersey, p. 600 (*lapsus*).
Macrocephus nigripennis Ghigi, 1915, Redia, 10:306.
Hartigia nigripennis, Klima, 1937, Hym. Cat., 2:19.
Hartigia mexicana, Klima, 1937, Hym. Cat., 2:17.
Hartigia trimaculata, Ries, 1937, Trans. Amer. Ent. Soc., 63:310.

Geographic range.—Atlantic coast from Florida to Quebec, west to Louisiana, Rocky Mountains, Washington, and British Columbia, Utah, Idaho and Chiapas, Mexico.

California records.—Not recorded from California.

Hosts.—Blackberry, rose.

Life history notes.—Champlain (1924) made some observations on the biology of this species. The adults fly during the latter part of May and through June and July in Pennsylvania. Females were observed flying around rose bushes, alighting from time to time head downwards on the terminals of the new shoots. Moving down the terminals head first the female used the tip of the abdomen and sometimes the ovipositor as a tactile organ, inserting the latter at short intervals into the tissues of the new growth. Oviposition has been noted in the second week of July. The egg was placed in the pith at right angles to the outer bark. Considerable damage was done by the female in puncturing the buds and terminals. Champlain reported that it was unlikely that each puncture contained an egg.

Apparently only the first larva to hatch survives in a single terminal, as never more than a single one was observed in each tunnel. The larva begins feeding on the terminal, which wilts and dies, and then starts feeding on the pith, packing the excrement in the tunnel behind it as it moves down the stem. The length of the tunnel varies with the length of the shoot and also the elapsed time since the egg hatched.

At certain intervals the larva girdles the inside of the stem above the spot where it is feeding, frequently causing the stem to break or at least wilt and die above that point. When fully grown, it makes a partial opening in the stem to the outside, spins a cocoon, and overwinters in that portion of the tunnel where it last fed. Pupation takes place in the spring and in Pennsylvania the first adults emerge the latter part of May.

Discussion.—Females are easily identified but males may be somewhat more difficult. Characters listed in the key will normally distinguish *trimaculata*.

Bechtel and Schlinger collected three males in Chiapas, Mexico, 6 miles south of Puebla Nueva, March 20, 1953, and deposited them in the California Insect Survey collection. A comparison of these with Guérin's 1845 description of *Cephus mexicana* leads me to believe they are the same. This is the only cephid known from Mexico.

Genus *Janus* Stephens, 1835

Holarctic and oriental with about thirteen known species, four of which occur in North America.

KEY TO NORTH AMERICAN SPECIES OF JANUS

1. Base of radial vein atrophied near stigma (fig. 7) 2
   Base of radial vein present 3
2. Wings entirely hyaline .....*abbreviatus* (Say)
   Wings with 2 round fuscous spots, one each in cells 3Rs and 3M of fore wing (fig. 7) .....
   ♂ *bimaculatus* (Norton)
3. Hind tibiae with 2 pre-apical spurs; abdomen black or orange 4
   Hind tibiae with 1 pre-apical spur; abdomen entirely red; wings faintly infuscated ....*rufiventris* (Cresson)
4. Wings with one fuscous spot below stigma .....
   integer (Norton)
   Wings with 2 round fuscous spots, one each in cells 3Rs and 3M or forewing ....♀ *bimaculatus* (Norton)

Janus abbreviatus (Say)
willow shoot sawfly
(Figs. 4, 7, 9)

Cephus abbreviatus Say, 1824, *In* Keating, Narr. Long's 2nd Exped. St. Mary's Riv., 2:314. Type ♀ (Pennsylvania; destroyed).
Xiphydria basalis Say, 1837, Boston Jour. Nat. Hist., 1:222.
Cephus heteropterus Norton, 1861, Proc. Boston Soc. Nat. Hist., 8:224.
Cephus interruptus Provancher, 1888, Addit. Corr. Faune Ent. Canada Hym., p. 355.
Janus abbreviatus, Konow, 1904, Zeit. Syst. f. Hym. u. Dipt., 4:119.

Geographic range.—Eastern United States and Canada west to Manitoba, Minnesota,* and south as far as Virginia.

California records.—Has not been collected in California.

Hosts.—Twigs of willow and poplar.

Life history notes.—According to Ries (1937), who compiled the information from original sources, adults appear soon after the middle of April in the vicinity of Washington, D. C., and fly until the early part of June. Soon after emergence the females deposit their eggs in the growing tips of willow and poplar. They are inserted in an oblique position in the pith from 5–15 cm below the tip. After depositing the egg the female girdles the twig about 2.5 cm distally to the oviposition puncture, which supposedly serves to protect the egg from being crushed by further twig growth. Soon afterwards the portion of the twig beyond the girdle withers and later may drop to the ground. The eggs hatch in seven to ten days.

The young larva begins boring in the pith soon after hatching, sometimes tunneling a distance of 30 cm down the stem before reaching maturity. The tunnel behind the larva is entirely filled with frass.

Late in the fall, about November in Washington, D. C., the larva chews a passage through the woody portion of the stem to the epidermis, which is left intact. It then spins a silken cocoon in the tunnel where is passes the winter. Pupation takes place about the first of March and lasts about six weeks. There is but a single generation a year.

Discussion.—The entirely hyaline wings lacking the base of the radial vein is distinctive. A female in the California Insect Survey was collected June 18, 1940, by D. McDonald at Camp Carlow, Alexander, Minnesota. This is a new state record.

Janus bimaculatus (Norton)

Phylloecus bimaculatus Norton, 1868, Trans. Amer. Ent. Soc., 2:346. Type ♂ (Farmington, Connecticut; ANSP).
Cephus quadriguttatus Westwood, 1874, Thesaurus Ent. Oxon., p. 111, pl. 20, fig. 11.
Janus bimaculatus, Konow, 1904, Zeit. Syst. Hym. u. Dipt., 4:118.

Geographic range.—Quebec, Maine, Massachusetts, New York, Maryland, Illinois, Wisconsin, Minnesota.

California records.—Has not been collected in California.

Hosts.—*Viburnum lentago* L.; *Viburnum prunifolium* L.

Life history notes.—During mid-November, 1958, an outbreak of this species occurred on the current season's growth of *Viburnum prunifolium* L. at Pittsburg, Pennsylvania. Sixty percent of the twig growth was affected according to Udine (1959).

Discussion.—The two round fuscous spots on the apical portion of the fore wing are distinctive.

Janus integer (Norton)
currant stem girdler

Cephus integer Norton, 1861, Proc. Boston Soc. Nat. Hist. 8:224. Type ♀ (Cambridge, Massachusetts; BSNH).
Janus flaviventris Fitch, 1862, Trans. N. Y. State Agr. Soc., 21:852.
Phylloecus integer, Norton, 1869, Trans. Amer. Ent. Soc., II:346.
Janus integer, Slingerland, 1897, C. U. Exper. Sta. Bull., 126:41.

Geographic range.—Quebec south to Maryland, west to Iowa, Washington and Manitoba.

California records.—Has not been collected in California.

Host.—Currant.

*A new state record.

Economic importance.—A fairly common pest of cultivated currants, *Ribes* spp. and may be locally injurious. It is especially objectionable in nursery cuttings.

Life history notes.—According to Slingerland (1897) and Britton (1921) the female deposits her eggs soon after emergence in May or June in the pith of currant stems 5 cm or more below the tips. The female then girdles the stem 1.5 to 2.5 cm above the puncture with her ovipositor. The stem is usually not severed, but subsequently wilts and breaks off above the cut, leaving a stub. The eggs hatch in about eleven days. The young larva tunnels downward in the pith and continues throughout the growing season. The tunnels, packed with frass, rarely extend more than 15–18 cm down the stem. In early September the larva forms a cell about 2 cm from the lower end of the tunnel, cuts through the wood to the epidermis, and spins a silken cocoon in which it passes the winter. Pupation occurs in early spring and lasts about two weeks. There is but one generation per year.

