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Plant Lice Infesting Grass Roots

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5th. The young corn plant shows injury if the seed has been immersed for fifteen minutes in water at 60.5°–61°C or more.

6th. The young corn plant shows injury if the seed has been heated for fifteen minutes in a dry oven at 65°C or more.

REMARKS.

The experiments show that corn heated, either dry or in water, may be considerably injured and still retain the power of germination; it may show a fair percentage of germination and be unable to push through an inch of soil. Hence, mere germination does not show the condition of the seed as regards vigor.

Bacteria in the cell cultures are a source of much annoyance. If a cell in which the spores do not germinate is found to contain large numbers of bacteria they may be the cause of the failure of the spores to germinate and the experiment must be repeated.

Spores of *Fusarium* when in immature condition so closely resemble the sporidia of corn smut spores that they are easily mistaken for them. It is not safe to conclude that the spores in a cell are germinating unless the promycelia are actually seen coming from the spores.

PLANT LICE INFESTING GRASS ROOTS.

HERBERT OSBORN AND F. A. SIRRINE.

During the fall of 1889 the senior author of this paper determined that a species of plant louse, infesting roots of annual grasses was identical with the "Dogwood plant louse" (*Schizoneura corni* Fabr.), carrying the work far enough to prove that the winged forms could be transferred from grass roots to dogwood, on which they colonized. As he found the root forms principally on annual grasses which were of no economic value, it was naturally a question of interest to determine whether they might affect forage plants. Furthermore, the occurrence of non-migratory forms on certain of the grasses examined,

left some questions which it seemed very desirable to follow up. In order to obtain winged forms and determine positively which of the annual grasses they migrate from, the following varieties: Barnyard grass, *Panicum crus-galli;* Old Witch grass, *Panicum cappilare;* Crab or Finger grass, *Panicum songuinale;* Foxtails, *Setaria glauca* and *viridis*, and some species of *Eragrostis*, were covered with large lantern globes during the fall of 1892. The globes were sunk into the ground around the plants and the tops closed by tying bunting over them. These traps failed to catch any winged forms, though at the time they were put out plenty of wingless forms could be found on the roots of the Barnyard grasses and Foxtails. It appeared from this that some mistake had been made, or that the work was not done with sufficient care. During the season of 1893, with a view to determine this matter, if possible, the "Dogwood louse" was bred in confinement and artificial transfers made. The wingless brood from the eggs was found on Dogwood or Silky Cornel (*Cornus asperifolia*, Michx.) May 17th, and confined by covering with cheese cloth. Young plants of Foxtail (*Setaria viridis*) were transplanted to flower pots and put in the green-house, lantern globes with tops closed with cheese cloth being put over the plants. In one jar a colony of the small field ant (*Lasius brunneus*) var. *alienus*, was put. This was done because these ants are usually found with root lice. On June 3d winged specimens of the second (?) brood were found under nets on Dogwood and transferred to jars containing Foxtail, by cutting off the twigs and inserting them into the dirt by the sides of the plants. They were left on the twigs because they are delicate to handle and, besides, in the case of the ants, it was a means of supplying the lice their natural food-plant for a few days till the ants could transfer them to the grass roots, in case the latter were essential to the migration. They have been observed carrying winged root lice out of doors during this season of the year. Both these transfers proved a failure, the lice refusing to colonize on the grass and dying. This may have been due to confinement, but seemed to indicate the wrong species of grass.

At the same time that the artificial breeding was being carried on observations were kept up in the field. On May 24 a root louse was found on Shepherds' Purse (*Capsella bursa-pastoris*, Mench.) and Knot weed (*Polyganum aviculare*, L.), which resembled *Schizoneura*, though of a different color than the

apterous specimens found on Dogwood at the same time, and having five instead of six jointed antennae. Plants of Shepherd's Purse containing the root lice and their attendants were transplanted to the green-house. No winged forms were obtained from these, the plants maturing and dying.

