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THE PLUM LEAFHOPPER (*MACROPSIS TRIMACULATA* FITCH) IN ONTARIO

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The plum leafhopper, *Macropsis trimaculata* Fitch, has been shown by Kunkel (4), Hartzell (2) and Manns (5) to be the insect vector of peach yellows and little peach, two extremely important virus diseases of the peach in the Niagara district of Ontario. Hartzell (3) has published an account of the bionomics of the species as it occurs in southern New York state. The notes which follow were prepared from original observations made during the years 1936 to 1939 in the Niagara Peninsula. All rearing was carried on in a screened insectary at Vineland Station.

Distribution.—According to Breakey (1) this leafhopper has a wide distribution in northeastern North America. Provencher lists the species from Quebec in his "Petite Faune Entomologique du Canada" published in 1886, and records in the Canadian National Collection show that the insect has been taken at Strathroy in western Ontario (1935), in Prince Edward county and the Ottawa region in eastern Ontario (1914 and 1906), and in the Niagara Peninsula.

Hosts.—In the years during which the species was studied it was always most abundant on wild plum (*Prunus americana* Marsh), being found in small numbers on this host during periods of scarcity when it could not be located on others. Cultivated plums, both European and Japanese varieties, were also quite heavily infested when the insect was generally prevalent. In 1936 European varieties appeared to be somewhat more favoured, although this is contrary to the experience of American workers. The disappearance of the insect in later years prevented further studies of host preferences. The leafhopper also breeds on peach in small numbers. In the course of observations made during 1931 to 1935 in connection with another project both nymphs and adults were found each year in a peach orchard at Grimsby Beach and occasionally in other orchards at St. Davids and Vineland Station. The hoppers were always comparatively scarce on peach and did not average more than one or two per tree at any time. Other species of *Prunus*, including wild black cherry (*P. seretina*) and choke cherry (*P. virginiana*), growing in the vicinity of infested plums were examined but no hoppers were found.

While wild plum is most heavily infested it is too scarce in the peach-growing areas to be ordinarily of any importance as a source of leafhoppers for virus transmission; but as the insect may persist in small numbers on this host during times of general scarcity when it has apparently disappeared from cultivated orchards, clumps of wild plum may be very important as foci of infestation while the insect is becoming reestablished.

Prevalence in the Niagara Peninsula.—In 1936 *M. trimaculata* was common on all wild plum trees and present in all but one of 11 plum orchards examined in the Niagara Peninsula between St. Davids and Grimsby. In two orchards it was especially abundant, the most heavily infested being a block of seedling European plums about eight years old at Vineland Station, and the other an old bearing orchard at Jordan Station containing both European and Japanese varieties. A few were also taken on peach trees at Jordan Station, Vineland and Grimsby.

For the years prior to 1936 little information is available; but that already given on the insect's occurrence in peach orchards from 1931 to 1935, and its relative abundance on wild plum at St. Davids during the same period, suggests that the species had been prevalent, at least in some localities for several years.

In 1937 it was practically impossible to find the insect anywhere in the Peninsula. Only about 25 specimens were seen during the season, all from one clump of wild plum situated on the escarpment two miles southwest of Vineland. No explanation can be offered for the sudden disappearance of the insect. Presumably the eggs failed to hatch; this was certainly true of those laid on wild plum trees by caged adults.

The leafhopper was still very scarce the following year, although small numbers appeared at St. Davids as well as at Vineland. In 1939 a few were taken at Queenston, St. Davids, Vineland and Grimsby, so it would appear that the species is gradually recovering, but it will probably require several years to regain its original numbers and distribution.

The terms "abundant" and "common" as applied above to the plum leafhopper are only relative; in the writers' experience it has always been comparatively scarce and never abundant in the sense with which this term is generally used in reference to a species of economic importance.

