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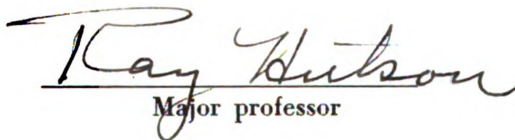
MICHIGAN SPITTLEBUGS

presented by

Murray K. Hanna

has been accepted towards fulfillment
of the requirements for

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Major professor

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MICHIGAN SPITTLEBUGS

By

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A THESIS

Submitted to the School of Graduate Studies of Michigan
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THESE

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INTRODUCTION

Michigan Spittlebugs

The insects commonly known as "spittlebugs" or "frog-hoppers" belong to the order Homoptera, family Cercopidae. Other common representatives of this order are plant lice, leafhoppers, and mealybugs.

The order Homoptera exhibits a high degree of specialization. The gula is absent or represented merely by a membrane. The head is inflexed in such a manner that it comes into contact with the fore coxae. The mouthparts, arising from the hind part of the head, include paired mandibular and maxillary setae. This type of mouthparts is well adapted for piercing and sucking.

Insects belonging to the family Cercopidae have structure and arrangement which readily distinguish them from members of other homopterous families. The antennae, inserted beneath the vertex and between the eyes, are setaceous with two bead-like basal segments. The cylindrical hind tibiae, each crowned

with a crescent of spical spines, bear one to three stout, lateral spurs.

These family characteristics readily distinguish spittlebugs from insects belonging to related families. The hind tibiae of insects belonging to the family Cicadellidae are each armed for the entire length with a row of spines beneath, while the hind tibiae of spittlebugs are each armed with one to three stout, lateral spurs. Insects belonging to the family Fulgoridae may have tibial spurs similar to those of spittlebugs, but in this instance the antennae are inserted beneath rather than between the eyes.

Immature spittlebugs (Plate II, Figs. 1 to 8) have the unique habit of surrounding themselves with a white bubbly foam. This frothy mass, frequently called "spittle," apparently affords the nymphal stages protection against parasites and predators. Species adapted to arid conditions make spittle masses on subterranean portions of plants. Spittle is composed of anal excretions fluffed with air. More than one or even nymphs of different species may occur within each mass of spittle. In the sixth century it was believed that the froth masses were the spit of the cuckoo bird and that the insects

were spontaneously generated from it. During the sixteenth century it was thought that certain plants secreted the white spittle mass and a list was made of the plants which seemingly produced the spittle. During another period spittlebug froth was thought to be tree frog spit. At the present time these creatures are known simply as spittlebugs or froghoppers. Presumably, the latter name was suggested by the formidable leaping power and squat appearance of commonly encountered forms.

Spittlebug nymphs have a curious arrangement of spiracles. The spiracles are situated in such a manner that they will not become choked with the froth within which the immature forms develop. An invagination of the ventral surface of the abdomen is canal-like in appearance. The tergal plates and pleura of the abdomen have been produced and bent around to form a large air-chamber or reservoir on the underside. The spiracles open into the upper part of this chamber. Although immature spittlebugs may seal themselves with froth, the amount of air trapped in the chamber seems sufficient for considerable time. It appears likely that

nymphs must break through the covering of froth from time to time to replenish fresh air supplies.

Nearly all spittlebug species occurring in Michigan are of similar life cycle and habit. Usually there is one generation per year, the winter being passed in the egg stage. Late in the season the eggs (Plate I, Fig. 3) are deposited by gravid females on stems or twigs of the nymphal host plant. In the spring the eggs hatch into tiny, wingless, nearly colorless, crawling creatures that make their way to young, succulent plant tissue. Here the nymphs settle down, insert their beaks, and begin to ingest the juices of the plant. Almost immediately upon feeding, the nymphs make protective spittle masses. There are four nymphal instars, the nymphs of each instar undergoing transformations in size and structure. Nymphs are very active, moving about on the same plant or even migrating to adjacent plants. The nymphs of the fourth instar, upon undergoing ecdysis, emerge as winged imagoes. The adult stage is an active, free-living, sexually mature form. Newly emerged adults, like the foregoing stages, are pale yellowish in color. Shortly after ecdysis, however, pigment becomes deposited in the integument and elytra, and within a

few hours typical adult pigmentation has resulted. Sometimes both immature and adult stages of a spittlebug species have similar food habits. In other instances, the plant hosts of the nymphal and imaginal stages may differ.

There are certain exceptions to this generalized account. One species is believed to winter over as winged adult. In this instance the eggs hatch during the same season they are deposited. Likewise, it is possible that certain other species may produce more than one generation during a single season if favorable conditions prevail.

Doering (24) summarizes records concerning ovipositing and feeding habits of spittlebugs. She relates that Clastoptera obtusa Say deposits eggs during September and October in bark of alder, frequently behind buds, and during July on new growth in slits. Clastoptera proteus Fitch deposits one to three eggs per puncture, presumably on dogwood, beneath bark on outer twigs. Lepyronia quadrangularis Say deposits eggs during the spring in rotten stems and twigs. The female Philaenus lineatus (Linn.) does not thrust her ovipositor through any portion of plant tissue, but merely inserts the eggs between stalk and sheath of grasses within two or three inches of the

ground. There are two to twenty-four eggs per mass, and each mass is surrounded with a white, frothy material that is tough and inelastic. Philaenus leucophthalmus (Linn.) deposits eggs in single rows, two to eighteen eggs per mass and covered by a protective material. In addition, Craighead (16) reports that eggs of Aphrophora parallela (Say) are deposited at the bases of the terminal buds of pine during July and August.

Shaw made the following interesting early record which quite generally expresses the present considerations concerning a common Michigan species, the meadow spittlebug, in General Zoology (1806).

"Among the smaller European Cicadae one of the most remarkable is the Cicada spumaria or Cuckow-spit Cicada, so named from the circumstance of its larva being constantly found enveloped in a mass of white froth adhering to the leaves and stems of vegetables. This froth, which is popularly known by the name of Cuckow-spittle, is found during the advanced state of summer, and is the production of the included larva, which, from the time of its hatching from the egg deposited by the parent insect, continues, at intervals, to suck the juices of the stem on which it resides, and to discharge them from its vent in the form of very minute bubbles, and by continuing this operation, completely covers itself with a large mass of froth; which is sometimes so overcharged with moisture, that a drop may be seen hanging from its under surface. The included larva, or pupa, (for no material difference can be observed between these two states,) when arrived

at its full growth, is about the fifth of an inch in length, of an oval shape, with broad head and thorax, and slightly pointed abdomen: its colour is a beautiful pale green, and the trunk or sucker with which it extracts the sap of the plant, may be observed by examining the under part of the thorax, where it will be seen pressed down in a strait direction from the head. When the time arrives in which the animal is to undergo its change into the complete insect, it ceases to absorb any longer the juices of the plant and to discharge the protecting over the insect, instead of entirely investing it as before: the skin of the larva is gradually thrown off, and the animal in its complete form emerges from its concealment. Its size is scarcely superior to that of the larva, but its colour is brown, with a pair of broad, irregular, pale or whitish bands across the upper wings. If disturbed, it nimbly springs to a great distance, and is commonly known by the name of the Froghopper, from some fancied resemblance to the colour and shape of that animal in miniature. These insects breed during the month of September, and towards the beginning of October deposit their eggs, which are not hatched till the succeeding spring. "

CHRONICLE

The chronicle acknowledges important contributions concerning spittlebugs in order of their appearance. Not all inclusions of the chronicle were consulted in preparation of this work.