Winged specimens of root lice were found on roots of Foxtail (*Setaria viridis*) in field with ants June 24th. The venation of the wings showed them to be related to the *Schizoneura*, but they were not as large nor of the same color as the winged forms found on Dogwood. (Color dirty white, antennae, head, thorax and wing callosities slightly dusky, seventh and eighth abdominal segments each with a dusky band, sometimes with pulverulent area on abdomen. Joints III, IV, V and VI, each with one sensorium.) Furthermore, all winged forms had disappeared from Dogwood before June 15th. A few days later, June 28th, a plant of Foxtail was found containing pupæ and wingless root lice; this, with the colony of ants, was transplanted to root cage and kept in laboratory. July 3d winged individuals were obtained from root cage identical with winged forms found out doors on Foxtail June 24th. Winged specimens; taken in colonies on roots of Pigeon grass (*Setaria glauca*, Beauv.) at the same time, were apparently identical with those of the Foxtail. These latter were depositing their larvæ on the grass roots without apparent attempts to migrate.

The latter part of August, as the annual grasses commenced to die from the effects of dry weather, lantern globes, also tents made of bunting, were placed over the same species of grass as in the preceding fall. On August 30th ants were observed, apparently removing wingless root lice from one of the traps. This they accomplished by mining under the lantern globe. This fact may account for the failure to obtain winged forms from covered grass roots the previous fall. Examination of the roots of grasses earlier in the fall showed that the *Setarias* were most infested. Later in the season, when these grasses commenced to die, the lice were found more abundant on the Panic grasses.

Winged specimens of *Schizoneura corni*, Fabr., were found returning to Dogwood (*Cornus asperfolia*, Michx.), September 8th. As we had been watching annual grasses, it seemed more than evident that they could not have migrated from those, for no winged forms had been found on the roots since July 3d.

On September 22d a root louse, of a decided ochre yellow color, especially in the wingless and pupal forms, was found on roots of "Beard Grass" or "Blue Joint" (*Andropogon furcatus*, Muhl.), and "Cord Grass" or "Bull Grass" (*Spartina cynosuroides*, Willd.). A few winged forms were also found. These agreed more closely with those found on Cornus at the time than any previous root forms taken from grass. A similar root louse was found September 25th on roots of "Drop Seed" (*Muhlenbergia racemosa*, Michx.). Specimens of these perennial grasses, with root lice and ant colonies, were transplanted to pots and kept in the laboratory. At the same time, specimens of the same grasses were covered in the field with traps, the same as the annual grasses. From those covered out of doors and also those transplanted, winged forms issued and rested in large numbers on the sides of the traps. In color markings and structural characters these agreed with *Schizoneura corni*.. A plant of Dogwood (*Cornus sericea*, L.) had been covered with bunting early in the fall. To this, numbers of these winged forms were transferred, where they willingly deposited their brood of wingless males and females.

In examining the roots of the annual grasses, in one or two instances wingless lice were found, of a yellow color, but not of such marked character as those on the perennial grasses. On September 25th a few winged specimens were found on roots of Pigeon grass (*Setaria glauca*, Beauv.), one of which, from the wing characters, appeared to be a typical *Schizoneura corni*, but the ends of its wings had been gnawed off. The natural supposition was that the ants had captured it and made it a prisoner, or had transferred it from a perennial grass. The other specimens, taken at the same time, resembled the forms already mentioned as taken on this grass in July, except that the wing venation was very variable, as shown in figs. 7 and 7½. These were also transferred to Dogwood, where they perished.

At the time the winged *Schizoneura* were found on "Drop Seed" a wingless form of a dirty white color was found with them, resembling the wingless form on Foxtail. These latter forms could be found on roots of Panic grasses (*Panicum crus-galli* and *sanguinale*) and *Muhlenbergia racemosa* as late as November 10th. No eggs had been found so far on the roots of any of these grasses, that is, attached to the roots. In 1889 the eggs were observed in the earth in breeding jar.

During the spring of 1894 the following additional notes were made:

On April 12th large numbers of a *Schizoneurini-like* louse, which resembled the large wingless forms taken the preceding fall (Sept. 25) on roots of "Drop Seed" were found in an ant's nest (*Lasius latipes?*), stored under an old rotten stick. Roots of "Blue Grass" covered and penetrated this stick. A few were apparently attached to the roots. The majority were old fundatrici, apparently full of pseudova. A few specimens of larval forms were present. April 18th the same louse, apparently, was found with the same species of ant on strawberry roots. They were also found on roots of Blue Grass, with another species of ant (*Lasius flavius?*). Specimens of each were confined to root cages, but no winged specimens were obtained.