Discussion.—This species may be easily distinguished by the fuscous spot in the fore wing just below the stigma in cell $2R_1$.

Janus rufiventris (Cresson)
(Map 3)

Cephus rufiventris Cresson, 1880, Trans. Amer. Ent. Soc., 8:33. Type ♀ (Napa County, California; ANSP).
Janus rufiventris, Rohwer, 1917, Proc. Ent. Soc. Wash., 19:141.

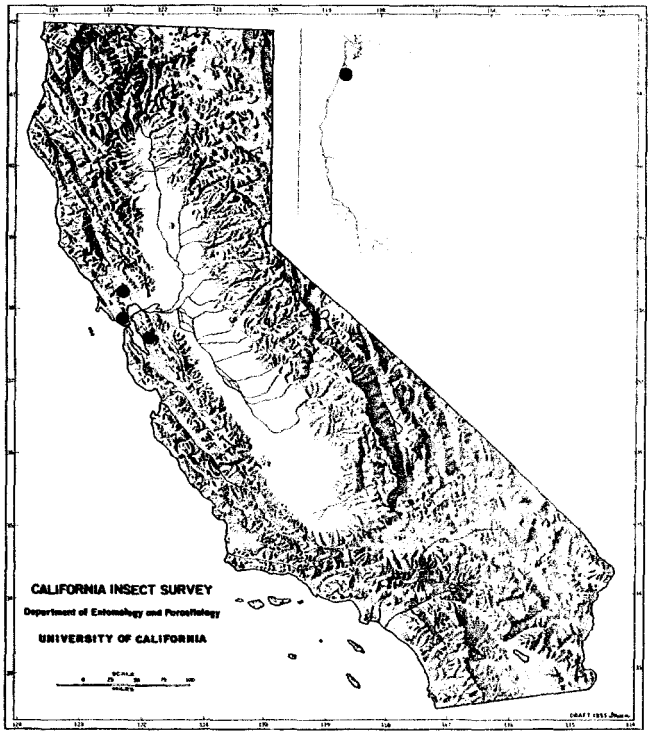
Geographic range.—California, Oregon (map 3).

California records.—ALAMEDA Co.: Berkeley, ♂, IV-22-35 (UCD); ♀, IV-23-48 (R. E. Beer, CIS); ♀, III-27-51 (W. W. Middlekauff, CIS). MARIN Co.: Mill Valley, 52, VI-7-15, III-18-23, IV-5-24 (E. P. Van Duzee, CAS).

Host.—Unknown.

Life history notes.—Unknown.

Discussion.—A previously undescribed male specimen is in the University of California collection at Davis. The antennae are broken, but otherwise the specimen is intact. Coloration is essentially similar to that of the female, with the abdomen reddish and the head, thorax and hind legs jet black. Base of mandibles, as well as the apices of fore and mid femora and the anterior tibiae and tarsi are whitish. Mid and hind tibiae with a pre-apical spine as in the female.



Map 3. California distribution of *Janus rufiventris* (Cresson). Inset map shows distribution in the United States.

Tribe CEPHINI

Adults of the tribe Cephini are usually found among the grasses in which they lay their eggs. They are also frequently found upon yellow and blue flowers of various families, where they feed on pollen and also mate. During rainy or windy weather they remain hidden in the plant foliage. While representatives of this tribe are Holarctic in distribution most species are concentrated in the Eurasian steppes and the Mediterranean area.

Losses due to sawfly infestation in small grains are manifold. Larval feeding interferes with nutrient transfer, weakens the stem, and causes a smaller and lighter kernel. Larvae also girdle the stem at the base when preparing for hibernation. Girdled stems break off and lodge of fall to the ground. Some of the fallen heads are lost in harvesting, and occasionally wet weather causes molding or germination of their seeds. Adult females seek the larger diameter stems in which to oviposit. This does not in itself permanently injure the stem nor has it been noted to produce an infection route for pathogens to any great extent.

Genus *Cephus* Latreille, 1802

Holarctic with about twenty-five species. The North American fauna consists of three species: *cinctus, clavatus,* and *pygmaeus,* the latter adventive from Europe.

KEY TO NORTH AMERICAN SPECIES OF CEPHUS

1. Left mandible bidentate (fig. 2); cercus long, about ¾ as long as antennal segment 3; abdominal sternite 8 in male apically notched (fig. 10), and lacking long, scalelike setae on margin .....*clavatus* (Norton)
   Left mandible tridentate (fig. 1); cercus short, about half or less as long as antennal segment 3; abdominal sternite 8 in male without an apical notch, and with long, scalelike setae on margin (fig. 11) 2
2. Stigma and costa uniformly dark brown, mesepisternum, femora, apical tergite, and venter entirely black .....*pygmaeus* (L.)
   Costal margin of stigma, and costa yellow; mesepisternum with upper angle yellow; femora, apical tergite, usually the venter, in part yellow .....*cinctus* Norton

Cephus cinctus Norton
wheat stem sawfly
(Figs. 1, 11; Map 4)

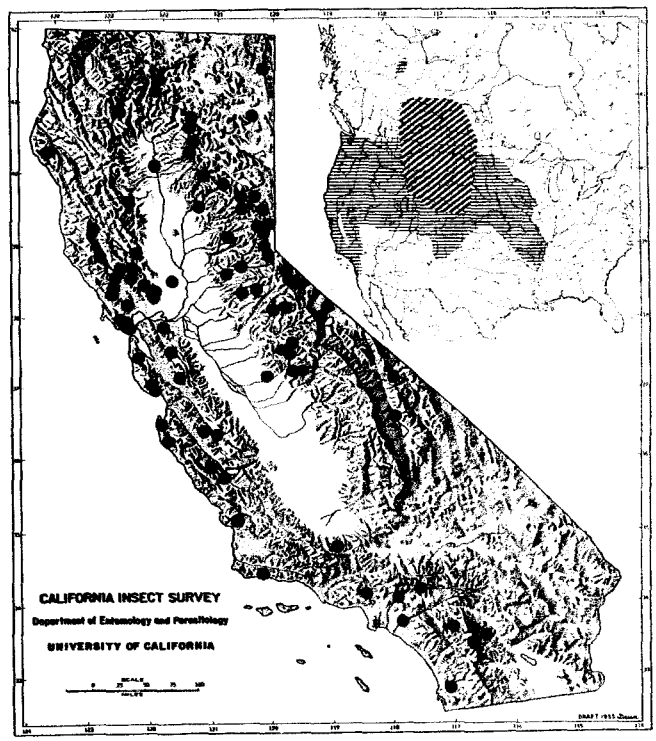
Cephus cinctus Norton, 1872, Trans. Amer. Ent. Soc. 4:86, ♂ (Colorado, ANSP).

Cephus occidentalis Riley & Marlatt, 1891, U. S. Dept. Agric. Ins. Life 4:177.

Cephus graenicheri Ashmead, 1898, Canad. Ent. 30:182.

Geographic range.—Widely distributed in the United States west of the Mississippi River and northward into Canada. Causes economic losses in Montana, North Dakota, South Dakota, Wyoming, Nebraska and in the wheat growing areas of Canada north of Montana and North Dakota (map 4).