Another species, *Macropsis insignis* Van Duzee, very closely allied to *trimaculata,* appeared on wild plum at Queenston and a few other localities in 1938. In 1939 it was extraordinarily abundant on a small group of wild plums at Queenston, a hundred or more nymphs frequently being clustered on a branch a couple of feet long. The habits and life history of *insignis* appear to be very similar to those of *trimaculata.*

Egg.—The elongate oval eggs, about 0.6 mm. in length and pearly white in colour, are laid in one to three-year-old twigs or occasionally in older wood. They are inserted obliquely and diagonally within the bark, either upward or downward, and to the right or left at an angle of about 45 degrees to the axis of the twig. The egg lies entirely within the cortex and phloem with the outer end just below the surface of the bark and the inner at or near the cambium. When growth of the twig occurs after insertion of the egg the inner end may finally lie in a shallow depression of the wood formed by later growth of the xylem about it. On young twigs with the epidermis still intact a very small scar, enlarging with age (Plate 1, Fig 2.), and sometimes a slight swelling, marks the position of the egg, but on rough-barked wood the latter cannot be located.

Hatching of Eggs.—In 1936 eggs hatched from May 13 until May 30, and in 1937 from May 19 to June 8. The nymphs emerge from the eggs during the morning hours as a rule and may hatch at temperatures as low as 41 degrees F. The first eggs hatched when apple buds were in the pink stage, and most of the nymphs appeared during apple blossom period. A summary of hatching during three years is given in Table 1.

TABLE 1—*Hatching Period of Plum Leafhopper Eggs*

	1936	1937	1938
First eggs hatched	May 13	May 19	May 18
25% of eggs hatched by	May 15	May 29	May 21
50% of eggs hatched by	May 18	May 31	May 23
75% of eggs hatched by	May 22	June 1	May 26
100% of eggs hatched by	May 30	June 8	June 1

Method of Rearing Nymphs.—The newly hatched nymphs were transferred by means of a camel-hair brush to small Myrobalan plum and peach trees planted in five inch plōts (Plate 1 ,Fig. 6.). In some cases the plants were covered with lantern globes, but in others they were left uncovered. *Macropsis trimaculata* was not easily reared in the insectary, many of the nymphs being lost particularly during the first instar. The greatest success was secured when the nymphs were moved to new plants just after hatching. It was also important to use the right type of plant; if the growing points were removed, or they were at all woody and hard, the insects invariably succumbed or wandered off. The use of vigorous plants with plenty of succulent growth was essential in successfully rearing the nymphs. Mortality was much higher on peach than on plum.

First Instar Nymph.—When the nymph first hatches it is whitish in colour and quite conspicuous, but gradually darkens to brown in a few hours. The intensity of colour varies considerably in this and later instars. The abdomen is crested, each segment possessing a prominent tooth projecting backwards; this crested and toothed abdomen is characteristic of *trimaculata* nymphs of all instars.

Second Instar.—This instar is dark brown and very short and stout with a prominent thorax and short transverse head. The metathoracic posterior margin is definite in outline with the wingpads only slightly extended.

Third Instar.—Older specimens are a uniformly olive gray in colour with some individuals much darker than others. The shape is similar to that of the second instar but more robust. The wingpads are somewhat more conspicuous, extending to the first abdominal segment (Plate 1, Fig. 3.).

Fourth Instar.—The general coloration of this instar is similar to that of the bark of year old plum twigs. The head and thorax with the wingpads are pale olive; the basal part of the abdomen reddish-brown, with the three terminal segments olive green shading into brown on the last. The legs are pale grayish or greenish brown. Some of the nymphs are more uniformly coloured, being largely brown with a greenish tinge. The wingpads reach half way over the second adbominal segment.

Fifth Instar.—The wingpads are conspicuous, reaching over the third abdominal segment, and vary from green to greenish yellow in colour. The coloration of the body varies considerably, but is generally reddish brown with yellowish brown markings. The eyes are pinkish. The general appearance is one of robustness; the crested and toothed abdominal segments giving a foreshortened appearance (Plate 1, Fig. 5).

Moulting.—All of the instars, as a rule, migrate from the twigs to the underside of the foliage, usually along the midrib, when about to moult. The cast skin (Plate 1, Fig. 1), greyish brown in colour, is left attached to the leaf, but a moderate breeze will blow it away. The final exuviation occurs, as in previous moults, along the midrib of the underside of the leaf. As the adult leafhopper forces its way out of the exuviae there are two ball-like protrusions prominent on the thorax. These are the unfolded wings, which in a few minutes are extended to their normal shape, and are folded along the dorsal surface in the usual way. The insect soon takes on its reddish brown colour, requiring about one hour on a warm day to attain full pigmentation.