April 18th, found eggs of plant lice stored in chambers of the nest of *Lasius flavius?* The color was such that they closely resembled the light brown "mite" that is to be found on roots, especially around decaying and diseased roots. These were taken to the laboratory, where on April 23d they hatched into *Schizoneura-like* Aphids.

April 24th, found what is apparently the same larval root form of louse, as bred from eggs obtained in ants' nest, on roots of *Spartina cynosuroides* with *Lasius flavius?* Also found a few eggs. These differ slightly in color from the larval forms found earlier in April on Blue Grass roots and under the decaying stick. They are not as light colored, and are more hairy. A few days later these larval forms were quite plenty on roots of annual Panic Grass, or *Setarias.*

May 24, found pupal winged form and fundatrici of what appeared to be the same *Schizoneura* as taken the previous spring on roots of Setarias. Winged specimens similar to these latter were obtained on roots of *Panicum, Muhlenbergia,* and on *Œnothera biennis* in field June 2d, 8th and 26th.

Apparently none of the *Schizoneura corni* which were colonized under netting during the fall of 1893 survived. In fact, this species was very hard to find in any locality during the spring. A few colonies were located on some low protected cornus shrubs. Winged specimens were obtained from these colonies as early as May 28. A few winged specimens were found as late as June 15. Perennial grass roots were watched from the last of May till the middle of July, and the nests of

*Osborn, U. S. Dept. of Ag., Div. of Ent., Bull. 23, p. 25.

Lasius latipes and *flavius* examined on numerous occasions, but not a *Schizoneura corni* could be found. Even some artificial transfers proved a failure.

The latter part of August a winged specimen of *Schizoneura corni* was found on cornus. The peculiar conditions to which this species of *Schizoneura* was subjected, viz.: a warm spell in March, followed by freezing weather, and then the drouth of a midsummer, nearly annihilated this Aphid.

Although numerous descriptions of some stages of *Schizoneura corni* have been published, it seems desirable for sake of comparison to give full description of the root forms*.

Schizoneura corni root-type from perennial grasses, September 23d.

Adult winged viviparous form, from: *Andropogon furcatus:* Expanse of wings, 6.61mm. Length of body, 2.25mm. Width, 1.22mm. Length of antennæ, .87mm. (Joint I, .087mm; II, .06mm; III, .3mm; IV, .11mm: V, .13mm; VI, with unguis, .17mm.) Eight sensoria on joint three, two each on IV and V, one on VI. (It is doubtful if the roughened areas near apices of IV, V and VI are true sensoria, if not, then IV and V have one each.) Antennæ and head dusky to black, membrane of articulations, yellow; prothorax and margin of thorax, dusky; callosities, black; abdomen, yellow. A dusky brown patch covers the fourth, fifth and sixth, and sometimes base of third segments; a band of same color extends across the seventh and eighth segments, also spots of the same color occur on the connexivum. Eyes, brick red; wing insertions, yellow; distance between points of insertion of first and second discoidals and base of cubital approximately equal. The latter obsolete at base, furcal starting about midway between base and apex. Stigmal with slight compound curve. Stigma .435mm x .18mm†. Legs, dusky; apical portion of femora and tibiae darker.

After migrating and depositing pseudova the yellow colors are not so marked, while the dusky markings are darker, The shrinking of the abdomen causes the dusky patch to appear to cover the whole dorsal surface.

*Since plant lice are subject to slight variations in color markings. wing venation and sensoria markings, though probably no more than other insects, if examined with compound microscope, and as many species are covered with pulverulent and flocculent secretions, or with hairs, it would be a help, and avoid some error in comparison if authors would state under what conditions the descriptions are made. If examined with naked eye or hand lens, and held so the light is reflected, the pulverulent matter and hairs produce one color effect; if held between the observer and the light, enough light is transmitted through the thin body walls to give a different effect. If the specimens are mounted in balsam, and examined with compound microscope, different shades of color will be produced from those noted when examined before mounting. These latter will vary according to whether transmitted or reflected light is used. Unless otherwise stated the color markings as given are from mounted specimens with reflected light, and the measurements from transmitted light.

†The length of the stigma as given means distance from point of union of costal and subcostal veins and apex.

Adult winged viviparous form, from *Muhlenbergia racemosa.*

Color markings, venation, and length of antennæ and wings approximately the same as form on Andropogon, but the sensoria on joint III, vary from five to seven.