California records.—This species is widely distributed in California, especially in the foothills and lower mountain ranges surrounding the central valley. It is conspicuously absent or rare in the central valley, and Mojave and Colorado desert areas. It should occur in Ventura, Del Norte, and in those portions of valley counties which extend into low foothills. ALAMEDA Co.: Livermore, 2♂, V-11-30 (E. C. Van Dyke, CAS). Redwood Park, E of Oakland, ♀, V-18-53 (R. Schuster, CIS). Sunol, ♀, V-24-33 (UCD). ALPINE Co.: Silver Creek, ♀, VI-17-58, ex. meadow grasses (Blanc, Allen, Middlekauff, CDA). Woodfords, 2♀, V-29-57, ex *Elymus* (H. T. Osborn, CDA); 3♀, VI-17-58 (W. W. Middlekauff, CIS); 3♀, VI-17, 18-58 (F. L. Blanc, CDA); 5♀, VI-10-58, ex wheat grass (Blanc, Allen, Middlekauff, CDA); ♀, VI-13-59 (R. P. Allen, CDA); 4♀, V-29-59 (R. P. Allen, CDA); 3♀, VI-12-62 (R. P. Allen, CDA). AMADOR Co.: Volcano, ♂, V-5-53 (R. M. Bohart, UCD). BUTTE Co.: Hurleton, ♂, V-26-28 (H. H. Keifer, CIS). CONTRA COSTA Co.: Mt. Diablo, ♀, V-5-44 (G. E. Bohart, CIS). Russelmann Park, Mt. Diablo, ♂, V-20-67 (D. C. Rentz, CIS). EL DORADO Co.: Camino, 3 miles S, ♂, VI-28-48 (C. D. MacNeill, CIS). China Flat, ♂, VI-28-48 (P. D. Hurd, CIS). Echo Lake, ♂, ♀, VII-21-48 (P. D. Hurd, CIS). Greenwood, ♀, VI-21-67 (J. Powell, CIS). Meyers, ♀, VII-24-55 (J. C. Downey, CIS). Placerville, 2♂, VI-6-06 (CIS). Pyramid Ranger Sta., ♂, VII-12-48 (C. Chan, UCD). Snowline Camp, 3♂, VI-21-48 (R. C. Bynum, CIS); ♂, VI-27-48 (O. E. Myers, CIS); 3♂, ♀, VI-29-48 (J. W. MacSwain, CIS); ♀, VI-30-48 (R. C. Bynum, CIS). Strawberry, 2♂, VII-6-58 (L. E. Campos, UCD). GLENN Co.: Plaskett Mdws., 6200 ft. elev., ♀, VII-30-60 (J. Powell, CIS). HUMBOLDT Co.: Honeydew, 10 miles W, ♀, VI-14-60 (T. R. Haig, CDA). INYO Co.: Westgard Pass, ♀,VI-26-37 (N. W. Frazier, CIS). Big Pine Cr., 9500 ft elev., ♀, VI-22-42 (R. Bohart, CIS). Lone Pine, ♂, VI-9-29 (R. L. Usinger, CAS). KERN Co.: Fort Tejon, ♀, V-29-27 (A. C. Davis, CAS). LAKE Co.: North Fork Cache Creek, ♂, V-16-56 (J. C. Downey, UCD). Cobb Mt., 2♂, ♀, V-7-36 (UCD); ♂, V-7-36 (CIS). Middletown, ♂, V-14-66 (J. Powell, CIS). Middletown, 8 miles S, ♀, V-26-59 (T. R. Haig, CDA). LASSEN Co.: Termo, 6.5 miles N, ♀, VI-11-60 (G. I. Stage, CIS). LOS ANGELES Co.: Tanbark Flat, ♀, VI-17-56 (H. W. Michalk, CDA). Van Nuys, ♂, V-26-46 (CIS). MADERA Co.: Bass Lake, ♀, VI-6-38 (R. M. Bohart, UCD). Biledo Meadow, ♂, VII-11-46 (R. L. Usinger, CIS). Oakhurst, ♀, VI-8-42 (E. G. Linsley, CIS); ♀, VI-1-42 (E. G. Linsley, CIS); ♂, VI-1-42 (C. Kennett, CIS). MARIN Co.: Bear Valley, ♂, V-15-21 (C. L. Fox, CIS). Ft. Baker, ♀, IV-23-22 (C. L. Fox, CIS). Inverness, ♂, V-4-57 (CIS); 3♂, ♀, V-20-62 (C. A. Toschi, CIS); ♀, V-14-61 (C. A. Toschi, CIS); ♂, IV-30-60 (C. A. Toschi, CIS). Inverness, 1 mile SE, ♀, V-28-58 (P. D. Ashlock, CDA). Mt. Tamalpais, ♀, V-13-34 (Bryant, CAS). Muir Woods, ♂, V-6-50 (W. J. Woll, UCD). Phoenix Lk., ♂, ♀, V-17, 18-62 (D. C. and K. A. Rentz, CAS). Vic. of Phoenix Lk., 2♂, ♀, V-3-62 (D. C. Rentz, CIS). MARIPOSA Co.: Yosemite Valley, 4♀, VI-10-28 (E. O. Essig, CIS); ♀,



Map 4. California distribution of *Cephus cinctus* Norton. Inset map shows distribution in North America. Area of crop damage is shown by heavy slant lines. Modified from Wallace and McNeal (1966).

