OKLAHOMA
AGRICULTURAL AND MECHANICAL
COLLEGE

AGRICULTURAL EXPERIMENT STATION

STILLWATER, OKLAHOMA

BULLETIN NO. 116 JULY, 1917

THE SYCAMORE LACE-BUG

(*Corythucha ciliata,* Say)

BY OTIS WADE

DEPARTMENT OF ENTOMOLOGY

THE SYCAMORE LACE-BUG

(*Corythucha ciliata,* Say)

INTRODUCTORY

The importance of the sycamore lace-bug as a pest in Oklahoma first occupied the writers' attention two years ago (1915) while making a study of the western sycamore or buttonwood tree (*Platanus occidentalis*) as a suitable shade tree.

Previous to the summer of 1915, when this problem was first taken up by the writer under the direction of Professor Sanborn, considerable data and material relative to the life history and habits of this insect had been worked out by the Station entomologist, but this data, together with Ms., collections, etc, was entirely lost in the Morrill Hall fire. This necessitated beginning anew the entire project, which the writer was fortunate in being allowed to undertake.

Since this tree is gradually coming into favor for planting throughout its natural habitat the seriousness of this insect's attacks caused a thorough study to be made of its life history and habits, and of the most practical methods for its control.

The western sycamore has few serious insect enemies and, in Oklahoma, is practically free from insect depredations, aside from the bag-worm and this lace-bug, which is found wherever its host tree thrives.

HISTORICAL

The family *Tingidae,* to which the sycamore lace-bug belongs, presents a very interesting group of unique and beautiful insects which have scarcely received the attention they deserve from economic entomologists until quite recently. Some of the more important ones which have been studied in detail are the Oak Tingid (*Corythucha arcuata,* Say) by Morrill, and *Gargaphia solani,* Heid, by Fink. The latter species is quite important as a pest of the eggplant.

The lace-bug of the sycamore was described by Say in 1831 as *Tingis ciliata.* In 1873 Stal created the genus *Corythucha* and transferred *ciliata* to it.

DISTRIBUTION

The sycamore lace-bug is widely distributed throughout the United States; it is the most common and probably the best known of the *Tingids*. The writer has found it in every locality in Oklahoma where the sycamore is grown. During the summers of 1915 and 1916 it was particularly abundant in Oklahoma City, Muskogee, Tulsa, Guthrie and numerous other localities where the sycamore is becoming more popular, and it was a source of great damage to the foliage, especially of the younger trees.

LIFE HISTORY AND HABITS

C. ciliata is distinctly a sycamore lace-bug and confines itself to the genus *Platanus* so far as I have been able to learn from personal observation and from data of the more recent writers who have been careful to distinguish it from closely allied species inhabiting other host plants.

It is found throughout the range of the western sycamore (*P. occidentalis*) and has been taken into new localities with its host where the tree is grown for street and park shade. Although I made frequent observations in the nurseries of Oklahoma where the eastern plane tree (*P. orientalis*) is propagated, I have never seen it attacking this tree, and I can find no reference in literature to its having been taken from this host. Two other very similar buttonwood trees are found growing wild in the Western and Southwestern United States where the sycamore lace-bug is found and they no doubt act as exclusive hosts. These are *Platanus wrightii* of Arizona and New Mexico and *Platanus race-*