Apterous viviparous form, from roots of Muhlenbergia.

Length of body, 1.89mm. Width, 1.20mm. Length of antennæ, .83mm. Sensoria, one each on joints III, IV, V and VI. Whole body yellow; a few dusty brown bands on abdomen. Antennæ and legs, dusty brown; eyes, red.

Pupa: Length of body, 1.83mm. Width, .91mm. Length of antennæ .70mm. Sensoria not distinct except on joints V and VI.

Apterous viviparous form, from roots of Timothy (*S. corni ?.*)

Length of body, 2.00mm; width, 1.43mm; length of antennæ .42mm. Sensoria on joints IV and V, one on each joint. Color in balsam decidedly yellow. Beak reaching only to second coxæ, antennæ apparently five-jointed.

All the perennial grass root forms agree in having beak reaching slightly beyond second pair of coxæ, color of same varies from black in adult winged form, to light yellow in pupa. In adult winged forms there is a dusky brown patch before the anus, while in the apterous forms it is a continuation of the dusky bands on the eighth segment. (Possibly these bands and the quadrate patch are the location of dermal glands and the flocculent material is removed by the ants.) The legs and antennæ are hairy; body also slightly hairy.

Schizoneura corni[2], Spring migrant (second generation). From Cornus:

Expanse of wings, 6.00mm: length of antennæ, .69mm; (Joints I and II each, .05mm; III, .26mm: IV, .087mm; V, .095mm; VI, with unguis, .139 mm). Only two sensoria on joint III, one each on IV, V and VI. Venation as in fall migrant. Stigma .348mm by .174mm. Color and markings as in autumnal migrant, except the abdomen is reddish brown and without distinct quadrate patch, and the membranes of articulation are green. (Described with the exception of colors which were taken from notes, after clearing in balsam, and too shrunken for measurements and location of markings of body.)

Pupa: Length of body, 1.80mm; width, .87mm; length of antennæ, .53 mm; (joint I, .06mm; II, .065mm: III, .135mm; IV, .07mm; V, .087mm; VI, with unguis, .113mm). Sensoria on joint III, four; on IV, V and VI, one each. Color, head, wing callosities and margins of thorax, with wing pads white, or greenish white; thorax, yellowish brown; antennæ and legs, dusky white; abdomen light brown with two series of whitish dots on

[2]This form has previously been described by Kaltenbach; Monographie der Familien der Pflanzenlause, 1872, p. 168.

each margin; two yellow spots on head. No quadrate patch. Simply a dusky band on eighth and ninth abdominal segments.

Apterous adult (Fundatrix): Length of antennæ .52mm (joint I .069mm, II .06mm, III .13mm, IV .052mm, V .087mm, VI with unguis. 12mm). Length of body 1.82mm; width variable. Color light brown antennæ and legs dusky brown.

Larval fundatrix: .Fresh moulted specimens yellow, older specimens light brown, antennæ five jointed.

Schizoneura corni var (?) *panicola*, Thos.—Root-type from roots of annual grasses:

Winged vivip. form bred from *Setaria*, June 24, 1893 (probably spring migrant): Expanse of wings, 4.20mm: length of body, 1.67mm; width, .84mm; length of antennæ, .63mm. Joint III with one, and in a few specimens two sensora; joints IV, V and VI, one each. Color, grayish or greenish white; antennæ, head, prothorax and callosities dusky; seventh and eighth abdominal segments with dusky bands; some specimens show slight indications of pulverulent area; eyes red, legs dusky. Stigmal vein nearly straight. Cubital issuing close to second discoidal, in some cases following the latter a short distance. Point of issue of furcal variable, from two-thirds to three-fourths the distance from base to apex of cubital. Stigma, .32mm×.16mm. Contents of the body sometimes of a slight yellow tinge.

Apterous viviparous form: Length of body, 1.65mm: width, 1.13mm; length of antennæ, .57mm: sensoria only on joints V and VI. Color similar to winged forms. Antennæ and legs slightly dusky. Sixth, seventh and eighth abdominal segments with dusky bands; head slightly dusky.

Pupa: Length of body, 1.51mm; width, .78mm; length of antennæ, .52mm. Sensoria, one each on joints V and VI. Color nearly white.