V-28-28 (Graham Held, CIS); ♂, V-27-21 (CIS); ♂, VI-7, 12-21 (E. C. Van Dyke, CIS); ♀, VI-17-31 (E. O. Essig, CIS); ♂, VI-12-31 (CIS). MENDOCINO Co.: Willits, ♂, V-30-55 (J. C. Downey, UCD). Yorkville, ♂, ♀, IV-24-28 (CAS). MERCED Co.: Le Grand, ♀, V-18-56 (R. P. Allen, CIS). MODOC Co.: Cedarville, ♀, VI-14-66 (R. P. Allen, CDA). MONO Co.: Bodie, ♂, VII-1-64 (P. Rude, CIS). Coleville, 2♂, VI-21-57 (R. P. Allen, CDA). Devil's Gate, ♂, VII-12-64 (S. G. Seminoff, CDA). MONTEREY Co.: Arroyo Seco, ♂, V-11-58 (A. Menke, UCD). Big Sur, ♀, V-14-60 (J. F. Lawrence, CIS). Bradley, ♀, IV-23-17 (E. P. Van Duzee, CAS). Monterey, ♀, VI-27-56 (B. J. Adelson, CIS). NAPA Co.: Calistoga, ♀, V-15-64 (R. P. Allen, CDA). Lokoya, ♂, V-4-58 (E. G. Linsley, CIS). Samuel Springs, ♀, V-9-55 (UCD); 3♂, V-30-53 (E. I. Schlinger, UCD). NEVADA Co.: Boca, ♀, VI-28-54 (R. M. Bohart, UCD); ♂, ♀, VII-3-54 (R. C. Blaylock, J. C. Downey, UCD). Russell Val., ♂, VI-26-64 (J. G. Seminoff, CDA). 2 miles S Grass Val., ♂, VI-27-67 (J. Powell, CIS). Sagehen nr. Hobart Mills, ♂, ♀, VII-4-62 (J. Powell, CIS); ♂, VI-21-54 (P. D. Hurd, CIS); ♂, 2♀, VI-25-54 (R. M. Bohart, UCD); ♀, VII-4-54 (P. D. Hurd, CIS). Truckee, ♂, VI-19-27 (E. P. Van Duzee, CAS). Truckee, 7 miles E, ♀, VI-24-54 (R. H. Goodwin, CIS). ORANGE Co.: Brea, ♀, 200-250 ft elev. (M. Cazier, UCD). PLACER Co.: Auburn, 10 miles NE, ♀, V-5-58 (R. M. Bohart, UCD). Carnelian Bay, Lake Tahoe, ♂, VI-13-57 (R. M. Bohart, UCD). Colfax, 3♀, V-20-52 (R. M. Bohart, UCD). Dutch Flat, ♂, VI-10-52 (R. M. Bohart, UCD); ♀, V-20-50 (E. I. Schlinger, UCD). PLUMAS Co.: Graeagle, ♀, VI-18-49 (E. I. Schlinger, CIS); 3♀, VI-17-49 (E. I. Schlinger, UCD). Johnsville, ♂, VI-4-60 (M. Wasbauer, CDA). Quincy, 4 miles W, ♀, VII-3-49 (E. I. Schlinger, UCD); ♀, VI-20-49 (R. C. Bechtel, UCD); ♂, VI-21-49 (R. C. Bechtel, UCD); ♂, VI-30-49 (E. I. Schlinger, UCD); 2♀, VII-21,22-49 (UCD). Tobin, ♂, V-13-49 (P. D. Hurd, CIS). RIVERSIDE Co.: Hemet Reserv., San Jacinto Mts., ♀, V-22-40 (CIS). Idyllwild, San Jacinto Mts., ♀, VI-17-41 (E. C. Van Dyke, CAS); ♂, VI-1-39 (Ray F. Smith, CIS). Tahquitz Val., San Jacinto Mts., ♂, VI-14-39 (E. S. Ross, CAS). SAN BENITO Co.: Idria (Gem Mine), ♂, VI-15-55 (Don Burdick, CIS). New Idria, 10 miles NE, ♀, IV-24-64 (W. Turner, CIS). Pinnacles Nat. Mon., ♀, V-3-46 (T. O. Thatcher, CIS). SAN BERNARDINO Co.: Phelan, ♂, 2♀, IV-22-64, ex needle grass (Harper, CDA). SAN DIEGO Co.: La Mesa, ♂, III-23-53 (F. X. Williams, CAS). SAN LUIS OBISPO Co.: San Luis Obispo, ♂, ♀, IV-24-19 (E. P. Van Duzee, CAS); ♂, IV-24-19 (E. P. Van Duzee, CAS). SAN MATEO Co.: Crystal Lakes, ♂ (F. E. Blaisdell, CAS). SANTA BARBARA Co.: Gaviota Pass, ♂, IV-21-51 (S. F. Bailey, R. M. Bohart, UCD). SANTA CLARA Co.: Mt. Hamilton, ♂, V-7-61 (W. H. Tyson, SJSC); ♀, V-21-56 (Burdick, CDA). SANTA CRUZ Co.: Ben Lomond, V-16-31 (E. C. Van Dyke, CAS). Felton, 4♀, (W. H. Lange, UCD); 21♂, 17♀, V-17-47 (P. H. Arnaud, CAS). Santa Cruz, ♀, VI-6-22 (CIS). SHASTA Co.: Hat Creek P. O., ♀, VII-2-55 (E. E. Lindquist, CIS); 4♀, VII-2-55 (J. R. Jessen, UCD, CIS). Hat Creek, 3 miles N, ♂, VI-4-41 (CIS). Old Station, 2♀, VI-22-55 (J. W. MacSwain, CIS); ♂, 5♀, VI-22-55 (E. E. Lindquist, J. W. MacSwain, CIS); 2♀, VI-24-55 (R. D. Browning, A. J. Mueller, UCD). Viola, ♀, VI-27-47 (T. F. Leigh, CIS). 2 miles W Shingletown, ♀, V-20-66 (J. Powell, CIS). SIERRA Co.: Independence L., ♀, VII-16-55 (R. M. Bohart, UCD). Loyalton, ♀, V-25-57, ex smooth brome wheat grass (E. B. Bond, H. T. Osborn, CDA). Snag Lake, 2 miles S, ♀, VII-4-64 (CDA). SISKIYOU Co.: Dunsmuir, ♀, VI-30-64 (T. R. Haig, CDA). Shasta Springs, ♀, VI-6-20 (C. L. Fox, CAS). SOLANO Co.: Green Valley, ♂, V-9-53 (J. C. Hall, UCD). SONOMA Co.: Alexander Val., ♀, IV-28-35 (UCD). Forestville, 4♂, V-20-36 (A. T. McClay, UCD). Mark West Springs, ♀, V-10-30 (E. P. Van Duzee, CAS). Sobre Vista, ♂, V-19-10 (J. A. Kusche, CAS). Stillwater Cove, ♀, V-23-54 (E. I. Schlinger, UCD); ♀, V-23-54 (E. I. Schlinger, CIS). TEHAMA Co.: Mineral, 1 mile W, 3♀, VI-26-54 (R. O. Schuster, CIS). Red Bluff, ♂, V-22-52 (E. I. Schlinger, UCD). TRINITY Co.: Big Flat, Coffee Creek, ♀, VI-10-34 (CIS). Carrville, 2♀, V-27-34, 2400-2500 ft elev. (UCD). TUOLUMNE Co.: Dardenelles, ♂, VI-26-51 (S. M. Kappos, UCD); ♀, VI-26-57 (J. W. MacSwain, CIS). Strawberry, ♂, VI-29-51 (S. M. Kappos, UCD). YOLO Co.: Davis, ♀, VI-6-48 (E. I. Schlinger, UCD); ♀, V-23-55 (R. W. Bushing, UCD).

Hosts.—The principal host of *C. cinctus* is wheat, which it damages severely in certain areas. Lesser damage occurs on spring rye, barley, and timothy. Resistant varieties of wheat are available.

Prior to the introduction of cultivated grains, this species attacked many native grasses having acceptable stems large enough to accommodate the larvae. Not all of the recorded hosts are equally attractive for oviposition and larvae do not survive in all hosts in which eggs are laid.

One or more species in the following genera have been recorded as suitable hosts: *Agropyron, Beckmannia, Bromus, Calamagrostis, Calamovilfa, Deschampsia, Elymus, Festuca, Hordeum, Phleum,* and *Stipa.*

Economic importance.—*Cephus cinctus* Norton has been recognized as a pest of wheat since 1895 when it was reported damaging grain in Canada near Moose Jaw, Northwest Territory, and in Manitoba. Since that date many authors have reported on the damage caused by this sawfly in both Canada and the United States. It is our most economically important cephid.

Losses due to tunneling by this species may range from 10 to 20 percent of the crop. Seamans (1945) found that a bushel of wheat weighed an average of two pounds less from infested than from uninfested stems and usually rated one grade lower. Losses were estimated by the Montana Agricultural Experiment Station at almost 5 million bushels of wheat for Montana and North Dakota in 1951. Canadian losses were estimated by Platt and Farstad (1946) to be 20 million bushels annually. Resistant varieties of wheat have been developed in Canada as well as in the United States, but since they do not yield as well as certain of the nonresistant strains they have not as a rule been widely accepted.

Life history notes.—The biology of this species has been studied by a large number of workers in North America. For an excellent account and bibliography see Wallace and McNeal (1966).

Eggs deposited in suitable grass stems hatch in about eight days in the spring. The larvae develop throughout the summer. Eggs and smaller larvae encountered are cannibalized. When the plants begin to mature, the larva moves to the lower end of the stem, girdles it from the inside about 2–3 cm above the soil surface and spins a silken cocoon that occupies nearly the full length of the remaining stub. The winter is spent in this cocoon. Pupation occurs in the spring. The pupal stadium lasts 10–21 days, depending upon temperature and moisture conditions. Adults are most commonly collected in May and June, with an occasional specimen being taken in late March or April and into late July, a female having been taken July 24 at Meyers in El Dorado County. There is one generation per year.

Discussion.—This species is subject to considerable color and morphological variation, but the characters listed in the key will easily distinguish it from the common sympatric *C. clavatus*.