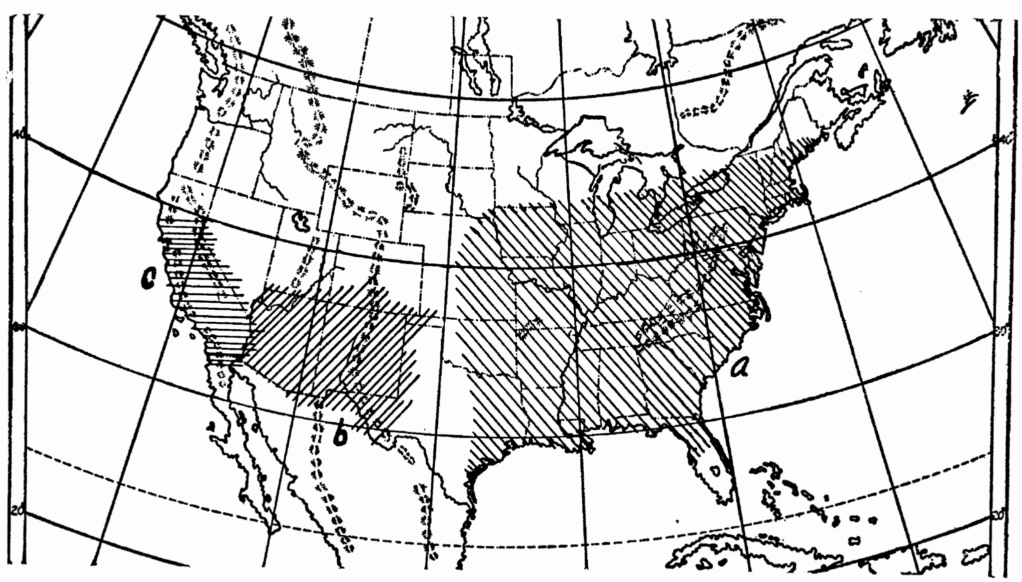

Figure 1—Map showing distribution of *P. occidentalis* in the Eastern United Statse; *P. wrightii* in Arizona and New Mexico; *P. racemosa* in California

mosa of California. The range of these two species is not altogether definite and may extend beyond or overlap the limits shown in the accompanying map.

The under surface of the leaves serve exclusively as feeding grounds and breeding places for the lace-bug, and while the adult is capable of making short flights it stays rather close to the leaves in its immediate vicinity, seldom leaving the tree unless there are other trees adjoining very closely. They seem to pair off, with a male and female found together on a leaf, although several pairs, as many as three or four, may be seen on one leaf. They are never found feeding on the upper surface of the leaves and will not stay if placed there. No doubt they find the surface underneath more easy to pierce and more succulent, together with the protection of the large ribs and downy pubescence of the under surface which attracts them. The immature bug moving about on the leaf with a mass of this fuzz or pubescence attached to the spines of its back, presents a striking and grotesque appearance. The adults, as well as the young, are capable of doing severe injury to the foliage by sucking the sap and leaving the foliage in a whitish, deadened state. The nymphs (immature forms) upon hatching, stay in groups and move about over the leaf, keeping very close together. They seldom leave the leaf upon which they hatch until the fourth stage is reached, when they begin moving about more freely and are inclined to separate into smaller groups or go about singly.

Hibernation

The sycamore lace-bug, as is common with all members of the *Tingid* family, the writer has observed, hibernates in the adult form, usually under the loose, rougher bark of the host tree, or it may sometimes be found in the cracks and crevices of fences, buildings, etc., near or under the sycamore tree. In Central Ohio they may be found going into their winter quarters about the middle of October; in Oklahoma the time is somewhat later, about a month. While there are still immature forms on the leaves in all stages, some of these successfully arrive at the adult stage and go into hibernation, but the majority are cut off with the first real cold and frost before they mature. No immature forms succeed in passing the winter, and seem never to seek a place of shelter in the late fall. The adults are able to withstand pretty severe cold, being able to weather a temperature as low as 10° below zero, although many of them, not favorably protected, succumb to the rigors of winter. In a particularly severe winter, as was experienced in Ohio the past year (1916-17), 50% or less are able to survive till warm weather. The writer collected some 300 individuals on the 15th of October, 1916, put them in salve boxes and placed them outdoors in a well protected place under an old crock.

They were brought into the insectary the 1st of March and less than half of them revived and lived. An interesting fact was here discovered; within fifteen to thirty minutes after being brought in from the cold to a temperature of 60° F., or above, the hibernating forms would be thoroughly active, and when placed on the leaves of the host tree would go to the under side at once and begin feeding. Owing to the milder winters in Oklahoma, a greater percentage are enabled to live till spring in well protected places and, together with the longer season of warm weather, they can accomplish very much more destruction than farther north and east, where the growing season is short.

The hibernating forms, with the approach of warm weather, will come out especially on bright, sunshiny days and swarm about over the trees, but on a cold day they again seek cover. By the time the trees are well in leaf they have ascended to the foliage and are feeding. About ten days are spent in feeding and mating before the females begin ovipositing.

Egg Laying

The eggs are laid along the larger ribs, the female seeming to prefer the forks of the ribs where she thrusts the egg, gluing it to the leaf surface and leaving it partially covered by the leaf fuzz. The eggs may be laid singly or in groups of as many as ten. Less frequently the eggs are deposited in larger, irregular patches on the leaf away from the ribs. Each egg is placed on end, usually erect, but frequently inclined to one side. The act of depositing an egg requires about two minutes, during which time the female has the ovipositor thrust forward against the leaf tissue, the wings are slightly spread and braced against the leaf as she leans back on them, they forming as it were, with the body and legs, a tripod for support while she places the egg and covers it with the sticky secretion. This gluey substance is spread over the chorion and in some instances is so profuse as to partially bury the egg. The females frequently seem to have an overabundance secreted which they exude in small drops when not depositing eggs.