In these forms the dusky bands on seventh and eighth abdominal segments extend entirely around on the ventral surface. Antennæ and legs hairy; body slightly hairy. In most cases the beak reaches third coxæ, and in apterous forms slightly beyond.

Dr. Forbes[3] quotes Thomas' description for *Schizoneura panicola* and adds:

Head and thorax are black; the abdomen pale, with imperfect dusky bands on the first and second segments, a quadrate dusky discal blotch, two terminal dusky bands, a series of quadrate dusky lateral spots, and two rows of black specks between these and the discal blotch. The antennæ are dusky throughout, sparsely pilose but not scabrous; .57mm long; the legs are black, and tip of abdomen and the band upon the preceding segment are also black. The beak is long, reaching to the abdomen: the body measures 1.57mm by .7mm, and the wing is 1.7mm. The tip of the abdomen is hairy, the tail is minute, the cornicles wanting being represented by a simple pore on the surface, measuring .13mm in diameter, and having the appearance of a black circlet within the dusky patch. Found on roots of Setaria and Panicum June 13th.

A late form from roots of corn October 13, 1891.

[3]13th Ill. Rept. 1884, pp. 51-54.

Expanse of wings, 4-92mm; length of body, 1.827mm; width, 1mm length of antennæ, .70mm. Joint III, two or three sensoria; IV, V and VI, one each. Other characters as in Schizoneura on Setaria.

Apterous viviparous form; length of body, 2mm; width, 1.36mm; length of antennæ, 0.65mm; no sensoria on joint III, in some cases one on IV, one each on V and VI. Body distinctly ovate.

The apterous form found late during the fall of '93 on roots of Drop seed (Muhlenbergia) and early in the spring of '94 on ants' nests are distinguished by being nearly twice as large as apterous forms found on annual grasses, by having the thorax margined and provided with a spine, by having very indistinct eyes, by the remarkably long rostrum which reaches to nearly the middle of the abdomen, and by having a rather large blunt cauda. This probably corresponds with what is generally described as Tychea.

From the results obtained thus far and the observations made by the senior author in 1889[4], also from the description as given as well as from those given by Dr. Thomas[5] and Prof. Forbes[6] for *Schizoneura panicola;* it seems that there must be two distinct root forms of *Schizoneura* infesting grasses. The true *Schizoneura corni* occurring mainly on roots of perennial grasses from June 15th to October, and the *panicola* form found in the ground at all seasons. The former is characterized further by having the habit of the brood next to the last migrating from the grass roots to Dogwood and depositing a brood of wingless males and females on the leaves, the females depositing their eggs on the rough bark. The eggs hatch about the middle of May. We have observed that the first brood feeds upon the tender stems, base of leaves and in flower clusters in Dogwood. This fact was noted in 1891[7]; also by Kaltenbach[8]. The second brood, as far as observed, feed together in the flower clusters until full grown, when they develop wings and migrate from June 1st to 15th, undoubtedly to perennial grasses, and locate upon the roots. The latter, the form described by Dr. Thomas as *Schizoneura panicola*, occurs throughout the whole season on roots of annual grasses. Whether this should be considered a distinct species we think still an open question, From the facts gathered in 1889 it was thought to be identical

[4]Osborn. U. S. Dept. of Ag , Div. of Ent., Bull. No. 22, pp 32-41.

[5]Thomas. Eighth Report, St. Ent., Ill., pp 131-139.

[6]Forbes. Thirteenth Report, St. Ent., Ill , 1884, pp 51-54.

[7]Osborn. U. S. Dept of Ag., Div. of Ent., Bull. No. 26, p 59.

[8]Kaltenbach. Monographie der Famlien der Pflanzenlause, p 168.

with corni, with the probability of a dimorphic form that remained on grass roots, or in the ground during winter. The observations of the past two seasons, however, seem to indicate a more distinct separation even than this. The fact that the *panicola* form has a fairly constant difference in color of the apterous individuals, is found quite constantly on annual grasses only, and its pseudogynes failed to colonize on Cornus, or the spring migrants from Cornus to colonize artificially on roots of annual grasses, favor the conclusion that it has become established as a variety at least, if not a distinct species. On the other hand the identity of almost all structural details and the fact that undoubted *corni* has been bred from *Setaria* and colonized on *Cornus*, also that one specimen of *corni* was taken on *Setaria* the fall of 1893, along with the extreme variability of the wing venation in the form found on grass roots seem to indicate a close relationship between the two.