Duration of the Instars.—During the three years this insect was studied under insectary conditions 83 leafhoppers were reared from eggs to adults using the method already described. Nymphs lived anywhere from 39 to 63 days, the average in 1937 being 42.2 days for 32 individuals. The length of the five instars as determined during 1936, 1937 and 1938 are presented in table II.

TABLE II—*Duration of Nymphal Instars*

Instar	*Max. length.* Days			*Min. length.* Days			*Aver. length.* Days		
	1936	1937	1938	1936	1937	1938	1936	1937	1938
First	17	11	15	10	5	11	13.1	7.1	13.5
Second	12	11	8	7	6	6	9.2	7.8	7.1
Third	13	11	9	7	6	6	9.6	7.9	7.0
Fourth	14	12	13	9	5	5	10.4	8.6	7.0
Fifth	14	14	16	9	7	9	11.6	10.8	12.5
Nymphal life	63	50	47	46	39	40	53.8	42.2	45.6

Span of Moulting—The seasonal occurrence of the various nymphal moults in the development of *M. trimaculata* to maturity was worked out from the life history records as follows (Table III):

TABLE III—*Time of Moulting*

	1936	1937	1938
Occurence of first moult	May 26-June 4	May 30-June 13	May 18-June 12
Second moult	June 6-June 12	June 7-June 21	May 27-June 19
Third moult	June 14-June 23	June 14-July 2	June 6-June 26
Fourth moult	June 26-July 4	June 21-July 10	June 13-July 7
Fifth moult	July 8-July 17	July 4-July 17	June 20-July 19
Nymphs	May 13-July 17	May 19-July 17	May 18-July 19

Habits of the Nymph.—This species of leafhopper is to be found on the twigs and small branches of the host plant, and very rarely on the foliage. The nymphs congregate on the twigs usually at the junction with larger branches, or hidden in the cracks and crevices of the spurs or axils of the leaves, where they remain except at moulting time when they migrate to the foliage. It should be mentioned they are very difficult to locate on the twigs, as their coloration approximates that of the bark, and as their triangular form and habit of clinging closely to the twigs make them resemble bracts or buds.

The Adult.—The general colour of the female leafhopper (Plate 1, Fig. 4) is a dull reddish brown, while the male is darker and nearly black. The female has three hyaline spots on each elytron, two of which are very distinct, and the male one conspicuous spot and two others not as clearly defined. The pronotum of the female is dull yellow-brown, with a dark patch on the disc; that of the male is a darker brown. The scutellum is grey, set with areas of dark brown with nearly black triangular areas at the outer edges. The face is lighter than the general colour, approaching yellowish brown, with the frons in the female more yellowish than that of the male. In size the males are slightly smaller than the females, which average 4.5 mm. in length from pinned specimens.

Habits of the Adult.—Like the nymphs, the adults are to be found mainly on the twigs and branches of the tree, but they may rest on the petioles and leaves occasionally. It has been observed that in extremely hot

weather they will gather on the underside of the foliage on the shaded side of the tree. They may take to flight if disturbed, especially on warm days, but usually remain on the twigs, crawling out of sight behind the limbs at the slightest movement on the part of the observer. The adults are equally as hard to locate as the nymphs, not only because of their protective coloration, but also because they are usually far from abundant.

Feeding of Adults.—This insect differs from the more familiar species of leafhoppers by feeding exclusively on the younger twigs and to some extent on leaf petioles. The feeding punctures are at first invisible but may later give rise to small lenticel-like structures. As very large numbers of *M. trimaculata* have never been seen in orchards it is not likely that any serious direct injury is done to plum or peach, but the fact that the insect is capable of transferring peach yellows and little peach from tree to tree makes the feeding a very important matter.

Sex Ratio.—In 1936 there were three females to every two males in the reared material, and in the general orchard collections amounting to some 390 specimens 52.6 per cent were females. During 1937 males and females appeared in equal numbers in the rearing cages. No information on the sex ratio in the field was obtaianed that year because of the extreme scarcity of the insect.