The number of eggs a female will lay has not been determined definitely. The experiments I began in the insectary in early March this year have not had sufficient time to determine this point, as there are still several females ovipositing. One female began depositing eggs on March 18 and had laid a total of 157 eggs when lost in transfer to fresh leaves. Another began depositing eggs March 18 and had laid 284 eggs up to June 9, when she died after being transferred a distance of several hundred miles. An interesting fact was noted in connection with the number of eggs an individual female will lay. The total number for one female for one day rarely exceeds fifteen, usually from seven to ten, and every other day this number is reduced by about half.

To illustrate: The following indicates the number of eggs laid by a female during a period of several days—March 19, 6 eggs; March 20, 12 eggs; March 21, 4 eggs; March 22, 9 eggs; March 23, 2 eggs; March 24, 11 eggs; March 25, 4 eggs. Some intervening days no eggs will be laid at all.

Flight of the Adults

The mature insect, when disturbed, will make short flights, darting about in a zig-zag manner. The flying wings are delicate, membranous structures, not strong enough for flights of great duration. The wing covers are extended at right angles and vibrated rapidly; they serve as balances for the insect while it is flying.

Life Cycle

The breeding experiments conducted by the writer were carried on in the insectary during March and April before the sycamores outside had put forth leaves, and while not exactly representing natural conditions, they should approximate quite closely the average growing conditions in Oklahoma throughout the summer. (See accompanying figure with curve showing the mean temperature and humidity for this period.)

It was found that temperature was an important factor in the time required for the hatching of the egg as well as the time necessary for each nymphal stage. The eggs hatch in from fourteen to twenty-one days. Under optimum conditions they

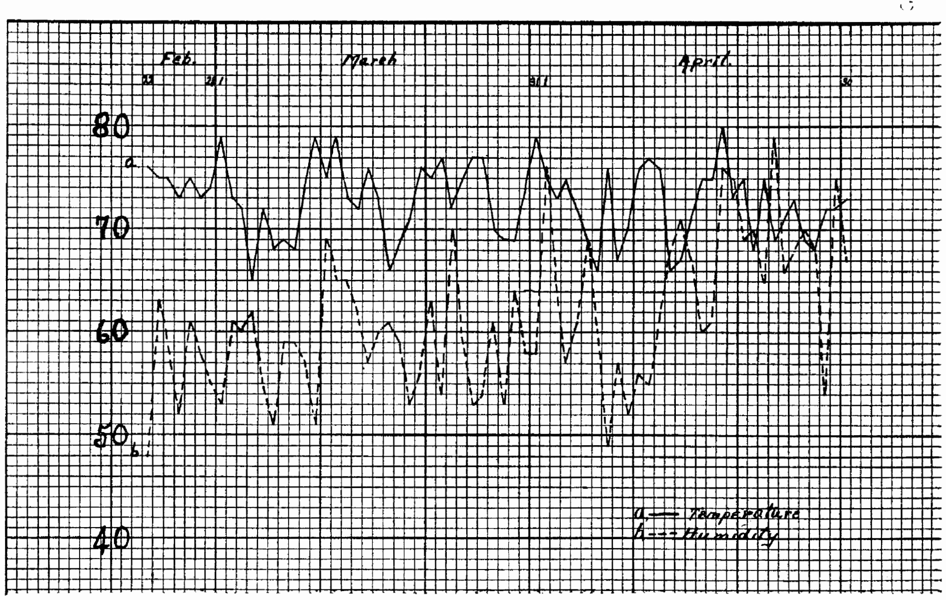

Figure 2—Curve showing humidity and temperature maintained in insectary during life history studies; *a*, temperature curve; *b*, humidity curve (original)

hatch readily in fourteen to fifteen days, by far the greater number requiring fifteen days. In hatching, the egg cap is pushed up by the head of the emerging nymph, which gradually forces itself out at the top of the shell by aid of the spines on its back. The thin, delicate membranous sack about the nymph is forced up with it and acts as a support for the small, compressed bug while it is expanding and drying out and extending its legs and antennae. This sack-like pellicle is split along the back after the nymph is partially out of the shell and slips off over the head in front carrying the egg cap with it.

The time required from the time the nymph begins pushing up the cap until it is free from the egg is approximately twenty minutes by actual count made on several occasions. The newly hatched nymph begins feeding at once and grows rapidly; at the end of the third day it molts into the second stage. If the temperature is very cool, the time may be extended a day, or even more.