There seems to be excellent reason for believing that the *panicola* form, if not a dimorphic one, is a variety which has arisen from *corni* as its antecedent and which, by the fostering care of ants, or possibly by selection of food plants, or some other condition, has become established as a permanently subterranean form.

The variability of the structural characters, especially the venation; the number of its food plants; its dependency upon ants and the occurrence of winged forms without migration, all seem to point to comparatively recent origin for this form[8].

Whether a variety or a dimorphic form, from the observation of Prof. Forbes, the facts gathered in 1889, and from those gathered the past season, it seems that their life cycle is as follows:

The eggs are probably deposited in the soil, though they have not been found on the roots of annual grasses, and stored by ants in their chambers. In the spring the eggs, or newly hatched lice, are gathered and carried by ants to the roots of young Panicums and Setarias, possibly to the roots of Spartina cynosuroides Œnothera biennis, where they feed till the middle of May, or till the first of July, at which time they are transferred to roots of Foxtail and corn. As the Foxtail dies early in the autumn they are again transferred to the Panicums, in

[8] One fact which is very strongly in favor of its being a distinct species is its habit of producing winged forms, principally in the spring. This habit has been noted in *Melonoxanthus floccolosus*, *Chaitophorus spinosi* and in a sedge infesting form.
F. A. S.

the earth around the roots of which they deposit their eggs. Corn is given as one of the plants infested as it is so recorded by Prof. Forbes[9], and specimens were received here from Mr. Jabez Bower[10], of Norway, Iowa. We have not found them on corn in this locality.

RECORD OF HOST PLANTS FOR BOTH FORMS.

Schizoneura corni.

Aerial type. Cornus sericea and C. asperifolia (Weed[11] gives C. sangiunea, which is not listed as occurring in this country). Buckton[12] gives C. sanguinea as its host plant in Europe.

Subterranean type. Observed at Ames, Iowa; Andropogon furcatus, A. scoparius, Spartina cynosuroides, Muhlenbergia racemosa, Panicum virgatum (?),* Phleum pratense (?).*

Recorded by Lichtenstein[13] *Schizoneura venusta ? Setaria viridis, S. verticillita.*

Recorded by Lichtenstein[13] *Schizoneura venusta* ? *Setaria viridis, S. verticillata.*

Schizoneura corni var.(?) *panicola.*

Subterranean type. Observed at Ames, Iowa. *Setaria glauca S. viridis, Panicum crus-galli, Eragrostis major?, Capsella bursa-pastoris* [*?*],* *Polyganum aviculare* [*?*] Spartina cynoseroides Œnothera biennis?) and corn (*Zea mays*).

Recorded by Thomas[14] *Panicum glabrum.*

Recorded by Passerini, *Setaria glauca, S. viridis, S. italica, Panicum glabrum, Fragrostis megastycha* and *Ceratochloa australis.*

Recorded by Forbes[15] *Setaria, Panicum glabrum,* Corn (*Zea mays*) and Sorghum.

NOTES ON SYNONOMY.

In the 13th report of the entomologist of Illinois, Forbes gives *Schizoneura venusta* as probably identical with *Schizoneura*

[9]Forbes. Thirteenth Report. St. Ent., Ill., 1884. p 52.

[10]Osborn. U. S. Dept of Ag. Div. of Ent, Bull., No. 26, p 59.

[11]Weed. Psyche. Vol. V, 1888, p. 129.

[12]Buckton. Monograph of British Aphids, Vol. III, p. 107.

[13]Forbes. Thirteenth Report St. Ent., Ill, 1884, p. 52.

[14]Thomas. Eighth Report St. Ent., Ill., p 139.

[15]Forbes. Thirteenth Report St. Ent. Ill, 1884. p. 52.