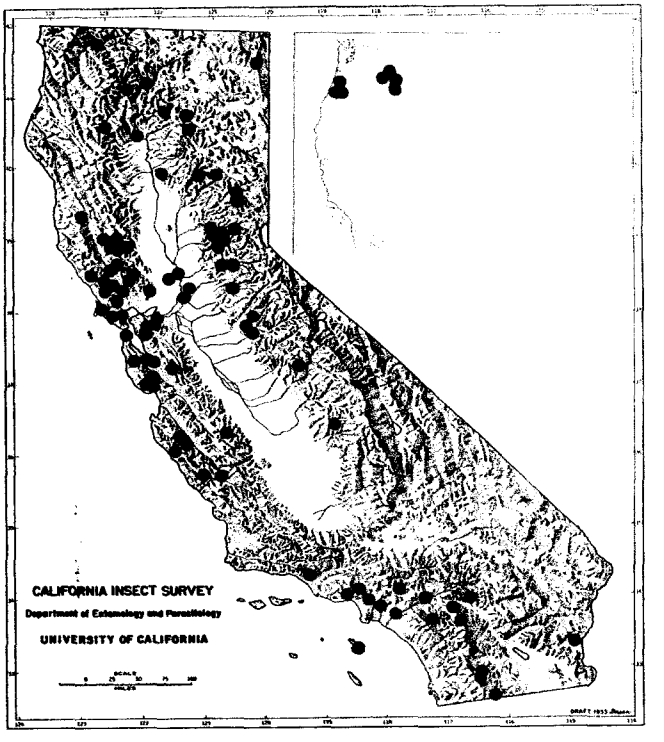
Cephus clavatus (Norton)

(Frontispiece; Figs. 2, 6, 10; Map 5)

Phylloecus clavata Norton, 1869, Trans. Amer. Ent. Soc., 2: 345, ♀ (San Francisco, California, ANSP).
Cephus clavatus, Cresson, 1887, Synopsis Hymenoptera, 192.
Calameuta clavatus, Konow, 1898, Ent. Nachr., 24:77.
Cephus clavatus, Ries, 1937, Trans. Amer. Ent. Soc., 63:287.

Geographic range.—California, Idaho, Oregon, Washington (map 5).

California records.—The distributional pattern of *C. clavatus* in California is essentially sympatric with that of *C. cinctus* (map 5). ALAMEDA Co.: Berkeley, ♂, V-6-57 (L. A. Sanchez, CIS); 2♀, IV-21-54 (J. W. MacSwain, CIS); ♂, IV-9-09 (CAS). AMADOR Co.: Tiger Creek, Afterbay, 2♂, V-21-49 (C. D. Duncan, SJSC). Volcano, ♂, V-5-57 (R. M. Bohart, UCD). CONTRA COSTA Co.: Orinda Crossroad, ♂, IV-1956 (S. F. Cook Jr., CIS). Lafayette, ♀, V-13-52 (Ray F. Smith, CIS); ♀, V-13-52 (R. A. Stirton, CIS). 1 mile S Lafayette, ♀, V-11-52 (R. A. Stirton, CIS). Marsh Creek, east Mt. Diablo, ♀, IV-20-47 (C. W. Anderson, CIS). EL DORADO Co.: Greenwood, ♀, VI-21-67 (W. Turner, CIS). Placerville, ♂, VI-6-06 (CAS); 2♀, V-17-37 (N. W. Frazier, CIS). Snowline Camp, 2♀, VI-20-48 (C. Chan, J. W. MacSwain, CIS); ♀, ♂, VI-19,20-48 (P. D. Hurd, CIS). 3 miles S Camino, ♀, VI-26-48 (J. W. MacSwain, CIS); ♀, VI-23-48 (C. Chan, UCD). IMPERIAL Co.: Palo Verde, ♀, IV-27-51 (G. Loshbaugh, CIS). LAKE Co.: Clear Lake Oaks, ♂, V-16-53 (Don Burdick, CDA). Blue Lakes, ♀, V-16-22 (E. P. Van Duzee, CAS). 5 miles S Kelseyville, ♀, V-10-53 (J. Lattin, CIS). Hobergs, ♀, V-11-40 (K. Frick, CIS). Lower Lake, ♂, V-10-51 (E. J. Taylor, UCD). Lakeport, ♂, V-7-36 (UCD). North Fork Cache Creek, Highway 20, ♂, V-16-56 (J. C. Downey, UCD). MADERA Co.: Bass Lake, ♂, VI-6-38 (R. M. Bohart, UCD). MARIN Co.: Alpine Lake, ♀, V-29-56 (J. Powell, CIS); 2♀, V-18-58 (D. C. Rentz, CAS). 1 mile N Alpine Lk., ♀, VI-3-64 (J. Powell, CIS). Carson Ridge, ♀, V-30-59 (C. W. O'Brien, CIS). Inverness, 3♂, V-4-57 (CIS); 6♂, 2♀, V-14-61 (C. A. Toschi, CIS); ♂, IV-22-62 (C. A. Toschi, CIS). Meadow Club, 2♀, V-1953 (E. S. Ross, CAS). Novato, ♂, V-6-52; 3♀, V-2-66; ♂, IV-14-67 (D. C. Rentz, CIS); 2♂, V-6-60 (T. R. Haig, CDA). Vic. of Phoenix Lk., ♀, V-3-62 (D. C. Rentz, CIS). MENDOCINO Co.: Leggett, ♂, V-19-66 (J. Powell, CIS). Ryan Creek, ♂, V-30-49; ♂, V-30-55 (R. Craig, CIS). Willits, ♀, V-30-51; 3♂, ♀, V-30-55 (E. I. Schlinger and J. C. Downey, UCD). MODOC Co.: Cedar Pass, ♂, VI-29-55 (J. W. MacSwain, CIS). Cedarville, ♀, VI-1-46 (W. F. Barr, CIS). MONTEREY Co.: Arroyo Seco, ♂ 2♀, V-5-57 (R. Eppley, CIS, CDA). Bradley, ♂, V-18-20 (E. P. Van Duzee, CAS). Bryson, 3♂, ♀, V-18-20 (E. P. Van Duzee, CAS). Hastings Res. nr. Jamesburg, ♂, ♀, V-3-58 (J. Powell, CIS). Paraiso Spgs., ♀, IV-18-32 (L. S. Slevin, CAS). White Oak campground, Santa Lucia Nat. For., ♂, ♀, V-9-59 (D. J. Burdick, CIS). NAPA Co.: 1 mile N Angwin, ♂, V-9-64 (H. B. Leech, CAS). 5 miles E Conn Dam, ♀, VI-5-64 (J. Powell, CIS). Lokoya, 6♂, V-4-58 (E. G. Linsley, CIS); ♀, V-4-58 (R. F. Smith, CIS). Pope Val., ♂, III-24-51 (W. Middlekauff, CIS). Samuel Spr., ♂, IV-25-54 (R. M. Bohart, CIS); ♂, V-9-55 (E. I. Schlinger, UCD); ♂, V-19-55 (E. C. Force, UCD). NEVADA Co.: Grass Valley, 8♂, 11♀, V-16-64 (R. F. Wilkey, CDA). Nevada City, ♂, ♀, V-16-30 (E. P. Van Duzee, CAS). ORANGE Co.: Casa Loma (Yorba Linda), ♂, ♀, V-30-49 (H. A. Hunt, UCD). PLACER Co.: Applegate, Cal., 3♂, IV-11-51 (R. C. Bechtel, UCD, CIS). 10 miles NE Auburn, ♂, ♀, V-5-58 (R. M. Bohart, UCD). 10 miles E Auburn, 2♀, V-5-58 (Eric Jessen, CIS). Baxter, 2♀, V-29-54 (R. M. Bohart, CIS, UCD). Colfax, ♀, V-20-50 (E. I. Schlinger, UCD); ♀, V-20-52 (A. A. Grigarick, UCD). Dutch Flat, ♀, V-20-52 (A. T. McClay, CIS);



Map 5. California distribution of *Cephus clavatus* (Norton). Inset map shows distribution in the United States.