The second stage is very much the same as the first, requiring three days to get its growth, or a day or two longer if the weather is cool. After molting to the third stage, another four days are necessary for the completion of this stage. I have observed a very few to complete the third stage in three days, but by far the greater number require at least four days under very favorable conditions. The fourth and fifth stages each require at least five days for full development with the temperature and moisture ideal.

Thus we see that the time required from the laying of the egg to emergence of the adult, with optimum conditions, is:

Egg	15 days
First instar or stage	3 days
Second instar	3 days
Third instar	4 days
Fourth instar	5 days
Fifth instar	5 days
Total	35 days

This time may be reduced to thirty-three days in a few instances when the egg stage lasts fourteen days and the third instar but three days.

With cooler weather the time from the egg to adult may often be extended to forty-six days, as was shown by several tests made with the immature forms on a small tree placed near the "cold room" from whence a chilly draft constantly passed over the bugs which were on the lower leaves of the tree.

In these experiments adults were isolated in pairs on leaves by means of cloth cages tied about the twigs. The nymphs were very difficult to enclose safely in anything of this type so were isolated as soon as hatched on very small sycamores grown in flowerpots where a careful check could be kept on them.

Females from this first generation were observed to lay their first eggs the eighth day following maturity, thus making the time, from egg to egg, forty-three to forty-five days with temperature and humidity approximating summer conditions.

DESCRIPTIONS OF THE DIFFERENT STAGES

The Adult

Length 3 to 3.75 mm.; width 1.56 to 2 mm. Its shape is roughly oblong-oval, and distinctly flattened dorso-venterally. The elytra (wing covers) and pronotum, or the part between the head and base of wings, are dilated laterally forming a much broadened, gauze or lace-like covering over the body of the insect. This gives a unique and characteristic appearance which serves to identify all members of this group.

The pronotum is produced anteriorly into an inflated bulbous-like hood which covers the head. The outer margin of the prono-

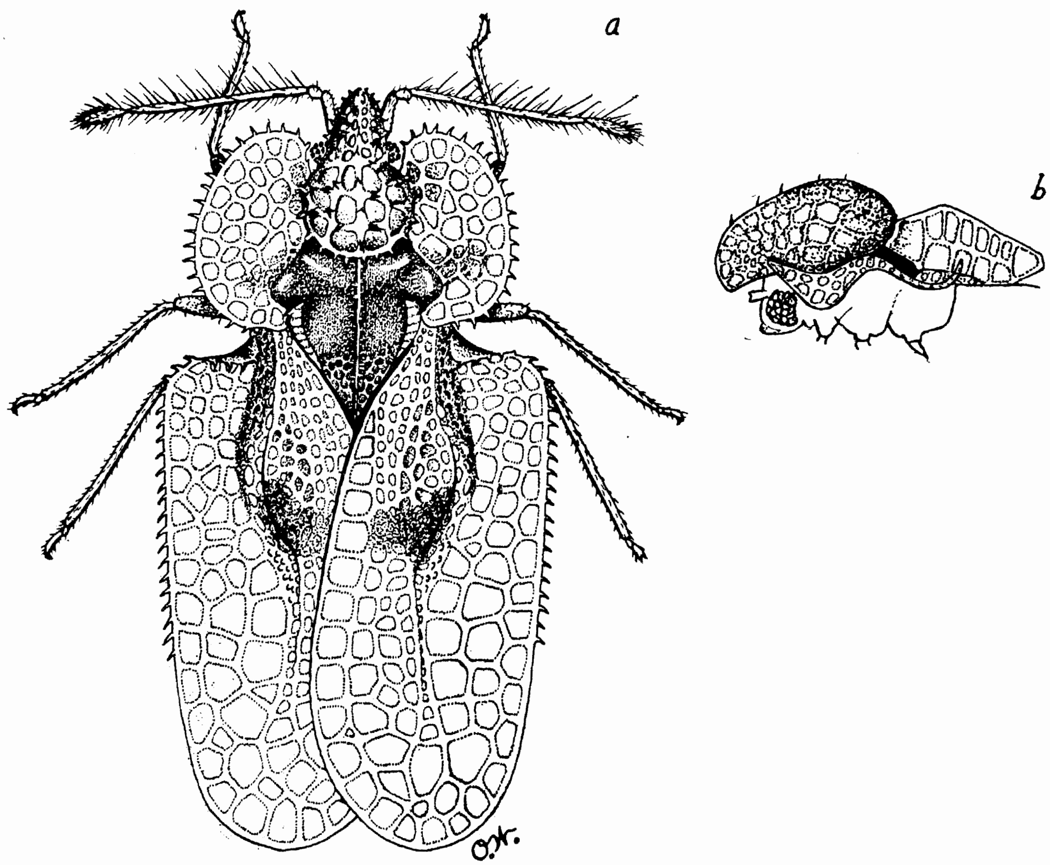

Figure 3—*Corythucka ciliata,* **Say:** ***a,*** **adult;** ***b,*** **side view of hood and median carina (original)**

tum and elytra, except the posterior third, bear small, pointed spines; the nervures of the hood, pronotum and elytra are also armed with a few erect spines.