* The winged forms have not been obtained from these plants, but the apterous forms on Panicum virgatum and Timothy seem to agree with the *corni*, and those on annual plants with *panicola.*

panicola Thos., which was also suggested by Thomas, but so far as descriptions can be relied upon *venusta* seems to be more closely related to *corni*. Quoting from the American Entomologist, 1880, page 129, he also says: "This species, *Pemphigus boyeri* Pass., is believed by Lichtenstein to represent two of the stages of *Schizoneura corni* Koch," but Lichtenstein, in his monograph in 1885, gives "*Pemphigus boyeri* Pass. = *Aphis radicum* Boyer, *Amycla fuscifrous* Koch., forme souterraine du *Tetraneura ulmi*."*

Buckton says: "M. Lichtenstein has hazarded the supposition that *Schizoneura venusta* is the underground form of *Schizoneura lanuginosa*." He also gives *Anœcia corni* Fabr. But Lichtenstein, in his Mon. Des Aphideans, 1885, gives *Anœcia corni* Koch. as a synonym of *Schizoneura Kochii* Licht. Koch's figures of *Anœcia corni* is not colored to represent a typical *Schizoneura corni*.

SYNONYMS.

Schizoneura corni Fab.

(1794) *Aphis corni* Fabricus, Ent. Syst., IV, 214.

(1857) *Schizoneura vagans* Koch, Die Pflanzenlause Aphiden, 268.

(1857) *Anœcia corni* (?) Fab., Koch, Pflanzenlause Aphiden, 275.

(1860) *Schizoneura venusta* Passerina (?), Gli Afida, p. 38.

(1852) *Eriosoma fungicola* Walsh, Proc. Ent. Soc., Phll., I, 304.

(1862) *Eriosoma cornicola* Walsh, Proc. Ent. Soc., Phil., I, 304.

(1872) *Schizoneura corni* Fab., Kaltenbach Monographie der Familien der Pflanzenlause, p. 168.

Schizoneura corni var (?) *panicola* Thos.

(1879) *Schizoneura panicola* Thomas, 8th Rep. Ill. Ent., p. 138.

(1889) *Schizoneura corni* Fab., Osborn Bull. 22 Div. Ent. U. S. Dept. Ag., 1889.

* At the time I prepared my article on this subject in 1889 I overlooked the references to the subject in Am. Entom. and in Forbes' Report, and while I was aware that Lichtenstein had been at work upon the migrations of some species, notably those infesting elm, his works were not at the time accessible to me, and I was entirely unaware that any suggestion even had been offered that *Schizoneura corni* had a subterranean form, H.O.

ECONOMIC CONSIDERATIONS AND REMEDIES.

Working as these forms do, on the roots of grasses, their injury is not noticed. The form that infests annual grasses is of but little economic importance unless they are transferred to corn by ants. Thorough cultivation will check this tendency, as the ants do not like to have their formicaries disturbed, and doubtless a proper rotation of the corn crop would avoid most of the injury. Though the perennial grasses, on which the migratory forms were most commonly found, are not used much in some parts of the state, they are the best native grasses we have. In localities where they are used the vitality must be greatly reduced by the juices being pumped away from the roots by these small pests. If timothy proves to be commonly infested, the importance of the pest is great. The most practical remedy at present seems to be the destruction of the worthless Dogwood shrubs. Spraying in the spring with kerosene, emulsion, would be effectual if these shrubs were not scattered around in every hedge row and fence corner in the country, but as the Dogwood possesses no value except possibly in some instances as an ornamental shrub, it would seem the part of wisdom to destroy them entirely. They should be cut up from the roots in late autumn, in winter, or early spring (at latest before blossoms open), and burned.

SUMMARY.

Schizoneura corni spring migrant failed to colonize artificially on annual grasses.

Schizoneura panicola failed to colonize artificially on Cornus when transferred in autumn.

Schizoneura from perennial grasses gave fall migrants that colonized readily in numbers when artificially transferred.

There are two, if not three, distinct forms on roots of grasses, one occurring mainly on perennials and migrating in autumn to Cornus, the other occurring on a variety of annual plants and remaining for the most part under ground, but depositing eggs each season, while the third hibernates in chambers of ants.

Schizoneura corni, root form, occurs on wild grasses and probably timothy.

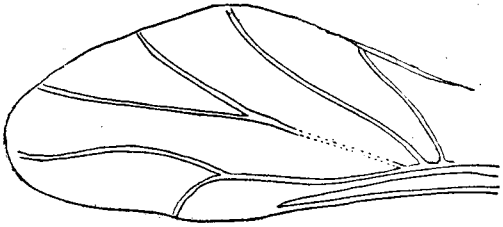

Fig. 1. *Schiz. corni* from roots of *Andropogon furcatus.*

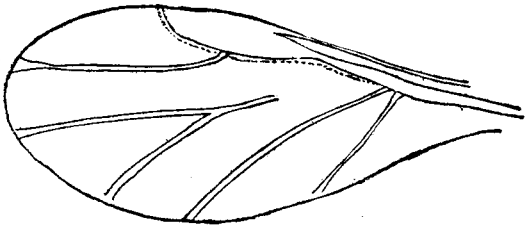

Fig. 2. *Schizoneura* from roots of *Letaria* and colonized on *cornus* in 1889.