Copulation.—Observations on copulation were quite fragmentary, altogether about nine pairs being noticed in the insectary during the 1936 season, and five pairs in 1937. It occurred from two to 49 days after maturity of the female. In 1936 copulation was in progress in both the orchard and insectary during the early part of July. A period of 3 or 4 weeks followed during which no mating was observed, and then adults were collected in copula in the orchard on August 7, and one was observed in the insectary. In 1937 it was shown that females may copulate more than once, as was suspected from the records of 1936. On July 12, four days after a male and female were placed together, copulation took place, and on August 26, 45 days later, the same female copulated again with the same or another male present in the cage.

Reproductive Capacity.—The hatching of eggs deposited on potted plum and peach seedlings in the insectary during the season of 1936 was recorded during May of the following year. Out of 60 plants on which females had been caged only five yielded nymphs as tabulated in Table IV.

TABLE IV—*Reproductive Capacity of Females*

Plant No.	Females in cage	Eggs hatching	Average per female
2	2	37	19
4	2	8	4
7	1	35	35
11	1	12	12
6	1	1	1
	7	93	13

On examining the twigs after hatching was completed for the season numbers of eggs were located which had not hatched, some of which appeared to be fresh-looking while others had collapsed, turned brown and dried up. In 1937 a single female laid a total of 57 eggs which gave rise to nymphs the following spring. This is the largest number of viable eggs so far secured from one individual.