The elytra bear, each a (tumid) elevation near the antero-inner margin. The body is black; the hood, pronotal margins and elytra are whitish except for an irregular brown spot on the tumid elevation of each wing cover.

The Egg

Length .5 mm.; width .16 to .18 mm. Barrel-shaped, rather pointed at the base where it is glued or stuck to the leaf surface. The top is not pointed and is about .1 mm. across with a cone-shaped cap resting on a circular band-like base and bearing on the top a number of ridges which converge from the outer margin to the apex. At the apex is sometimes a thread-like filament, usually short.

Color of egg, pitchy black; color of cap, a dull whitish, though sometimes dark. At time of deposition the female coats the egg with a black, sticky secretion (used to fasten egg to leaf, and pobably serves as a protection) which gives the surface a roughened appearance. The eggshell, with secretion removed, is smooth, shiny black on upper half, as though polished, while the base has a lighter greenish tinge. A group of eggs on the under side of a leaf has an odd appearance, resembling little the eggs of common insects, is usually overlooked and when noticed is oftimes thought to be fungi or just some dirt particles stuck to the leaf.

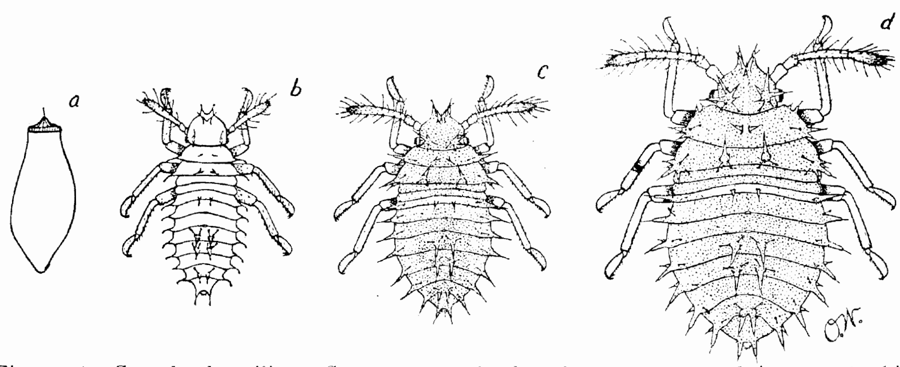

Figure 4—*Corythucha ciliata,* Say; *a,* egg; *b,* first instar; *c,* second instar; *d,* third instar (original)

The Nymphal Stages

The five stages, or instars, are characterized by several features which all have in common, though they may be somewhat modified in the various stages. All the nymphs are armed with spines along the margins of the body and head as well as on the back at different points. These spines are of two main types and quite prominent, no doubt functioning as a protection; this armature gives the nymph a very formidable and characteristic appearance.

In addition to these two general types of prominent spines are many minute spinules on the body surface, except in the first instar on which they do not appear. They are recurved, sharp, width at base almost half the length, and are well distributed over the entire body surface, being especially prominent on the base of the protuberances. These spinules are difficult to distinguish, even with the hand lens, but are quite evident under the microscope, giving the exterior a roughened, granulated appearance.

All the instars are flattened dorso-ventrally, this being especially pronounced in the last three stages, where the aymphs are much broader and more ovate.

At the posterior margin on the mid-dorsal line of the third and fourth abdominal segments are two apertures or openings of the "scent glands". The feet are composed of two segments, a small basal one and a larger, much longer distal one bearing two prominent claws. The last segment of the abdomen is rounded with the tip strongly deflected as if standing on the anal end, when viewed from the side. The abdomen is made up of ten segments.