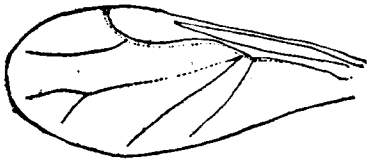

Fig. 3. Roots of *Setaria viridis.* 6-24-93.

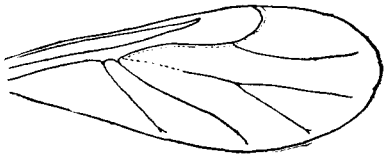

Fig. 4. Bred from roots of *Setaria glauca.* 7-3-93.

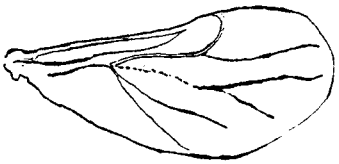

Fig. 5. Roots of *Setaria glauca.* 8-25-93.

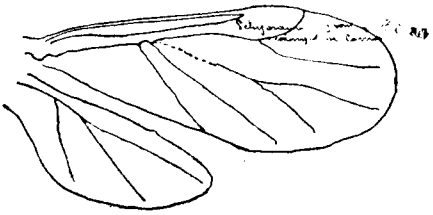

Fig. 6. Roots of Corn. Norway, Iowa. 10-13-91.

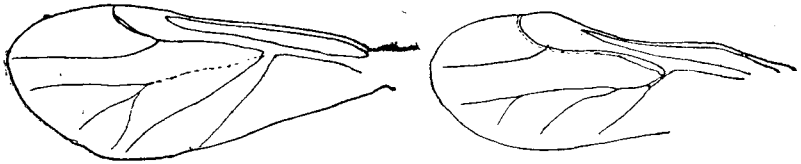

Fig. 7. Fig. 71.
Abnormal variations in spurs from *Panicum crusgalli.*

VARIATION OF SCHIZONEURA.

Schizoneura panicola is permanently root-inhabiting unless a dimorphic form, and occurs on roots of weeds, and also on corn and sorghum.*

Both forms are of economic importance, and may at times cause serious injuries.

The aerial form of corni may be destroyed by burning the Dogwood bushes in late autumn, winter or early spring.

The panicola form may be prevented from injury to corn or sorghum by a rotation of crops and by thorough cultivation.

EXPLANATION OF FIGURES OF VENATION OF SCHIZONEURÆ FROM GRASS ROOTS.

1. *Schizoneura corni*, from roots of *Andropogon furcatus*, (typical venation of *S. corni* on Cornus leaves.)

2. *Sch. corni.* From roots of Setaria, (specimen colonized on cornus in autumn of 1889, shows typical *corni* venation.)

3. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria viridis, June 24, 1893. Typical venation for the *panicola* form, but third discordial is forked a little nearer the base than in average specimens.

4. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria glauca, July 3, 1893. (Differs from No. 3 in point of furcation of third discoidal.)

5. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria glauca. Sept. 25, 1893. (Shows variation in point of origin of discoidals, all three starting close together.)

6. *Schiz. corni*, var. *panicola.* Thos. From roots of corn, Norway, Iowa, Oct. 13, 1891.

7 and 7½. *Schiz. corni*, var. *panicolu* (?). From roots of Panicum crus galli, autumn of 1892. (Showing variations from normal venation. The costa of lower figure was probably distorted slightly in mounting.)

In 1 and 2 the veins are drawn with double lines, as they were too robust to represent correctly by single line.

* The apparent failure to find *S. corni* on perennial grasses should not be taken as conclusive that there is another set of food plants besides the perennial grasses and cornus. As already stated, the scarcity of this species made it difficult to locate them. Not over 500 specimens were seen during the whole spring. When these were scattered by the winds at the time of migration, what few were picked up by the ants would still be harder to find. The work was given up after July 15.