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Fitch, Asa

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HISTORICAL BACKGROUND

About thirteen hundred species of spittlebugs have been described from all parts of the world. A great portion of these occur in Central and South America and in the region of Australia and the Orient. Although the family Cercopidae is of world-wide distribution, comparatively few representatives occur in Michigan. These few, until rather recently, have been imperfectly known. Literature, scattered and fragmentary, often contained incorrect generic references. Specific determinations, owing to the remarkable color similarity between certain species and the extreme color variation in others, have been rendered very questionable.

According to Lallemand (34) Linnaeus first described various species of spittlebugs placing them all under the genus Cicada. Some of the species described by Linnaeus occur in Michigan. Fabricus created the genus Cercopis to which he relegated all spittlebug species. Leach along with Amyot and Serville are responsible for descriptions of the family characteristics of Cercopidae. Leach described the family Cercopidae naming the group Cercopida. Amyot and Serville gave the

characteristics of the family and of the genus Lepyronia. Garman described the genera Aphrophora and Clastoptera. Stal described the genus Philaenus. Ball described the only remaining genus represented by spittlebug species occurring in Michigan, Philaronia.

Systematic work on American spittlebugs, except for isolated descriptions and a few lists, was first done by Uhler. Articles published by Ball during 1895 and 1898 comprised the foremost work of its time on North American spittlebugs. Since then both Ball and other authors have published numerous accounts concerning spittlebugs.

Lallemand (34) divided Cercopidae into three subfamilies. They are Machaerotinae, Cercopinae, and Aphrophorinae. Although the subfamilies Machaerotinae and Cercopinae are not known to occur in Michigan, they are of considerable interest.

Members of the subfamily Machaerotinae occur most abundantly in the Oriental and Australian regions. None are known to occur in the United States. Members of the subfamily Machaerotinae exhibit remarkable structure and habit. The scutellum is longer than the pronotum and is produced upward and back into a movable spine-like process. This

modification is unique for the group. Members of this subfamily are known as "tube-building" spittlebugs. Nymphs of the tube-building spittlebugs surround themselves with a frothy mass of excreta which hardens into a calcareous tube attached to the host plant. Nymphs of each species construct tubes of a distinctive shape and live in their own froth inside these tubes. The last nymphal stage resembles a true pupa.

Members of the subfamily Cercopinae are characterized by having the anterior margin of the pronotum cut off in a nearly straight line immediately behind the globular eyes. The width of the pronotum is considerably greater than the distance across the vertex and eyes. The sugarcane frog-hopper, Tomaspis varia Fabr. is a sugarcane pest of considerable economic importance. Although not directly associated with Michigan spittlebugs, this insect, in consequence of being the object of intense study, has been a contributing factor in the advance of knowledge concerning spittlebugs. Only one species of this group occurs in the United States. This species occurs in two forms, Tomaspis bicincta var. bicincta (Say), the banded form, and Tomaspis bicincta var. ignipecta Fitch, the dark form. The typical form, Tomaspis bicincta var.

bicincta, is dark chestnut brown in color, with a narrow transverse band across the pronotum and two slightly wider ones parallel to this trisecting the elytra. The color of these bands may range from red to creamy-yellow. In the varietal form, Tomaspis bicincta var. ignipecta Fitch, the bands are partly or entirely absent. The varietal distribution of this insect is quite conspicuous. The banded form normally ranges from Southern New Jersey southward through the gulf states and up the Mississippi Valley as far as Central Iowa. The dark form ranges from Southern New Jersey northward into Maine and westward to Pennsylvania.

Morse (40) discovered a number of the banded form in a restricted area in the central western part of Maine, the northern limit of distribution for the species. In surrounding localities only the dark form could be found. The occurrence of such aberrant groups would indicate that the two forms must breed true within their range of distribution.

Brown (13) reported on the role of morphology in systematics. The boundaries between species have been vague in the minds of systematists. The term species has been difficult to define. Species, according to Brown, have reality in nature.

A species is made up of actually or potentially interbreeding natural populations which are reproductively isolated from other such populations. Within a species populations may exist which are sufficiently distinct to be recognized as subspecies. Species and subspecies are differentiated by characters of the same order.

Boring (12) reported that among spittlebugs specific differences are frequently correlated with differences in chromosome number. The meadow spittlebug, Philaenus leucophthalmus (Linn.), has twelve as the reduced number of chromosomes while Philaenus lineatus (Linn.) has fifteen; Aphrophora quadrinotata (Say) has fourteen while Aphrophora parallela (Say) has fifteen; Lepyronia quadrangularis (Say) has eleven; and Clastoptera obtusa Say has eight, while Clastoptera proteus Fitch has seven. Tomaspis bicincta var. bicincta (Say) and Tomaspis bicincta var. ignipecta Fitch each have ten as the reduced number of chromosomes. Cytological studies reveal the chromosomal make-up of Tomaspis bicincta var. bicincta (Say) and Tomaspis bicincta var. ignipecta Fitch to be identical. Likewise, no distinction was found between chromosome groupings of various varieties of the meadow spittlebug.

In spittlebugs, varietal differences do not seem to be expressed in visible differences of any sort in the chromosomes.

Several of the spittlebug species found in Michigan occur in variety. The varietal forms of Michigan species are separated on the basis of coloration. Individuals determined to variety on the basis of coloration may differ in respect to other genetic factors. Yet few, if any, biological variations have been observed among varietal forms of Michigan species, as they are taken together in the same situations. (It should be noted that such is not the case with *Tomaspis bicincta* var. *bicincta* (Say), a form of southern distribution, and *Tomaspis bicincta* var. *ignipecta* Fitch, a form of northern distribution.) The occurrence of color types intermediate of typical varietal forms suggests genetical blending of varietal color characteristics. Repeated field observations of distinct varieties intermingling support this speculation. In the section of this work devoted to classification varietal forms are given consideration, although their significance is not known.

All spittlebugs have functional mouthparts and feed by sucking juices from plants.

An interesting internal feature of these insects is the remarkable filter-chamber of the gut which provides means for food to be "short-circuited" from the crop to the hind-gut with only the more solid food passing through the midgut. This feature enables spittlebugs to become gourmands sucking quantities of sap far in excess of nutritional requirements. In some parts of the world spittlebug infestations have given origin to the so-called "rain-trees." Great numbers of these insects feeding on a tree may excrete such quantities of liquid that it falls as rain, running down the trunk and out over the earth. In this country conifers sometimes become so heavily infested by the pine spittlebug that liquid may drip from the spittle masses and flow along the twigs and branches. Adult forms of the pine spittlebug eject undigested sap in the form of a mist. This mist, when produced by heavy infestations, may appear as falling rain.

Depredation and injury resulting from spittlebug attack have become economic factors in the production of crops. Some species restrict feeding to a single host species during both nymphal and imaginal stages. The active stages of other species may attack a variety of plants.

In the mid-western states and the area surrounding the Great Lakes four spittlebug species may become of some economic concern. These are the Saratoga spittlebug, the pine spittlebug, the lined spittlebug, and the meadow spittlebug, all of which occur in Michigan.

Osborn (45) treated the economic importance and life histories of all but the Saratoga spittlebug.

The adult stage of the Saratoga spittlebug is a pest of pine. The nymphal stages are passed on sweetfern, Comptonia peregrina (L.), and many other plants, but never on pine.

Craighead (16) suggests damage may be lessened or prevented by maintaining close stands of pine, and encouraging the better hardwoods to help in crowding out sweetfern.

Both the adult and immature forms of the pine spittlebug are pests of pine.