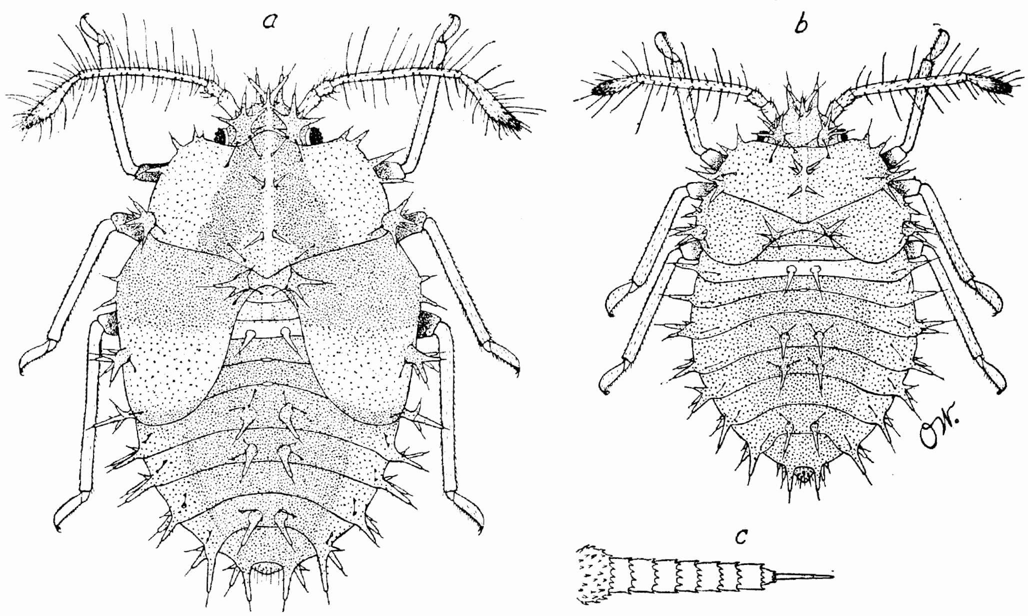

Figure 5—*Corythucha ciliata*, Say; *a*, fifth instar; *b*, fourth instar; *c*, long, cylindrical protuberance showing annulations with minute spinules (original)

Growth of the Young by Molting

After hatching the poung pass through five stages or instars before the adult form is reached. Growth or the increase in size is accomplished by casting the skin or molting as the body becomes too large for it. This takes place by the splitting of the skin at the mid-dorsal line from the head as far back as the second abdominal segment. The head is withdrawn first, the antennae are straightened out and the nymph gradually draws its body from the molted skin. The dorsal spines aid the nymph in breaking the skin and in pulling itself free from it. The act of molting requires from two to four hours, and a newly molted nymph is creamy-white, not assuming its normal dark brown color for several hours after it has left the old skin.

Distinguishing Characters of the Different Stages

The first stage can always be recognized by its more slender, less flattened appearance, the absence of long, spine-bearing protuberances, and by each spine having a blunt tip which is usually enlarged and rounded. The minute spinules found covering the body surface in the succeeding instars are absent in this stage. But five facets are present in each eye.

The second stage still has only the one spine on the lateral margin of each of the abdominal segments two to nine, but it now arises from an elongated protuberance instead of a conical base and is pointed, while just inside of this is a trumpet-shaped spine. The body is broader and darker in color. The antennae are still three-segmented, but the lateral margins of the pro and meso-thorax bear two spines on protuberances and a trumpet-shaped spine just inside of these instead of the single blunt spine on a conical base found in instar one. Each eye has six or more facets.

Ths third stage now has four segments in the antennae, but the wing pads are not developed beyond a faint enlargement. The lateral margins of abdominal segments two to nine have three spines, one on a protuberance, one arising from a conical base, and a trumpet-shaped spine just inside of these. Each eye has fifteen or more facets.

The fourth stage is easily recognized by the well developed wing pads which are oval in outline and reach to the second abdominal segment. The anterior margain of the pronotum is extended forward to the eyes, or slightly over them, while the posterior margin is produced into a rounded triangular point or apex at the median line.

The fifth stage will be known at a glance by the greatly developed wing pads, rather elongated and reaching to the fifth abdominal segment. The anterior margin of the pronotum at the median line is raised and extended a little forward while the posterior margain is quite distinctly triangular. The lateral margins of the abdominal segments one, two and three are without spines.

METHODS OF CONTROL

Natural Enemies

There are a number of predatory insects which prey upon the young of the sycamore lace-bug, but seemingly none to so great an extent as to make them an important factor in the reduction of the numbers of this pest. Among those which I have taken while feeding on the nymphs were one immature Chrysopid, several assassin bugs (*Reduviidae*), a few spiders, and a red mite (unidentified). This mite is found attached to the head or body and does not appear to be a common parasite on this host.