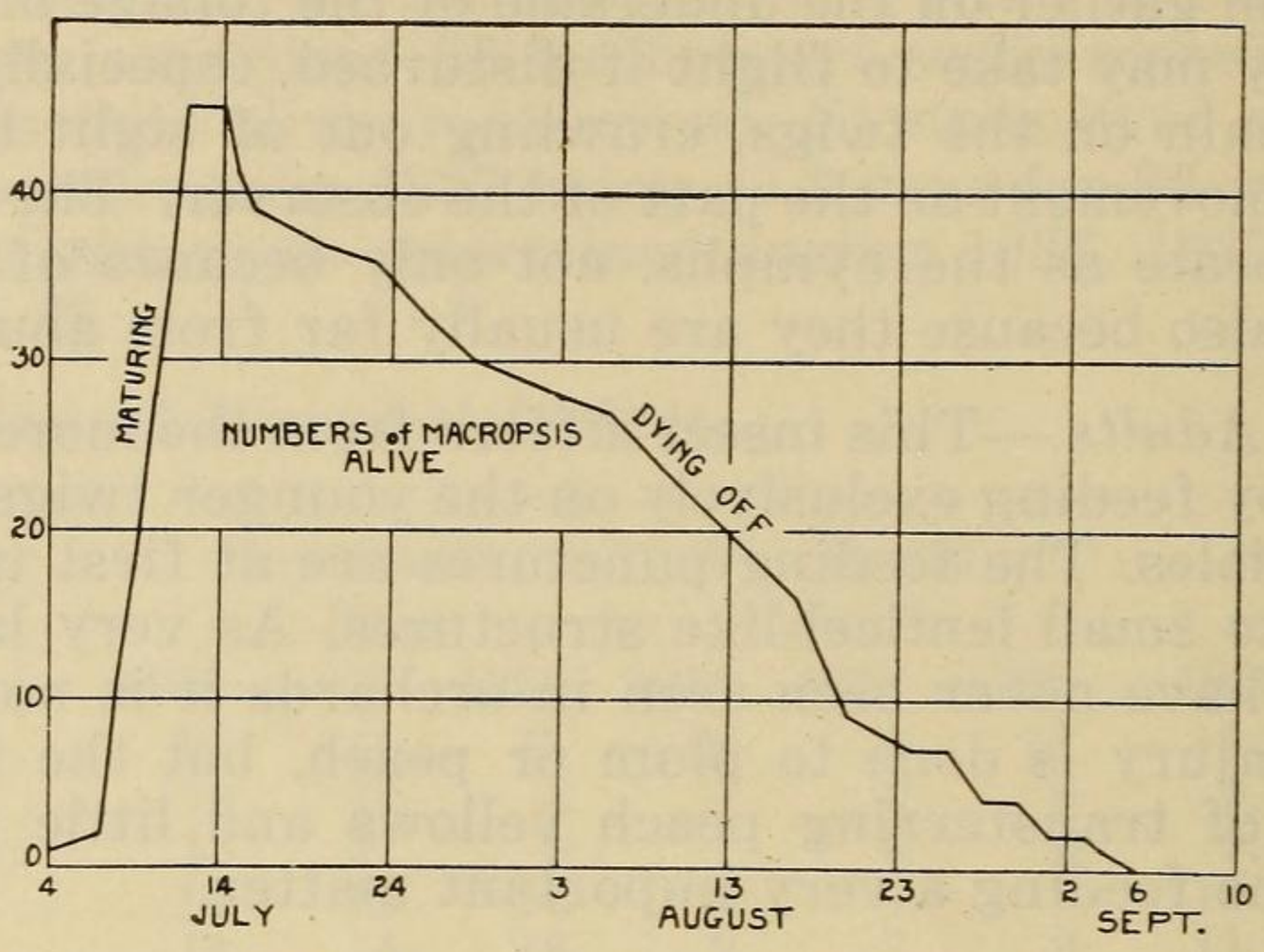

Fig. 1—Longevity of Plum Leafhopper

Length of Life.—In 1936 adults confined in lantern globe cages on peach seedlings lived from 2 to 66 days, the average of 136 individuals being 20 days. In this season one leafhopper lived until September 25 in the cages, but we were unable to find adults on the trees after September 1. During the following season leafhoppers survived as long as two months on potted plums but all had died by September 6. The accompanying graph (Text fig. 1) illustrates the length of life of plum leafhoppers in insectary cages during the 1937 season.

The mortality rate for two years is given below (Table V).

TABLE V—*Mortality of Adults*

	1936	1937
25% of adults dead by	July 14	July 25
50% of adults dead by	July 22	Aug. 10
75% of adults dead by	Aug. 16	Aug. 19
90% of adults dead by	Aug. 24	Aug. 30
95% of adults dead by	Sept. 1	Sept. 3
100% of adults dead by	Sept. 25	Sept. 6