♂, ♀, VI-10-51 (R. M. Bohart, CIS). PLUMAS Co.: Graeagle, ♀, VI-17-49 (E. I. Schlinger, UCD). Onion Valley, ♂, VII-7-49 (W. F. Ehrhardt, UCD). Quincy, 4 miles W, ♀, VI-22-49 (W. R. Schreader, UCD); VI-22-49 (W. F. Eberhardt, CIS); ♀, VI-19-49 (J. W. MacSwain, CIS); ♀, VI-19-49 (H. A. Hunt, UCD). Tobin, ♀, V-13-49 (P. D. Hurd, CIS). RIVERSIDE Co.: Banning, ♀, V-29-28 (E. C. Van Dyke, CIS). 2 miles N Perris, ♂, III-24-52 (E. Schlinger, CIS). Mt. San Jacinto, ♀ VI-6-42, 4000 ft elev. (R. Bohart, UCD). SACRAMENTO Co.: Elk Grove, 4♂, IV-18-52 (E. C. Carlson, UCD, CIS). SAN BENITO Co.: Idria, 2♂, VI-14-55 (M. Wasbauer, CIS). SAN BERNARDINO Co.: Morongo Val., ♂, V-4-58 (O. C. LaFrance, CIS). SAN DIEGO Co.: 6 miles E Cuyamaca, ♂, VI-21-65 (R. L. Langston, CIS). 4 miles NE Jacumba, ♂, IV-28-59 (F. X. Williams, CAS). Laguna Mts., ♂, VI-21-53 (J. Powell, CIS). Mt. Laguna, ♂, VI-21-63 (P. D. Hurd, CIS); ♀, VI-21-63 (J. D. Birchim, CAS). SAN MATEO Co.: Portola Val., ♂, IV-22-21 (W. M. Gifford, CAS). SANTA CLARA Co.: Los Gatos, ♀, V-3-52 G. W. Ellis, CIS). Menlo Park, ♀, IV-19-42 (P. H. Arnaud, CAS). Mt. Hamilton, ♂, V-2-63 (T. L. Erwin, SJSC); ♀, IV-19-48 (CIS). Stanford U., Palo Alto, ♀, V-1920 (CIS). SANTA CRUZ Co.: Felton, 4♂, V-17-47 (P. H. Arnaud, CAS). Mt. Hermon, ♂, V-17-47 (Ernest G. Meyers, CIS). SHASTA Co.: Hat Creek, ♀, VI-1-41 (C. D. Michener, CIS); ♀, VI-4-41 (CIS). Old Station, ♀, VI-22-55 (J. W. MacSwain, CIS). Round Mountain, V-23-49 (R. M. Bohart, UCD). 2 miles W Shingletown, ♀, V-20-66 (J. Powell, CIS). Whiskeytown, 2♂, V-28-55 (J. C. Downey, UCD). SIERRA Co.: Gold Lake, ♂, VI-8-54 (R. M. Bohart, UCD). SISKIYOU Co.: Seiad, ♂, ♀, V-26-52 (R. P. Allen, CAS). Shasta Spgs., ♂, ♀, VI-9, 17-20 (C. L. Fox, CAS). SOLANO Co.: Green Val., ♀, III-7-53 (D. E. Barcus, CIS). Gates Canyon, ♂, V-9-56 (E. I. Schlinger, UCD). SONOMA Co.: Alexander Val., ♂, IV-28-35 (UCD). Cazadero, ♂, III-31-34 (UCD). Forestville, 2♀, V-19-38 and V-20-36 (A. T. MacClay, UCD). Kenwood, ♂, V-2-54 (J. Powell, CIS). Mark West Spgs., ♂, ♀, IV-27-30 (UCD). 3 miles NE Occidental, ♂, V-17-63 (J. Powell, CIS). Petaluma, ♀, V-15-54 (E. I. Schlinger, UCD). Santa Rosa, ♂, 3♀, V-21-57 (S. M. Sidel, UCD). Sebastopol, ♀, V-19-36 (A. T. MacClay, UCD); ♀, VI-16-57 (R. E. Darby, CIS). Sobre Vista, ♀, IV-20-10 (A. J. Kusche, CAS). Sonoma, IV-20-50 (H. B. Leech, CAS). TEHAMA Co.: Deer Creek, ♂, VI-6-49 (R. M. Bohart, UCD). TRINITY Co.: Douglas City, ♀, V-22-63 (T. R. Haig, CDA). Eagle Creek, ♂, V-28-49 (A. T. MacClay, UCD). TULARE Co.: Sequoia Nat. Pk., ♂, VI-13-29, 2000-3000 ft elev. (CIS). TUOLUMNE Co.: Sonora, ♀, V-5-52 (W. H. Tyson, SJSC). North fork Tuolumne Riv., 3 miles NE Tuolumne, ♂, V-1-61 (J. Powell, CIS). VENTURA Co.: Ojai, ♂, IV-10-55 (Simonds, CDA). YOLO Co.: Davis, ♀, V-23-48 (CIS); ♀, 1949 (W. R. Schreader, CIS); ♂, V-20-49 (E. I. Schlinger, UCD). Elkhorn Ferry, ♂, V-13-51 (R. C. Bechtel, CIS); ♀, V-20-51 (M. F. McClay, CIS); ♂, V-12-52 (A. T. McClay, CIS).

Hosts.—Unknown grasses. The grass hosts of *C. clavatus* may turn out to be *Bromus laevipes* Shear. and/or *Deschampsia danthonioides* Trin., the ranges of which are sympatric with *clavatus*. The closely related *cinctus* feeds in both *Bromus* and *Deschampsia*.

Economic importance.—Unknown.

Life history notes.—Practically nothing is known about the biology of this species. Adults have been frequently collected by the author and others in grassy areas and especially from the yellow flower heads of *Ranunculus* (frontispiece).

Adults emerge in California considerably earlier than do those of *C. cinctus*, and disappear about two weeks earlier. While most emerge in May, specimens have been taken as early as March 7 in Solano County and as late as July 8 in Sierra County.

Discussion.—Both males and females vary greatly in their color patterns, but may easily be distinguished by characters given in the key to species.

Cephus pygmaeus (Linnaeus)
European wheat stem sawfly

Sirex pygmaeus Linnaeus, 1766, Syst. Nat. Ed. 12:929.
Tenthredo longicornis Fourcroy, 1785, Ent. Paris, p. 378.
Banchus spinipes Panzer, 1801, Faunae Ins. German., (1:92, 73:17).
Cephus pygmaeus, Latreille, 1802, Hist. Nat. Ins., 3:303.
Astatus floralis Klug, 1803, Monog. Siricum German., p. 53.
Banchus viridator Fabricus, 1804, Systema Piez., p. 127.
Pamphilius longicornis, Latreille, 1805, Hist. Nat. Insect., 13: 140.
Cephus leskii Lepeletier, 1823, Monog. Tenthred., p. 20.
Cephus atripes Stephens, 1835, Illus. Brit. Ent., 7:105.
Cephus cultratus Eversmann, 1847, Soc. Nat. Moscow Bul., 20:64.
Cephus flavisternus A. Costa, 1882, Accad. delle Sci. Fis. e Mat. Napoli, Rend., p. 198.
Cephus clypealis A. Costa, 1894, Prosp. Imin. Ital., 3:250.