Undoubtedly there are other forms, such as lady-bird beetles (*Coccinellidae*) and ground beetles (*Carabidae*), which prey upon them to a greater or less extent, but of these I have never observed any in the actual act of feeding upon the young. Morrill reports "The adult form a well known predaceous heteropteran—*Triphleps insidiousus,* Say—has been found feeding on the young of *C. ciliata*".

Insecticidal Measures

Since this species is a hemipteron with the characteristic piercing suctorial mouth parts, it is at once apparent that an effective insecticide would have to be a contact spray. Experiments were conducted during July and August (1916) at Oklahoma City in the Oklahoma City Nursey and in Belle Isle Park.

The first difficulty encountered was to apply the sprays so that all adults would be reached, as at the first disturbance caused by the spray striking the leaves, they would dart about in all directions, making it rather difficult to reach every one of them. Then while it is comparatively easy to kill the immature forms, it is quite difficult to accomplish this with the adults without getting a solution strong enough to injure the leaves or make it prohibitive in price.

Due to the unique and characteristic lace or gauze-like structure of the wings and thorax, which covers the entire body effectively, anything but a caustic penetrating liquid will not reach the spiracles or more vulnerable parts of the body.

The following mixtures were used and with the results recorded below:

Kerosene Emulsion

Laundry soap or fish oil soap	½	pound
Kerosene (coal oil)	2	gallons
Water	1	gallon

(Crude oil may be substituted for kerosene.)

The soap is shaved into thin slices and added to the gallon of boiling water and stirred until a good suds is obtained. It is then removed from the fire and the kerosene is added and the mixture is thoroughly emulsified until it makes a smooth, creamy liquid with no free particles of oil floating on top. This stock solution was diluted to a 10% strength of oil by adding 1 part stock solu-

Figure 6—Leaf showing nymphs and adults killed by the kerosene emulsion spray (H. R. Painter)

tion to 5 2-3 parts water and applied to the under surfaces of the leaves.

The results were quite favorable in most applications, accomplishing the destruction of all the young, and from 80% to 90% of the adults. However, in a few instances the foliage of some of the trees was burned slightly, indicating that a stronger solution would not be safe. This strength should not be used except on bright, sunshiny days when there is a slight breeze in order to volatilize the excess oil and prevent severe burning of the leaves, otherwise there may be great injury to the foliage, and if used at a weaker strength it is not effective enough for the adults to warrant its use in this case.