Craighead (16) reports Entomophthora aphrophora E. Raster, a parasitic fungus, is an important natural-control factor operating on the pine spittlebug. The relationship between the pine spittlebug and the parasite is such that periodic outbreaks of the insect may occur about every nine years.

Chemical control measures may be employed against this pest on ornamentals.

The lined spittlebug is considered somewhat of a meadow pest. In Michigan it occurs along with the meadow spittlebug, but usually not abundantly enough to warrant special attention.

The meadow spittlebug is the most abundant spittlebug in Michigan. It occurs in nine color varieties.

Ahmed and Davidson (1) have studied the life history of the meadow spittlebug in Ohio. The frothy mass or spittle within which members of this species spend their immature lives is made by nymphs while feeding on tender, rooted plants. Spittle is formed from normal alimentary excretions. The production of spittle is initiated by droplets of fluid excreted from the anal opening. The tip of the abdomen is extended beyond the fluid, and then whipped back catching a bubble of air. This action is rapidly repeated until a foamy mass of spittle has resulted.

Putman (47) considered the meadow spittlebug a carrier of the plum mite, Phyllocoptes frockeui Nal. and Trt.

Among the economic plants attacked by the immature stages of this insect are strawberry, celery, clover, and

alfalfa. Injury caused by the immature forms results from excessive feeding and extracting of plant sap in maintaining protective spittle masses. Attack by the adults on clover and alfalfa may result in shortening of the internodes and dwarfing of entire plants. Injured alfalfa may present a characteristic bunched-top condition. Seed pod injury may result in a high percentage of shriveled seed.

Weaver (57) stated that complete elimination of spittlebug nymphs by high concentrations of insecticide increased first cutting yields of red clover and alfalfa up to fifty-five percent. Some increase in carotenoid and protein content also resulted.

Medler, O'Neal, and Chamberlin (37) stated that to be very effective, insecticides should be applied when most of the nymphs are in the first or second instar. When applied to alfalfa or clover at that time certain chemicals seemed to have both immediate and residual action on the young nymphs migrating from the lower parts of the stem to the tops, where most of the late instars are found.

Scholl and Medler (48) described an interesting application of chemical control against adult spittlebugs which reduced

populations in alfalfa from ten per sweep to one per sweep.

First a trap strip was cut in the field and when the new growth became succulent, the remainder of the field was cut. Spittlebugs migrated to the succulent trap strip which was then treated with insecticides.

Weaver (58) studied the seasonal behavior of the meadow spittlebug in Ohio. Important spittlebug damage to legume crops is usually done during the first season of harvest. In second and third year meadows the spittlebug usually does not appear in economically important numbers. Egg masses are most readily deposited on grain stubble and only occasionally on legume stubble and green plant parts. First year meadows, previously seeded to grain, are likely to receive a large number of eggs. Reduction of egg deposition in a field will, in effect, reduce the subsequent nymphal infestation. Ordinarily, chemical control measures employed against adult populations within an area are of temporary nature, as reinfestation may occur. However, as developing eggs ripen, gravid female spittlebugs become less active. Weaver found control measures effective when applied prior to oviposition against adult spittlebugs torpid coincident with egg development.

METHODS, EQUIPMENT, AND PROCEDURE

At the time this work was contemplated the spittlebug fauna of Michigan was incompletely known. The Saratoga spittlebug, pine spittlebug, lined spittlebug, meadow spittlebug, and dogwood spittlebug were conspicuous by abundance or pestilence. The remainder, for the most part, was overlooked.

The initial preparation for this undertaking consisted of reviewing the college collection and abstracting literature on the subject. The college collection contained thousands of specimens of the meadow spittlebug which had not been determined to variety. Likewise, other species, some named, bearing Michigan locality labels were included, but in such small numbers that two or three specimens usually constituted a series. The spittlebug material belonging to the University of Michigan Museum of Zoology, although largely undetermined, was also made available for study. This material included about three hundred and fifty specimens bearing Michigan locality labels, and representing many species and varieties.

Rearing was initiated when spittle masses first appeared in the field. Nymphs naturally occurring on host plants were

caged, and the insects identified at maturity. Material to be reared was confined within cylinders of copper screening imbedded in the earth sustaining the host plant. The open ends of these cylinders were sealed with lawn cloth. In some instances, pockets made of lawn cloth and drawn closed with rubber bands were employed satisfactorily for confinement of immature stages to their host plants. Fifty cages enclosing infested strawberry plants were set in the vicinity of East Lansing. About one hundred and fifty other cages, most of them made of lawn cloth, were set in several areas of central and southeastern Michigan. After being set, these cages were revisited at infrequent intervals until the insects had matured. The insects were collected at maturity, mounted on card points, and labeled. The host plant was recorded whenever known. Otherwise, sample material was collected for later identification.

During the summer of 1951 field collections and observations were made in Ingham, Jackson, Hillsdale, Lenawee, Washtenaw, Livingston, Oakland, Wayne, and Monroe Counties. Much of the material collected was merely inspected and discarded, only the less common species and varieties being

retained. These were confined to the collecting jar until pinned and labeled. A number of nymphs were collected and preserved in dilute diaphane solvent. After prolonged preservation, many of them were removed and successfully mounted on card points.

Specimens obtained from these various sources were examined in an attempt to devise an identification key based on spot characteristics such as wing venation, male internal genitalia, and external structure. Since this attempt was unsuccessful, the works of several authors were modified and adapted to provide a key for the determination of Michigan spittlebugs.

The plates supplementing the key are composites of photomicrographs, obtained by photographing the subjects through a binocular dissecting microscope having a one power objective and a ten power ocular. Kodak 122 loaded with pancromatic film was employed. The camera was coupled in such a manner that the eye point of the microscope fell near the front surface of the camera lens. The plane of focus was located by projecting the image to a plastic screen temporarily substituted for film. A fixed point was established in this plane

as a guide for introducing subjects to be photographed. The large labeled figures (Plate I, Figs. 1-2) were taken with a universal view camera having an extension bellows. The photographs of each subject were trimmed and arranged on a white background. These were then photographically copied and reproduced.

SPITTLEBUGS RECORDED FROM MICHIGAN

Michigan spittlebugs all belong to the subfamily Aphrophorinae. This group of insects is characterized by having the anterior margin of the pronotum angulate or broadly rounded and anteriorly produced between the eyes. The fifteen species are distributed among five genera, Clastoptera, Aphrophora, Lepyronia, Philaenus, and Philaronia. Five of the species occur in two or more forms, making a total of twenty-nine species and varieties occurring in Michigan. Spittlebug species are divided into varieties on the basis of coloration. The species and varieties occurring in Michigan are listed below.

Clastoptera hyperici Gibson.

Clastoptera saint-cyri var. saint-cyri Provancher

Clastoptera saint-cyri var. anceps Mc Atee

Clastoptera proteus var. nigricollis Fitch

Clastoptera proteus var. oseola Ball

Clastoptera proteus var. proteus Fitch

Clastoptera juniperina Ball

Clastoptera obtusa var. obtusa Say

Clastoptera obtusa var. tristis Van Duzee

Clastoptera obtusa var. borealis Ball

Clastoptera achatina Germar

Aphrophora quadrinota Say

Aphrophora parallela (Say)

Aphrophora saratogensis (Fitch)

Aphrophora signoreti Fitch

Lepyronia quadrangularis (Say)

Philaenus lineatus (Linn.)

Philaenus leucophthalmus var. impressus DeLong

Philaenus leucophthalmus var. fabricii Van Duzee

Philaenus leucophthalmus var. pallidus (Zett.)

Philaenus leucophthalmus var. leucophthalmus (Linn.)