Geographic range.—Introduced. E. Canada, Connecticut, Delaware, Maryland, Massachusetts, North Carolina, New Jersey, New York and Pennsylvania. Widespread in England, Scandinavia, Russia, Germany, Holland, France, Italy, Spain, North Africa, Asia Minor, Caucasus to Turkestan.

California records—Has not been collected in California.

Hosts.—Attacks mostly cultivated grains, especially wheat, and to a lesser extent barley, rye and the uncultivated cheat grass, *Bromus secalinus* L.

Economic importance.—*C. pygmaeus* is an Old World insect which has long been known as a pest of wheat. It was introduced into North America sometime prior to 1887, since in that year Comstock (1889) reported it heavily infesting wheat at Ithaca, New York. European workers have reported outbreaks on grain in southern Russian, North Africa, France, Germany and Spain (Wallace and McNeal, 1966). In the United States infestations from Maryland, New Jersey, New York, and Pennsylvania have been noted.

Life history notes.—The life history of *C. pygmaeus* is not as well documented as that of *C. cinctus*. Ries (1926) studied the biology of *pygmaeus* in

upper New York state. The following is abstracted from his study. The female oviposits into a wheat stem in June just before the head leaves the boot. The egg hatches in 7–10 days.

The larva feeds downward for about one month to within 12 to 25 mm of the soil surface, and then forms a frass plug in the cavity. Just below this plug it cuts a V-shaped groove around the interior of the stem, leaving only the epidermis. Below this cut it places a similar plug to the underside of which it attaches its hibernation cocoon. The weakened stem usually breaks and falls over at the cut. Pupation takes place in the spring about a week before the adult emerges. There is but one generation per year, the adult emerging in late May or June.

Ries (1926) found *pygmaeus* copulating almost exclusively on yellow flowers.

Recent observations (Udine, 1941; Elton, 1960; DeBach, 1966) indicate that competition between *C. pygmaeus* and *T. tabidus* in areas of sympatry has reduced the range (competitive displacement) of the latter species in eastern United States. *C. pygmaeus* has replaced *tabidus* where it formerly existed in New Jersey, south central New York, northern Delaware, northeastern Maryland, and the eastern half of Pennsylvania. *C. pygmaeus* adults emerge about a week earlier and this appears to give it a competitive advantage by starting the life cycle earlier.

Discussion.—This species may be easily distinguished in both sexes from *cinctus* and *clavatus* by the completely black mesepisternum and the uniformly brown stigma.

Genus *Trachelus* Jurine, 1807

Benson (1946) includes eight species in this genus, with only one, *T. tabidus*, introduced into North America.

Trachelus tabidus (Fabricius)
black grain stem sawfly

Sirex tabidus Fabricius, 1775, Systema Ent., p. 326.
Tenthredo longicollis Fourcroy, 1785, Ent. Paris., 2:378.
Cephus mandibularis Lepeletier, 1823, Monog. Tenthred., p. 19.
Cephus nigritus Lepeletier, 1823, Monog. Tenthred., p. 20.
Cephus vittatus A. Costa, 1878, Accad. delle Sci. Fis. e Mat. Napoli, Atti., 7:14.
Calamenta (sic) *johnsoni* Ashmead, 1900 (1899), N. J. State Bd. Agr. Ann. Rpt., Sup., p. 600.
Trachelastatus tabidus, Morice and Durrant, 1915, Trans. Ent. Soc. London, 1914:383.
Cephus (*Trachelus*) *tabidus*, Ries, 1937, Trans. Amer. Ent. Soc., 63:291.
Trachelus tabidus, Benson, 1946, Trans. R. Ent. Soc. Lond., 96:103.

Geographic range.—Europe, widespread in England, Scandinavia, Russia, Germany, Holland, France, Italy, Spain, North Africa, Asia Minor, Caucasus, south-west Asia. Introduced into the United States.

In the United States it was first collected at Riverton, New Jersey, sometime prior to 1899 (Udine, 1941). Subsequently it spread into Pennsylvania, New York, Maryland, Delaware, West Virginia, Virginia, and by 1934 into eastern Ohio. The author found it to be very abundant in yellow flowers in a wheat field at Hagerstown, Maryland in the spring of 1935. Udine (1941) reported that it no longer occurs in New York, New Jersey, and the eastern half of Pennsylvania due to competition with *Cephus pygmaeus*. It presently coexists with *pygmaeus* in a narrow belt across Delaware, Maryland, and Pennsylvania.

California records.—Has not been collected in California.

Hosts.—Attacks wheat, barley, rye, and oats. According to Wallace and McNeal (1966) it has been a pest of cultivated grains for so long that it has lost its ability to infest uncultivated hosts. No wild grass host is known.

Economic importance.—*Trachelus tabidus* has long been a pest of cereal grains in Europe where it coexists with *Cephus pygmaeus*. *T. tabidus* contributes to the loss generally attributed to *pygmaeus*, but it is seldom given credit in the literature for damage it caused. It is difficult therefore to assess its exact economic importance. Hauser (1934) reported it causing spotty damage in eastern Ohio where it occurred alone.

Life history notes.—According to Gahan (1920) and Udine (1941) *tabidus* females lay their eggs in the upper internodes of the wheat stem about the time it begins to head. The egg hatches in 4 to 7 days. The larva feeds on the inner lining of the stem and gradually works its way downward, eating through the septa of the nodes, until it becomes full grown. It reaches the base of the plant by harvest time. It then forms a plug in the stem and just below this cuts a V-shaped incision completely around, leaving just enough fibre intact to hold the stem erect. Directly below the cut a second plug is placed and under this the larva forms a silk-lined, cylindrical cell in which it overwinters. As the stem dries and becomes more brittle, the weight of the head, together with the action of wind or rain, causes it to break at the incision. The remaining stub is left in the ground with the inactive prepupa inside until

the following spring, when pupation and emergence takes place.

In areas of the United States where *C. pygmaeus* and *T. tabidus* coexist, the latter species emerges about one week later in the spring. This gives *pygmaeus* a competitive advantage since the first larva to hatch will eat eggs and all smaller larvae it may encounter. More than one cephid egg is often found in wheat stems, but only one larva reaches maturity.

Discussion.—Benson (1946) considered *Trachelus* to be sufficiently distinct from *Cephus* as to warrant generic status. Other authors (Ries, 1937; Udine, 1941; Wallace and McNeal, 1966) have considered it to be a subgenus of *Cephus*. I am following Benson's decision.

The sawsheath of the female, which is somewhat broadened apically; the setiferous pits on sternites 7 and 8 of the male; and the lack of dorsal, transverse, yellow bands on the abdomen of both sexes distinguish this species.