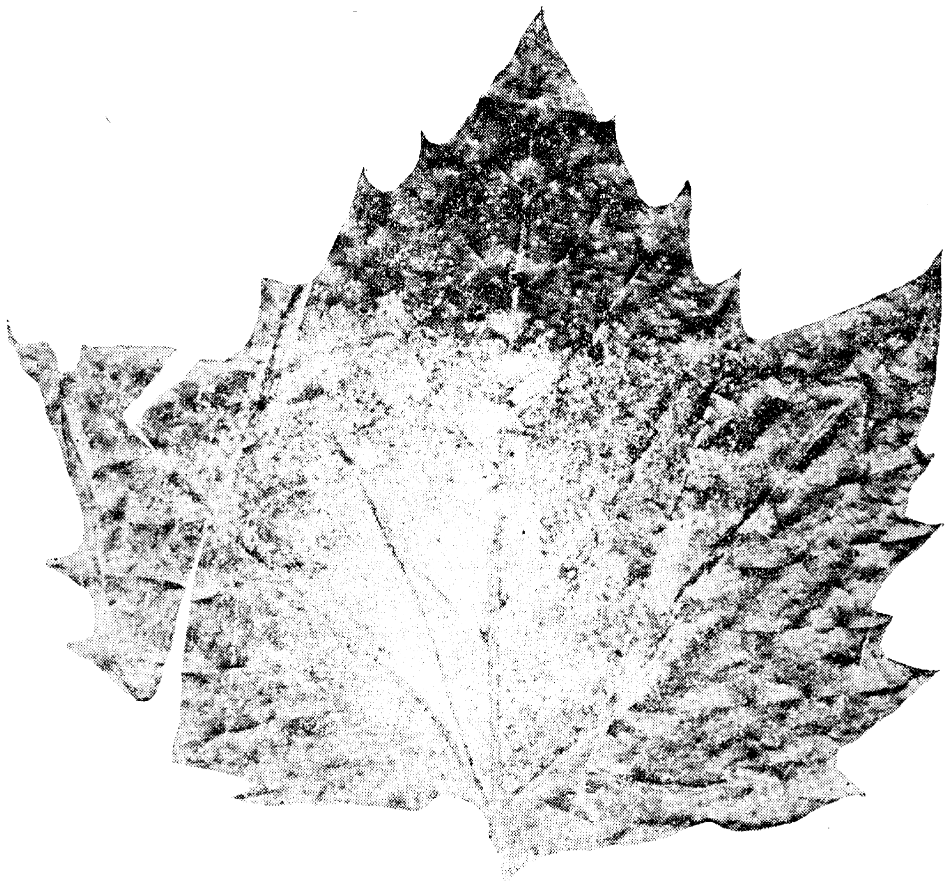

Figure 7—Leaf illustrating whitish, deadened condition caused by the sycamore lace-bug (H. R. Painter)

Fish Oil Soap Solution

This solution was used and with excellent results, being almost a perfect control for adults as well as the immature forms when carefully applied. It gave much better results than any other formula tested, and with no disastrous results to the foliage. It is safe to use at any time and has excellent spreading and penetrating qualities:

Formula Used

Fish oil soap	1 pound
Water (preferably soft)	6 gallons

To prepare this, shave the soap into a small quantity of boiling water and stir until it is well dissolved, then add enough water to make the proper proportion and thoroughly mix by pumping the solution into the spray tank.

To effectively apply this spray, a pressure of at least 150 pounds is necessary and a nozzle of the larger disk type which throws a large, even, hollow or solid, cone-shaped spray, and rather coarse, should be used. An angle at the end of the spray rod for the nozzle to fit on is absolutely essential for effective application, as it is necessary to throw the liquid upward in order to reach the bugs on the under side of the leaves. This should be followed up in two weeks with another application to get the young that have hatched after the first application. The eggs are not affected by any spray that was used as they are so very well protected by the gluey substance secreted by the female at time of deposition.

Nicotine Sulphate

Several brands of nicotine sulphate were used, containing 40% active nicotine, at the strength of 1 to 700 and 1 to 600, but with unsatisfactory results. When used, a small quantity of soap is necessary as a spreader and sticker as the nicotine alone collects on the leaves in small drops and does not reach all the insects. Fish oil soap added to the tobacco decoction enhances its value.

Fink in his control experiments with the eggplant lace-bug (*G. solani,* Heid) also records unsatisfactory results with nicotine sulphate as a control for the adult forms when used as strong as 1 to 600. The writer hesitates in recommending tobacco solution as his results from the use of the same were not uniform or satisfactory.

Concentrate commercial lime sulphur, 1 to 40, was used but proved unsatisfactory in controlling the adults. Lime sulphur plus nicofume liquid was also tried out with no better results. The proportion used was, concentrate lime sulphur 1 quart, nicofume liquid ¼ pint, water 25 gallons.

Conclusion.—Results from the tests made indicate the fish oil soap solution to be the most practical and effective, and when carefully applied with a good spraying apparatus, it should be as economical as the other solutions tested, if not cheaper.

BIBLIOGRAPHY

1840 Herrick-Schaeffer; Wanz. Ins., Vol. V, p. 84.
1843 Harris. Letter in The New England Farmer for June.
1859 Say. Complete Writings, Vol. I, p. 348.
1867 Walsh. Practical Entomology, Vol. II, p. 47.
1868 Walsh and Riley. Leaf-Bugs, The American Entomologist, Vol. I, No. 1.
1873 Stal. *Enumeratio Hemipterorum.*
1875 Glover. Report of Entomologist to New York Commission of Agriculture.
1887 Lintner. Fourth Report of the New York State Entomologist.
1883 Comstock. An Introduction to Entomology.
1891 Summers. The True Bugs, or *Heteroptera* of Tennessee. Bull. Tenn. Agr. Exp. Sta. No. 111, p. 75
1897 Champion. *Biologia Centrali-americana,* Rhynchora, Vol. II.
1903 Morrill. Psyche, Vol. X, p. 133.
1909 Heideman. New Species of *Tingitidae,* Bull. Buffalo Soc. Nat. Sci., Vol. IX.
1915 Fink. Bulletin No. 239, U. S. Department of Agriculture.
1916 Van Duzee. Check List, *Hemipt.* of America North of Mexico.
1916 Osborn and Drake. The *Tingitoidae* of Ohio, Ohio Biol. Surv., Bull. 8, Vol. II. Some New Species of *Nearctic Tingidae,* Ohio Jour. Sci., Vol. XVII.
1917 Notes on American *Tingidae.* Ohio Jour. Sci., Vol. XVII.