Philaenus leucophthalmus var. spumarius (Fall.)

Philaenus leucophthalmus var. fasciatus (Fabr.)

Philaenus leucophthalmus var. leucocephalus (Linn.)

Philaenus leucophthalmus var. lateralis (Linn.)

Philaenus leucophthalmus var. marginellus (Fabr.)

Philaronia abjectus var. abjectus Uhler

Philaronia bilineata var. bilineata (Say)

Philaronia bilineata var. orbiculata Ball

Genus Clastoptera, Germar

Clastoptera. Germar, Zeit. fur die Ento., p. 187 (1838).

Clastoptera is represented in Michigan by six species.

They are Clastoptera hyperici Gibson, Clastoptera saint-cyri Provancher, Clastoptera proteus Fitch, Clastoptera juniperina Ball, Clastoptera obtusa Say, and Clastoptera achatina Germar. Clastoptera saint-cyri Provancher occurs in two varietal forms, while both Clastoptera proteus Fitch and Clastoptera obtusa Say occur in three varietal forms.

Clastoptera hyperici Gibson.

Clastoptera proteus var. hyperici Gibson. McAtee, W. L.,
Proc. Bio. Soc. Wash., Vol. 33, p. 174, (1920).

This species has been recorded from Maryland and
Virginia.

Adults have been taken on Hypericum prolificum.

Michigan records: Romulus, July 10, 1951, and Adrian, July 24, 1951.

Clastoptera saint-cyri var. saint-cyri Provancher.

Clastoptera saint-cyri Provancher. Provancher, Nat. Can. IV, p. 351, (1872).

This variety has been recorded from Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Wisconsin, and Michigan.

This variety occurs along with Clastoptera saint-cyri var. anceps McAtee.

Michigan records: Flat Rock, July 5, 1951; Flat Rock, July 17, 1951; and Adrian, July 27, 1951.

Clastoptera saint-cyri var. anceps McAtee.

Clastoptera proteus var. anceps McAtee. McAtee, W. C. Proc. Bio. Soc. of Wash. 33, p. 174, (1920).

This variety has been recorded from Maine, Maryland, Massachusetts, New Jersey, New Hampshire, New York, Rhode Island, Washington, D. C., Wisconsin, and Michigan.

The writer has reared this variety from spittle masses occurring on Vaccinium in the vicinity of Flat Rock. The mature forms were collected July 17, 1951.

The imago of this variety has been observed emerging from the final exuvium. The newly emerged individual appeared yellowish-white. Placed in a vial devoid of food or liquids, the insect gradually began to darken in color. After six hours the coloration approached normal for this variety.

Michigan records: Flat Rock, July 5, 1951, and Flat Rock, July 17, 1951.

Clastoptera proteus var. osceola Ball.

Clastoptera proteus var. osceola Ball. Ball, E. D. Can. Ent., Vol. 58, p. 108, (1927).

The common name of Clastoptera proteus Fitch is dogwood spittlebug. This variety has been recorded from Massachusetts, New Jersey, New York, Wisconsin, and Michigan.

It occurs along with Clastoptera proteus var. nigricollis Fitch.

The writer has reared this variety from spittle masses occurring on Cornus in the vicinity of Brighton. The mature forms were collected July 2, 1951.

Michigan records: Brighton, July 2, 1951, and Wayne, July 2, 1951.

Clastoptera proteus var. nigricollis Fitch.

Clastoptera proteus var. nigricollis Fitch. Fitch, Asa.

Homoptera, New York State Cab. Nat. Hist., p. 53, (1851).

This variety has been recorded from California, Colorado, Connecticut, Florida, Illinois, Iowa, Kansas, Maine, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Dakota, Texas, Utah, West Virginia, Wisconsin, and Michigan.

The writer has reared this variety from spittle masses occurring on Cornus in the vicinity of Brighton. The mature forms were collected July 2, 1951.

Michigan records: Brighton, July 2, 1951.

Clastoptera proteus var. proteus Fitch.

Clastoptera proteus Fitch. Fitch, Asa. Homoptera, New York State Cab. Nat. History, p. 53, (1851).

This variety has been recorded from Iowa, Kansas, Massachusetts, Missouri, New York, South Dakota, and Wisconsin.

This is not an abundant variety. It apparently occurs along with Clastoptera proteus var nigricollis Fitch.

Michigan records: Brighton, July 2, 1951.

Clastoptera juniperina Ball.

Clastoptera obtusa var. juniperina Ball. Ball, E. D. Ia. Acad. Sci. XXVI, (1919).

This species has been recorded from Arizona, California, Colorado, Massachusetts, Montana, North Dakota, Texas, Utah, Virginia, and Washington, D. C.

Nymphs, presumably of this species, and adults have been found on Juniperus.

Michigan records: Taylor Center, July 12, 1951, and Adrian, July 23, 1951.

Clastoptera obtusa var. obtusa Say.

Cercopis obtusa Say. Say, Thomas. Complete Writ. II,
p. 256, (1825).

This variety has been recorded from California, Colorado, Connecticut, Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Minnesota, North Carolina, Nebraska, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee, and Michigan.

Garman (28) reported the occurrence in Connecticut of two broods of Clastoptera obtusa Say. Eggs had wintered over on twigs. These hatched giving rise to a first brood of nymphs which matured in early summer. Eggs deposited by mature individuals of the first brood gave rise to a second brood of nymphs during the same summer. Eggs deposited by adults of this second brood winter over.

The number of broods occurring in Michigan is not known.

Michigan records: Douglas Lake, July 20, 1925.

Clastoptera obtusa var. tristis Van Duzee.

Clastoptera obtusa var. tristis VanDuzee. VanDuzee, Bul.
Buf. Soc. Nat. Sci. X, p. 508, (1912).

This variety has been recorded from Alabama, Arizona, California, Colorado, Iowa, Kansas, Maine, Massachusetts, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Florida, and Michigan.

Adults have been taken on Tillia.

Michigan records: Ann Arbor, July 5, 1951, and Flat Rock, July 5, 1951.

Clastoptera obtusa var. borealis Ball.

Clastoptera obtusa var. borealis Ball. Bal , E. D. Proc. Ia.
Acad. Sci. XXVI, p. 145, (1919).

This variety has been recorded from California, Colorado, Connecticut, Florida, Iowa, Kansas, Massachusetts, North Carolina, North Dakota, New Jersey, New York, and Michigan.

The writer has reared this variety from spittle masses occurring on Hamamelis in the vicinity of Flat Rock. The

mature forms were collected July 2, 1951. Adults have also been taken on *Tillia*.

Michigan records: Flat Rock, July 2, 1951, and Flat Rock, July 17, 1951.

Clastoptera achatina Germar.

Clastoptera achatina Germar. Germar, Zeit. f. Ent. I, p. 87, (1838).

This species has been recorded from Connecticut, Florida, Indiana, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Texas, West Virginia, Wisconsin, and Washington, D. C.

The writer has reared this species from spittle masses occurring on Carya. The mature forms were collected July 1, 1951.

Michigan records: East Lansing, July 1, 1951.

Genus Aphrophora, Germar

Aphrophora. Germar, Mag. Ent. Vol. 4, p. 50 (1821).

Aphrophora is represented in Michigan by four species. They are Aphrophora parallela (Say), Aphrophora quadrinotata Say, Aphrophora saratogensis (Fitch), and Aphrophora signoreti Fitch.

Aphrophora parallela (Say).

Cercopis parallela Say. Narr. Long's Exped., 1824.