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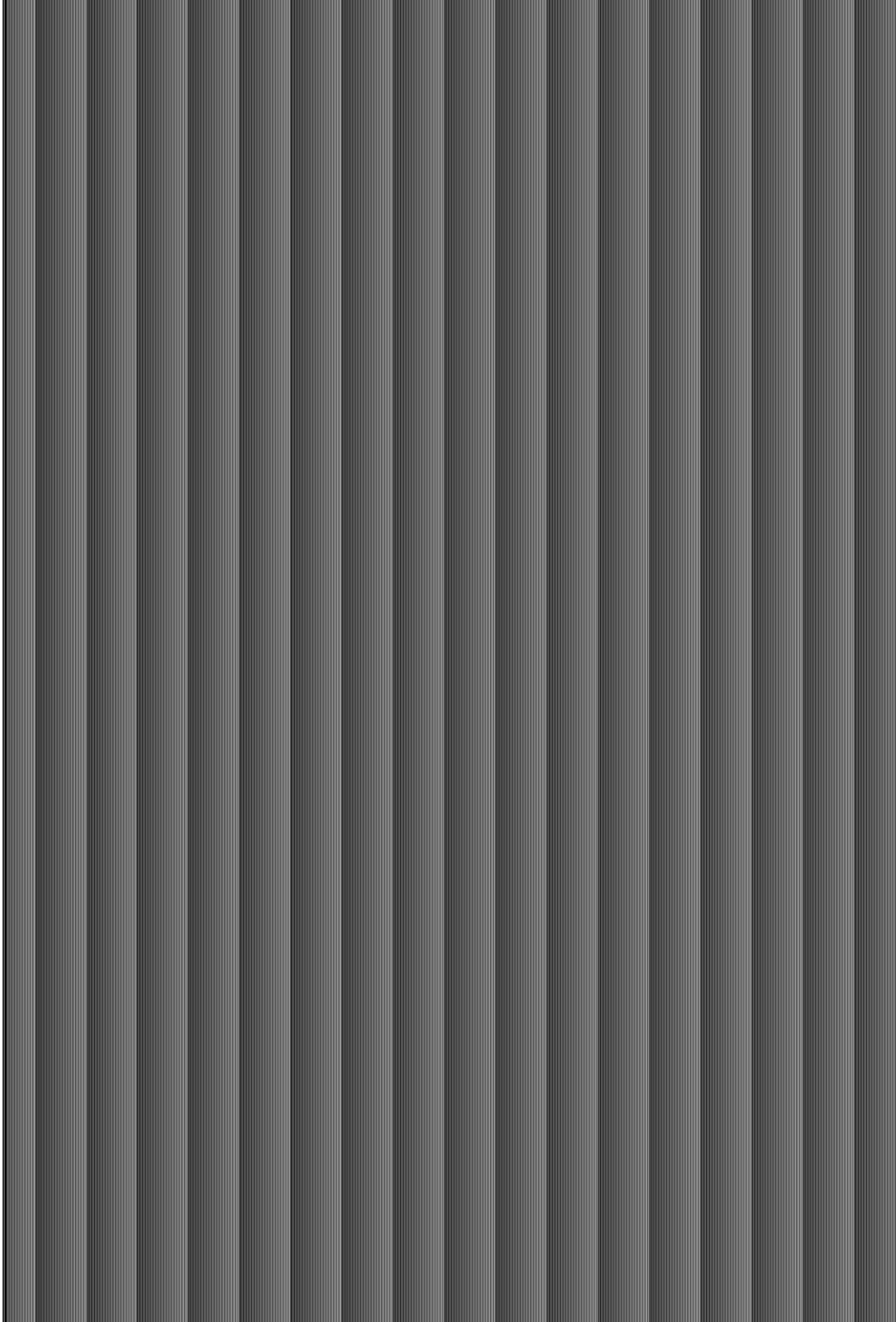
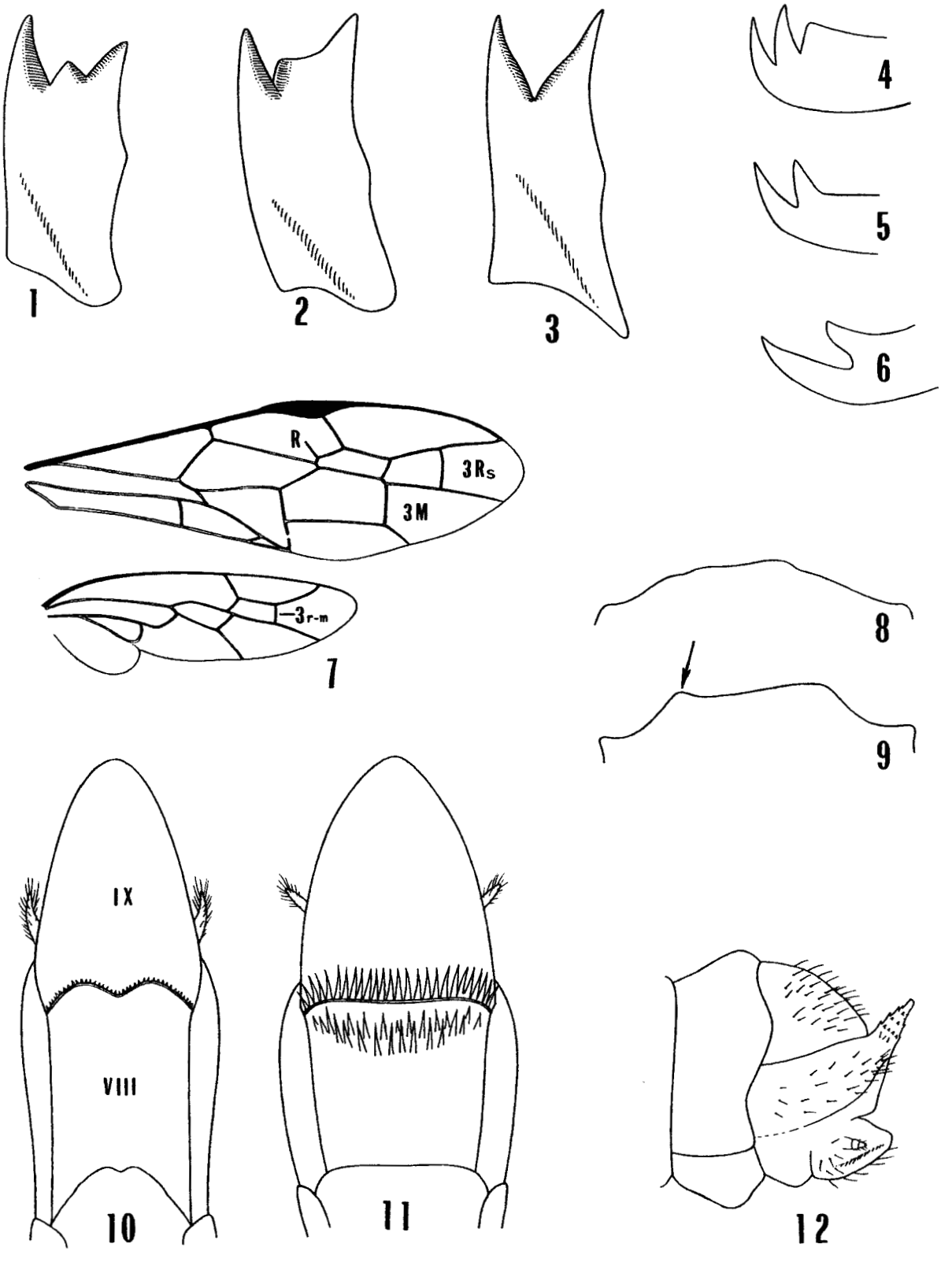


FIGURES

Fig. 1. *Cephus cinctus* Norton, left mandible, ♀.
Fig. 2. *Cephus clavatus* (Norton), left mandible, ♀.
Fig. 3. *Caenocephus aldrichi* Bradley, left mandible, ♀.
Fig. 4. *Janus abbreviatus* (Say), tarsal claw.
Fig. 5. *Caenocephus aldrichi* Bradley, tarsal claw.
Fig. 6. *Cephus clavatus* (Norton), tarsal claw.
Fig. 7. *Janus abbreviatus* (Say), front and hind wing.
Fig. 8. *Hartigia cressonii* (Kirby), clypeal profile.
Fig. 9. *Janus abbreviatus* (Say), clypeal profile.
Fig. 10. *Cephus clavatus* (Norton), abdominal sternites VIII, IX, male.
Fig. 11. *Cephus cinctus* Norton, abdominal sternites VIII, IX, male.
Fig. 12. *Hartigia cressonii* (Kirby), tip of larval abdomen, lateral aspect.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