The common name of this native insect is pine spittle-bug. This species has been recorded from Connecticut, Illinois, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Vermont, West Virginia, Wisconsin, and Michigan

The eggs are deposited at the bases of terminal buds of Pinus where they winter over. The eggs hatch in the spring and the young nymphs begin feeding on the twigs. Almost as soon as the nymphs begin feeding, they begin surrounding themselves with froth. There are five stages of

nymphal development. Before transforming into adults, the nymphs leave the spittle masses and migrate to the needles. The adult stage of this insect also feeds on Pinus. Attack by the pine spittlebug may cause serious injury, particularly to Scotch pine. The pine spittlebug was reported abundant during 1950 in several areas of Michigan. Heavy infestations were reported in Scotch pine plantations in Grand Traverse County. Scotch pine in the Higgins Lake Forest has been heavily infested for several years. Infestations of this insect were also reported along highway U. S. -2 in the Upper Peninsula and in the Rapid River District of the Hiawatha National Forest.

Michigan records: Cheboygan, July 23, 1928, and Higgins Lake, August 8, 1932.

Aphrophora quadrinotata Say.

Aphrophora quadrinotata Say. Jour. Acad. Nat. Sci., Phila., 1831.

This species has been recorded from Alabama, Connecticut, Georgia, Florida, Illinois, Iowa, Kansas, Maine,

Maryland, Massachusetts, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Tennessee, Virginia, Washington, D. C., West Virginia, Wisconsin, and Michigan.

Adults were taken on low vegetation.

Michigan records: Flat Rock, July 17, 1951; Flat Rock, July 24, 1951; and Flat Rock, July 27, 1951.

Aphrophora saratogensis (Fitch).

Lepyronia saratogensis Fitch. Cat. Hom. N. Y. 1851.

The common name of this insect is Saratoga spittlebug. This species has been recorded from Connecticut, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Wisconsin, and Michigan. The nymphal stages occur on sweetfern, Comptonia peregrina (L.) and many other plants. The spittle masses are formed usually just above the root collar, but below the surface of the forest litter. The adult forms migrate to Pinus or Larix. Serious injury to the host plant may result from adult feeding. Scar tissue forming around feeding punctures may coalesce and girdle branches. The Saratoga spittlebug was reported abundant during 1950 in three of

Michigan's forests. In the Baldwin district of the Manistee National Forest one hundred percent flagging of a red pine plantation was reported. Infestations also occurred in Ottawa and Hiawatha National Forests.

Michigan records: Higgins Lake, August 10, 1932, and Milford, September 4, 1921.

Aphrophora signoreti Fitch.

Aphrophora signoreti Fitch. Trans. N. Y. St. Ag. Soc., 1856.

This species has been recorded from New York, North Carolina, South Carolina, and Michigan. Adults have been taken on Pinus. The writer has reared this species from spittle masses occurring on Daucus, Quercus, Laportea, and Rubus, in the vicinity of East Lansing. The mature forms were collected on July 1, 1951.

Michigan records: East Lansing, July 1, 1951.

Genus Lepyronia, Amyot and Serville

Lepyronia. Amyot and Serville, Hist. Nat. Hem. p. 567 (1843).

Lepyronia is represented in Michigan by a single species,
Lepyronia quadrangularis (Say).

Lepyronia quadrangularis (Say).

Cercopis quadrangularis Say. Jour. Acad. Nat. Sci. Phila.,
VI, (1825).

This insect has been recorded from Colorado, Connecticut, Florida, Georgia, Iowa, Maryland, Mississippi, Nebraska, New Hampshire, New York, Ohio, Pennsylvania, South Dakota, Texas, Washington, D. C., and West Virginia.

This species is thought to hibernate in the adult stage among debris and litter on the ground. Presumably, the eggs are deposited during the spring in decaying stems of weeds. Spittle masses appear on a wide range of plants during early summer.

The writer has reared this species from spittle masses occurring on Baptisia, Lespedeza, Pedicularis, and Quercus in

the vicinity of Flat Rock. The mature forms were collected July 17, 1951.

Michigan records: Flat Rock, July 17, 1951, and Adrian, July 24, 1951.

Genus Philaenus, Stal

Philaenus, Stal. Stal, C., Stet. Ent. Zeit. XXV, p. 66, (1864).

Philaenus is represented in Michigan by two species, Philaenus lineatus (Linnaeus), and Philaenus leucophthalmus (Linnaeus). Philaenus leucophthalmus (Linnaeus) occurs in nine varietal forms.

Philaenus lineatus (Linnaeus).

Cicada lineata Linnaeus. Linnaeus, Faun. Suec., 241, 888, (1761).

The common name of this species is lined spittlebug. One generation of this insect occurs per year. The eggs winter over and hatch in early spring. The nymphs make

their spittle masses on various grasses. The adult forms appear in late spring and remain until the onset of cold weather.

The author has reared this species from spittle masses occurring on Poa, Danthonia, and Agrostis in the vicinity of East Lansing. The mature forms were collected June 24, 1951.

Michigan records: East Lansing, June 24, 1951; Romulus, July 10, 1951; and East Lansing, October 11, 1951.

Philaenus leucophthalmus (Linnaeus).

Cicada leucophthalmus Linnaeus. Linnaeus, Systema Naturae, Edition X, (1858).

The common name of this insect is meadow spittlebug. The synonym, P. spumarius, frequently appears in literature. This insect is widely distributed throughout the United States. Coloration of the meadow spittlebug is so variable that it can only be indicated under varietal forms. Varietal characteristics are somewhat intergraded, apparently resultant of indiscriminate inter-breeding. One generation of this insect occurs per year. The eggs (Plate I, Fig. 3) of the meadow spittlebug are deposited during the fall on the stubbles or lower portions of plants. The eggs are laid side by side and

covered with a tough, inelastic material. The eggs winter over and hatch in early spring. The nymphs feed on a wide range of weeds and cultivated plants. Among the plants attacked by the immature stages of this insect are strawberry, clover, and alfalfa. Nymphs may wander about on their host plants, or migrate from one host to another. Adult forms appear in late spring and remain until the onset of cold weather.

The author has reared this species from spittle masses occurring on the garden strawberry, Fragaria chiloensis Duchesne, in the vicinity of East Lansing. The mature forms were collected June 29, 1951. Included were Philaenus leucophthalmus var. lateralis (Linn), P. leucophthalmus var. marginellus (Fabr.), P. leucophthalmus var. fabricii Van Duzee, P. leucophthalmus var. pallidus (Zett.), P. leucophthalmus var. spumarius (Fallen), and P. leucophthalmus var. impressus DeLong. Presumably, these varietal forms occur along with P. leucophthalmus var. leucophthalmus (Linn.), P. leucophthalmus var. leucocephalus (Linn.), and P. leucophthalmus var. fasciatus (Fabr.) and are of similar habit. All varieties except Philaenus leucophthalmus var. leucocephalus (Linn.) were taken during the survey.

Michigan records: Hartford, June 5, 1951, and East Lansing, October 11, 1951.

Genus Philaronia, Ball

Philaronia. Ball, E. D. Ia. Acad. Sci., Vol. VI., p. 220, (1898).

Philaronia is represented in Michigan by Philaronia bilineata var. bilineata Ball, Philaronia bilineata var. orbiculata Ball, and Philaronia abjectus var. abjectus Uhler.

Representatives of this genus do not appear especially abundant in Michigan, as none were taken during the survey.

Insects of this genus have been recorded in Arizona, Colorado, Connecticut, Idaho, Iowa, Kansas, Maine, Massachusetts, Montana, Nebraska, New Hampshire, North Carolina, North Dakota, South Dakota, Utah, Wisconsin, and Wyoming.

Philaronia abjectus var. abjectus Uhler.

Philaenus abjectus. Uhler, P. R. Bull. U. S. Geol. Surv. I, p. 346 (1876).

Michigan records: Cheboygan, July 6, 1939.

Philaronia bilineata var. bilineata (Say).

Aphrophora bilineata. Say. Jour. Acad. Nat. Sci. Phila.,
VI, p. 304 (1831).

Michigan records: Manistique, July 15, 1925.

Philaronia bilineata var. orbiculata Ball.

Philaronia bilineata var. orbiculata. Ball, E. D. Ia. Acad.
of Sci. Bull. XXVI, p. 143, (1919).

Michigan records: Manistique, July 25, 1945.

A KEY TO CERCOPIDAE OF MICHIGAN

Adult members of family Cercopidae (Plate I, Figs. 1-2) have structure and arrangement which readily distinguish them from representatives of other homopterous families. The antennae, inserted beneath the vertex and between the eyes, are setaceous with two bead-like basal segments. The cylindrical hind tibiae, each crowned with a crescent of apical spines, bear one to three stout lateral spurs.

Representatives of the family Fulgoridae (Plate I, Fig. 7) may have similar tibial spurs, but in this instance the antennae are inserted beneath rather than between the eyes. Representatives of the family Cicadellidae (Plate I, Fig. 8) may be similar in general appearance to the cercopids, but close examination of the hind tibiae reveals a row of spines beneath, rather than one to three stout spurs.

Modification and adaptation of works by Ball, Walley, Stearns, and Doering have resulted in a key for the identification of spittlebugs occurring in Michigan. Determination to variety is frequently difficult where intermediate forms appear.

Illustrations of species and varieties (Plates I-IV) supplement the key. Hind wings (Plate II, Figs. 19-20) confirm determination of Philaronia abjectus var. abjectus Uhler and Philaenus leucophthalmus (Linn.). Genital plates (Plate II, Figs. 21-24) confirm male species of Aphrophora.

This key is based on readily available characteristics, making determinations possible with the aid of a hand lens.

Key to Genera

1. Small, globose insects having pronotum transversely wrinkled, clavus blunt and broadly rounded at the apex, and corium with a broad terminal membrane Clastoptera

- Larger, more elongate insects having acutely apexed clavus and corium lacking a terminal membrane 2

2. (1) Labium long with three visible segments and extending posteriorly beyond the hind coxae.

Vertex and pronotum with a distinct median

carina Aphrophora

- (1) Labium short with but two visible segments.

Labium extending posteriorly only to middle

coxae. Vertex and pronotum without a median

carina 3

3. (2) Anterior margin of vertex between eyes and

front compressed to a thin edge. Densely

pubescent above Lepyronia

Anterior margin of vertex between eyes and

front sulcate 4

4. (3) Elytra with about five usually easily dis-

tinguished apical cells. Slightly pubescent

above Philaenus

- (3) Elytra irregularly reticulated apically.

Venation indistinct. Densely pubescent

above Philaronia

Key to the Species and Varietal Forms
of Genus Clastoptera

1. Forms having the anterior portion of the
face shining black, the remainder bright
yellow 2

- Forms having the anterior portion of the face
chiefly yellow or brown 6

2. (1) Body obovate, tapering at both ends equally.
Entirely black above and, in general, dark
beneath Clastoptera hyperici Gib.

- (1) Not as above 3

3. (2) Broad, with elytra greatly inflated. Body
pear-shaped, widest posterior to the middle.
Front approximately equal to length of ver-
tex. A black band appearing on the postcly-
peus two-thirds or three-fifths its length . . . 4

- (2) Semi-elongate, pear-shaped, elytra moderately
inflated. Front not more than two-thirds length

of vertex. Black band on postclypeus usually
not more than one-half its length 5

4. (3) Each elytron with three oblique yellow stripes
. . . . Clastoptera saint-cyri var. saint-cyri Prov.

- (3) All black above except for brownish-hyaline
elytral apexes and in general yellow beneath
. . . . Clastoptera saint-cyri var. anceps McAtee

5. (3) All black above except for hyaline elytral
apexes and yellow bands across head and
pronotum . . . Clastoptera proteus var. oseola Ball

- (3) As above except with base of clavus yellow
. . . . Clastoptera proteus var. nigricollis Fitch

- (3) All yellow or washed in smoky hyaline. Some-
times the pronotum banded on the anterior
margin with black, or the entire pronotum
marginated in black
. Clastoptera proteus var. proteus Fitch

6. (1) Front at least two-thirds length of vertex.

The pronotum entirely yellow. Elytra light tan or fuscous, with markings and apical veins dark brown in sharp contrast. A band appearing on the postclypeus and small spots on the genae . . . Clastoptera juniperina Ball

- (1) Front at least one-half length of vertex . . . 7

7. (6) Posterior half of face black or sometimes

mottled proceeded by five or six pairs of arcs on postclypeus 8

- (6) Face yellow with a dark band across

middle proceeded by several pairs of dark arcs 10

8. (7) Elytra fuscous brown with an oblique white

band, sometimes only barely discernible, across clavus 9

- (7) Elytra uniformly bronze fuscous

. Clastoptera obtusa var. tristis Van Duzee

9. (8) Elytra very dark fuscous brown with a very
distinct white claval band
. Clastoptera obtusa var. borealis Ball
- (8) Elytra fuscous, mottled, with white claval
band much less distinct, sometimes only
barely discernible
. Clastoptera obtusa var. obtusa Say
10. (7) Pronotum uniformly yellow without brown
markings. No indication of a white band
on elytra. Elytra for the most part dark
fuscous except for the anterior portion of
the clavus. The anterior portion of the
clavus tawny yellow
. Clastoptera achatina Germar

Key to the Species of Genus Aphrophora

1. Insects having two more or less distinct
hyaline areas on each elytron. Postocular
space reduced to a mere line. Male genital

plates as figured (Plate II, Fig. 22)

. Aphrophora quadrinotata Say

Elytra without such hyaline areas. Post-

ocular space reduced to a mere line. 2

2. (1) Postclypeus greatly inflated and produced

beyond the front as viewed from above.

Head on mid-dorsal line two-thirds as long

as width across the vertex and eyes. Male

genital plates as figures (Plate II, Fig. 23)

. Aphrophora parallela (Say)

(1) Postclypeus never or only slightly seen

from above. Head on mid-dorsal line not

more than one-half as long as width across

the vertex and eyes 3

3. (2) Ocelli only slightly nearer posterior margin

of vertex than front. Front, vertex, and

pronotum usually with a broad median pale

stripe. Male genital plates as figured (Plate

II, Fig. 24). . . . Aphrophora saratogensis (Fitch)

- (2) Ocelli decidedly nearer posterior margin
of vertex than front. Front and vertex with
at most only a narrow pale median stripe.
Male genital plates as figured (Plate II, Fig.

21) Aphrophora signoreti Fitch

Key to the Species of Genus Lepyronia

Only a single representative of this genus
occurs in Michigan.

Elongate insects having the width across
the combined elytra less than one-half the
length of the body. Coloration varying from
dusky gray to deep tawny brown. A distinct
fuscous "V" appearing on each elytron . . .

. Lepyronia quadrangularis (Say)

Key to the Species of Genus Philaenus

1. Narrow, elongate species having tylus longer than broad. Elytra having costal margins parallel. Straw yellow above with the costal margin of each elytron white. Each elytron having a fuscous stripe arising at the base and running just mesad of the white costal margin and becoming indistinct toward the apex Philaenus lineatus (Linn.)

- Not as above 2

2. (1) Broader, more bulging forms. Tylus broader than long. Elytra having convex costal margins. Coloration so variable that it may be indicated only by variety. Forms included variously marked from all pale yellow through fuscous and brown to blackish, and with or without lighter markings

- Some varietal form of Philaenus leucophthalmus (Linn.)

Key to the Varietal Forms of Philaenus
leucophthalmus (Linn.)

1. Forms having four impressed dark pigment
spots arranged transversely across the an-
terior portion of the pronotum 2

- Forms lacking such impressed spots 3

2. (1) Philaenus leucophthalmus var. impressus De Long

- The general coloration of this varietal form
may vary greatly. However, it can readily
be identified by the occurrence of four im-
pressed dark pigment spots arranged in a
row transversely across the anterior portion
of the pronotum. Usually the area in the
vicinity of these impressed spots is lighter
in color than surrounding regions.

3. (1) Forms having longitudinally striped vertex
and pronotum 4

- Forms not having vertex and pronotum longi-
tudinally striped 5

4. (3) Philaenus leucophthalmus var. faoricii Van Duzee

Individuals of this varietal form are yellowish-white above with a fuscous to blackish median stripe arising from the anterior tip of the tylus (sometimes from the pronotum) and extending posteriorly along the inner margins of the elytra to the apex of the clavus. This median stripe is usually paralleled by a dark stripe on each corium.

5. (3) Forms uniformly all yellow or yellowish-

brown 6

Forms not uniformly all yellow or yellowish-

brown 7

6. (5) Philaenus leucophthalmus var. pallidus (Zett.)

Individual members of this varietal form exhibit rather uniform coloration. However, a wide range of shades and colors appears within the group. Coloration may vary from pale yellowish-white through yellowish, yellowish-red, and light yellowish-brown, to dark yellow-brown.

7. (5) Forms dark brown to blackish with yellowish
or lighter markings in sharp contrast 9
- (5) Forms dark brown to blackish without large
areas of yellow in sharp contrast 8
8. (7) Philaenus leucophthalmus var. leucophthalmus (Linn.)
Individuals of this varietal form are uni-
formly dark brown to blackish in color.
Sometimes traces of yellow occur on the
vertex or elytra.
9. (7) Fuscous and yellow forms having elytra
with two light spots on each costal margin . . 10
- (7) Forms not as above. Dark brown to blackish
above with yellow or light markings in sharp
contrast 13
10. (9) Forms having the vertex and anterior half
of the pronotum yellow; the remainder of the
pronotum and the elytra fuscous to brown . . . 12

- (9) Not as above. All over yellowish to fuscous forms having vertex of rather uniform coloration 11

11. (10) Philaenus leucophthalmus var. spumarius (Fallen)

This varietal form occurs in a variety of over-all colors ranging from yellowish to brown. In every instance, however, each costal margin will have two light markings which may vary from quite small spots to elongate areas extending across the elytra.

12. (10) Philaenus leucophthalmus var. fasciatus (Fabricius)

In this varietal form the costal margin of each elytron has two light markings as in Philaenus leucophthalmus var. spumarius (Fallen). It differs, however, in the markings of the vertex and pronotum. This color variety includes those forms having the vertex and anterior half of the pronotum yellow; the remainder of the pronotum and elytra fuscous to brown.

13. (9) Dark brown to blackish with yellowish or
light markings in sharp contrast. Forms
having elytra entirely dark brown to black-
ish 15
- (9) Elytra having a broad, white stripe along
each costal margin 14
14. (13) Vertex and pronotum entirely black 16
- (13) Vertex and anterior half of pronotum
entirely yellow 17
15. (13) Philaenus leucophthalmus var. leucocephalus (Linn.)
In this varietal form the vertex and an-
terior half of the pronotum are pale yellow,
while the remainder of the dorsal surface,
in sharp contrast, is dark brown or black-
ish.
16. (14) Philaenus leucophthalmus var. lateralis (Linn.)
In this varietal form the costal margins
of the elytra are pale yellow, while the

remainder of the dorsal surface, in sharp contrast, is dark brown or blackish.

17. (14) Philaenus leucophthalmus var. marginellus (Fabr.)

In this varietal form the vertex, the anterior half of the pronotum, and the costal margins of the elytra are pale yellow, while the remainder of the dorsal surface, in sharp contrast, is dark brown or blackish.

Key to Species and Varietal Forms of Philaronia

1. Width across elytra considerably greater than across vertex and eyes. The broadest portion of the elytra located slightly anterior to the middle. Tylus broader than long. Cubitus of hind wing (Plate III, Fig.) forked. Color reddish-brown to blackish-brown . . . Philaronia abjectus var. abjectus Uhler
- Not as above

2. (1) Width across elytra only slightly greater than width across vertex and eyes. Broadest portion of elytra located considerably posterior to the middle. Tylus longer than broad. Cubitus of hind wing not forked
 . . . Some variety of Philaronia bilineata (Say) 3
3. Pale straw above with costal margins of the elytra broadly white. Forms having a white median stripe, enclosed within two fuscous bands, extending from the anterior tip of the tylus posteriorly across the vertex and pronotum
 Philaronia bilineata var. bilineata (Say)
 Not as above 4
4. (3) Dark smoky brown above with the costal margins and the apical portion and the elytra creamy white in sharp contrast
 Philaronia bilineata var. orbiculata Ball

SUMMARY

It was undertaken to determine which species and varieties of spittlebugs occur in Michigan and to provide a key for the determination of the adult forms. Wherever possible, the key was supplemented with information concerning the biology and life stages of these insects.

Data was obtained by reviewing literature and by making collections and observations in the field. Also specimens were examined from the Michigan State College collection and the University of Michigan Museum of Zoology.

Nymphs naturally occurring on host plants were caged and the insects identified at maturity. Material to be reared was confined within cylinders of copper screening imbedded in the earth sustaining the host plant. The open ends of these cylinders were sealed with lawn cloth. In some instances, pockets made of lawn cloth and drawn closed with rubber bands were employed satisfactorily for confinement of immature stages to their host plants.

The identification key was supplemented with pictures. Photomicrographs were obtained by photographing the subjects through a binocular dissecting microscope.

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KEY TO PLATES

Plate I

- Fig. 1. Aphrophora quadrinotata Say, dorsal view.
- Fig. 2. Aphrophora quadrinotata Say, ventral view.
- Fig. 3. Egg mass, Philaenus leucophthalmus (Linn.).
- Fig. 4. Hind wing, Philaronia abjectus var. abjectus Uhler.
- Fig. 5. Male genitalia, Aphrophora parallela Say.
- Fig. 6. Philaenus leucophthalmus var. marginellus (Fabr.),
lateral view.
- Fig. 7. Fulgoridae, dorsal view.
- Fig. 8. Cicadellidae, dorsal view.
- Fig. 9. Lepyronia quadrangularis (Say), dorsal view.
- Fig. 10. Lepyronia quadrangularis (Say), lateral view.

Plate II

- Fig. 1. Nymph, Philaenus leucophthalmus (Linn.), dorsal
view.

- Fig. 2. Nymph, Philaenus leucophthalmus (Linn.), lateral view.
- Fig. 3. Nymph, Philaenus lineatus (Linn.), dorsal view.
- Fig. 4. Nymph, Philaenus lineatus (Linn.), lateral view.
- Fig. 5. Nymph, Aphrophora signoreti Fitch, dorsal view.
- Fig. 6. Nymph, Aphrophora signoreti Fitch, lateral view.
- Fig. 7. Nymph, Lepyronia quadrangularis (Say), dorsal view.
- Fig. 8. Nymph, Lepyronia quadrangularis (Say), lateral view.
- Fig. 9. Philaenus leucophthalmus var. leucophthalmus (Linn.), dorsal view.
- Fig. 10. Philaenus leucophthalmus var. leucocephalus (Linn.), dorsal view.
- Fig. 11. Philaenus leucophthalmus var. lateralis (Linn.), dorsal view.
- Fig. 12. Philaenus leucophthalmus var. marginellus (Fabr.), dorsal view.
- Fig. 13. Philaenus leucophthalmus var. fasciatus (Fabr.), dorsal view.
- Fig. 14. Philaenus leucophthalmus var. spumarius (Fall.), dorsal view.

- Fig. 15. Philaenus leucophthalmus var. fabricii Van Duzee,
dorsal view.
- Fig. 16. Philaenus leucophthalmus var. fabricii Van Duzee,
dorsal view.
- Fig. 17. Philaenus leucophthalmus var. pallidus (Zett.),
dorsal view.
- Fig. 18. Philaenus leucophthalmus var. impressus DeLong,
dorsal view.
- Fig. 19. Hind wing, Philaronia abjectus var. abjectus Uhler.
- Fig. 20. Hind wing, Philaenus leucophthalmus (Linn.).
- Fig. 21. Male genitalia, Aphrophora signoreti Fitch.
- Fig. 22. Male genitalia, Aphrophora quadrinotata Say.
- Fig. 23. Male genitalia, Aphrophora parallela (Say).
- Fig. 24. Male genitalia, Aphrophora saratogensis (Fitch).

Plate III

- Fig. 1. Philaenus lineatus (Linn.), dorsal view.
- Fig. 2. Philaenus lineatus (Linn.), lateral view.
- Fig. 3. Philaronia abjectus var. abjectus Uhler, dorsal view.

- Fig. 4. Philaronia abjectus var. abjectus Uhler, lateral view.
- Fig. 5. Philaronia bilineata var. bilineata (Say), dorsal view.
- Fig. 6. Philaronia bilineata var. bilineata (Say), lateral view.
- Fig. 7. Philaronia bilineata var. orbiculata Ball, dorsal view.
- Fig. 8. Philaronia bilineata var. orbiculata Ball, lateral view.
- Fig. 9. Aphrophora saratogensis (Fitch), dorsal view.
- Fig. 10. Aphrophora saratogensis (Fitch), lateral view.
- Fig. 11. Aphrophora parallela (Say), dorsal view.
- Fig. 12. Aphrophora parallela (Say), lateral view.
- Fig. 13. Aphrophora signoreti Fitch, dorsal view.
- Fig. 14. Aphrophora signoreti Fitch, lateral view.
- Fig. 15. Aphrophora quadrinotata Say, dorsal view.
- Fig. 16. Aphrophora quadrinotata Say, lateral view.

Plate IV

- Fig. 1. Clastoptera proteus var. proteus Fitch, dorsal view.

- Fig. 2. Clastoptera proteus var. osceola Ball, dorsal view.
- Fig. 3. Clastoptera proteus var. nigricollis Fitch, dorsal view.
- Fig. 4. Clastoptera proteus var. nigricollis Fitch, lateral view.
- Fig. 5. Clastoptera obtusa var. obtusa Say, dorsal view.
- Fig. 6. Clastoptera obtusa var. tristis Van Duzee, dorsal view.
- Fig. 7. Clastoptera obtusa var. borealis Ball, dorsal view.
- Fig. 8. Clastoptera obtusa var. borealis Ball, lateral view.
- Fig. 9. Clastoptera juniperina Ball, dorsal view.
- Fig. 10. Clastoptera juniperina Ball, lateral view.
- Fig. 11. Clastoptera achatina Germar, dorsal view.
- Fig. 12. Clastoptera achatina Germar, lateral view.
- Fig. 13. Clastoptera saint-cyri var. anceps McAtee, dorsal view.
- Fig. 14. Clastoptera saint-cyri var. saint-cyri Provancher, dorsal view.
- Fig. 15. Clastoptera saint-cyri var. saint-cyri Provancher, lateral view.

Fig. 16. Clastoptera hyperici Gibson, dorsal view.

Fig. 17. Clastoptera hyperici Gibson, lateral view.



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17



Fig. 18



Fig. 19

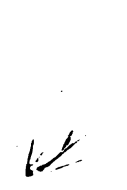


Fig. 20



Fig. 21



Fig. 22



Fig. 23



Fig. 24

PLATE III



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16

PLATE IV



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17

1

PLATE I

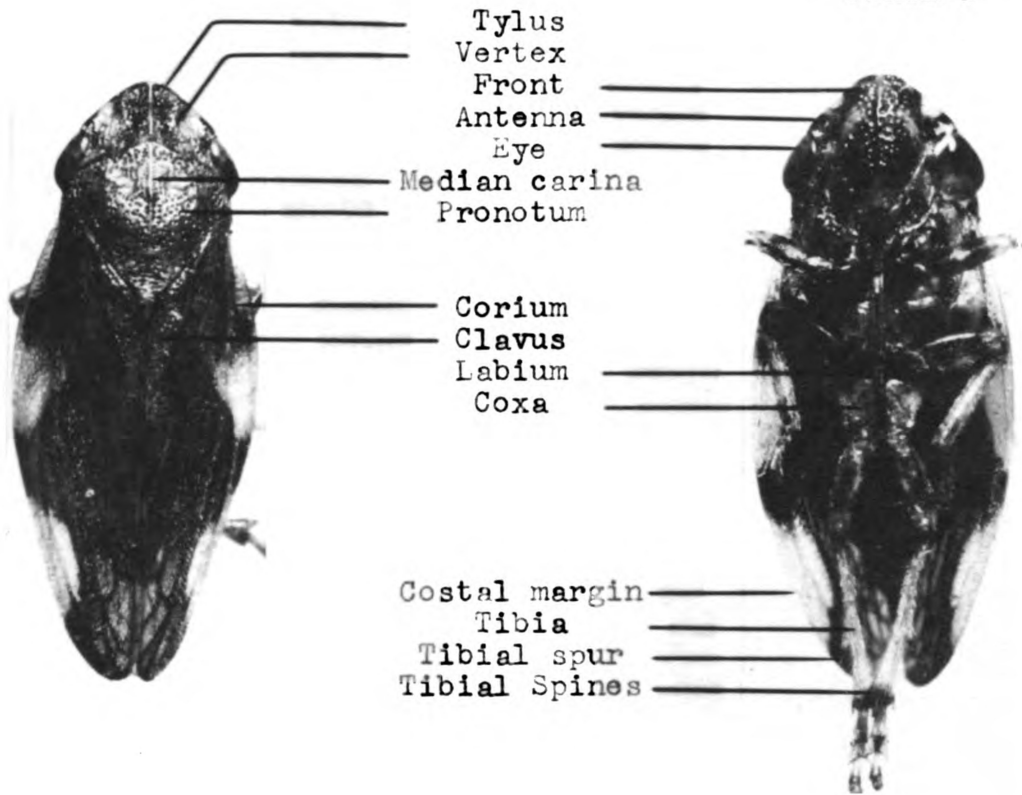


Fig. 3

Fig. 1



Fig. 4

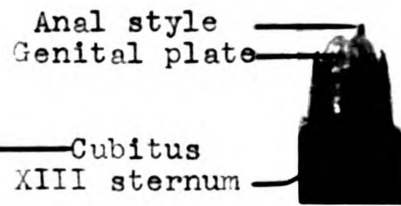


Fig. 5

Fig. 2



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10

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