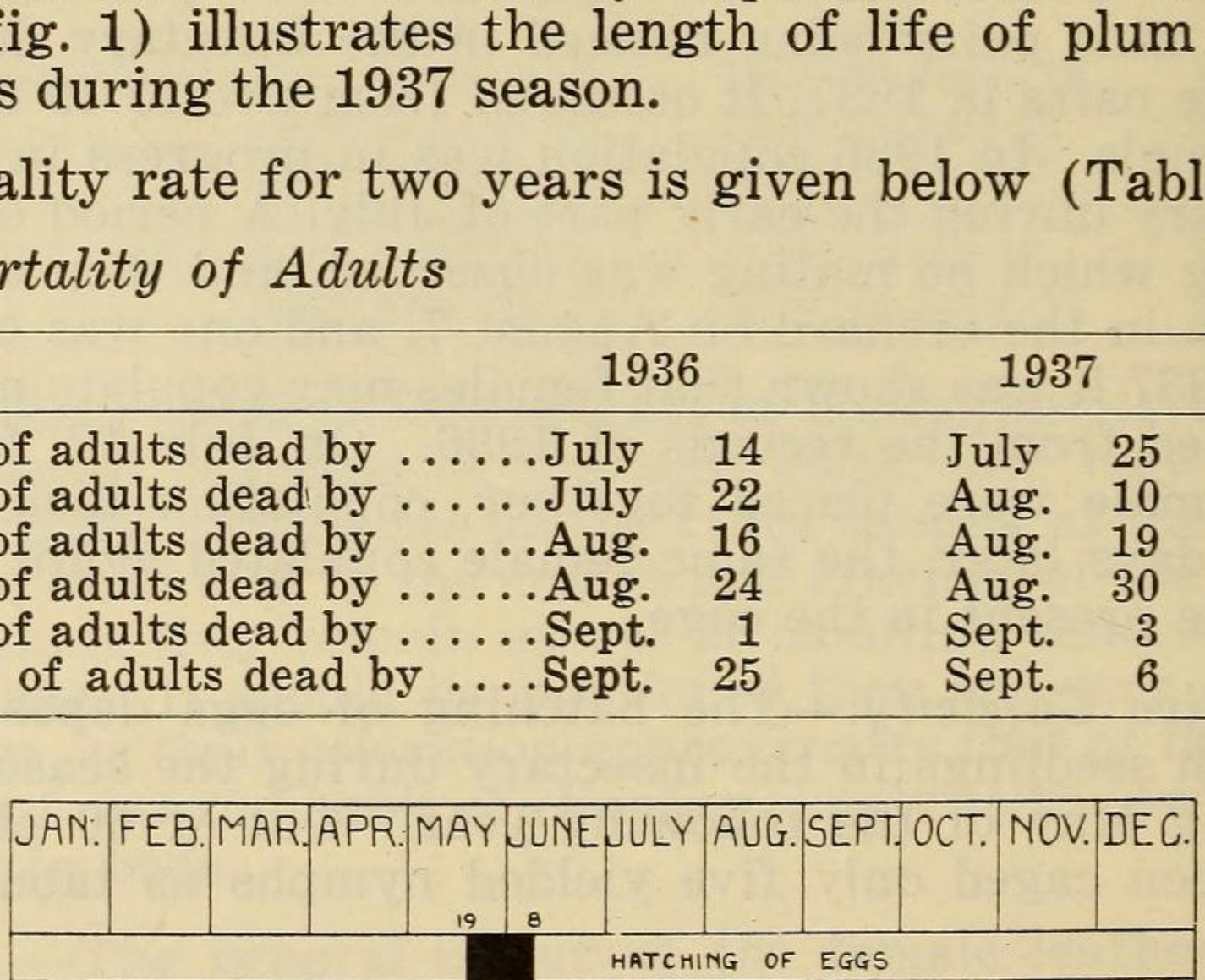

Fig. 2 Life History of Plum Leafhopper

Life History Summary.—There is but one generation in a year, with the insect passing the winter in the egg stage. Eggs commence hatching about

mid-May, and continue until the first week of June. The nymphal period covers a little more than two months, mid-May to mid-July, the insects moulting five times. Adults start to mature in early July and continue to appear until about July 15. They live from a few days to over two months, being present in the trees during July and August. Most of them are dead by the first of September but occasional individuals may live until September 25. The life history in diagrammatic form is appended (Text fig. 2).

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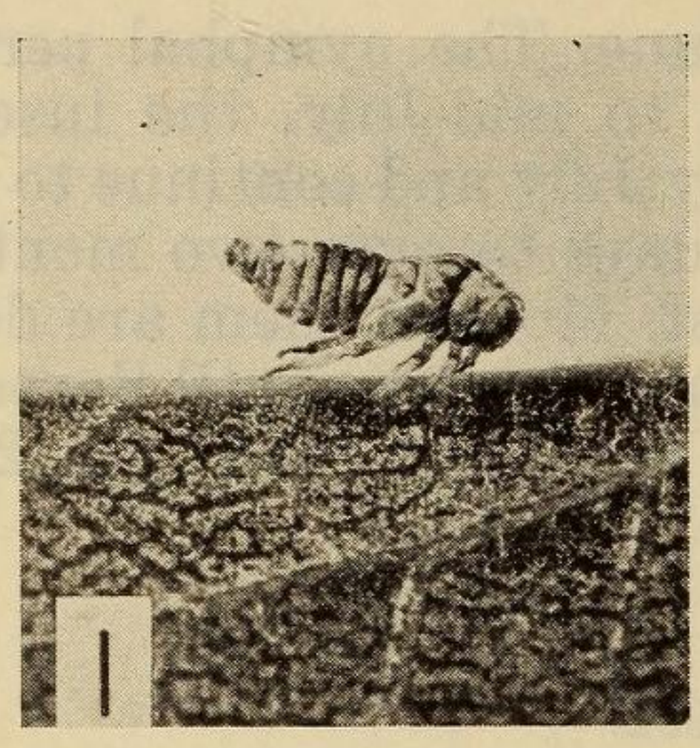
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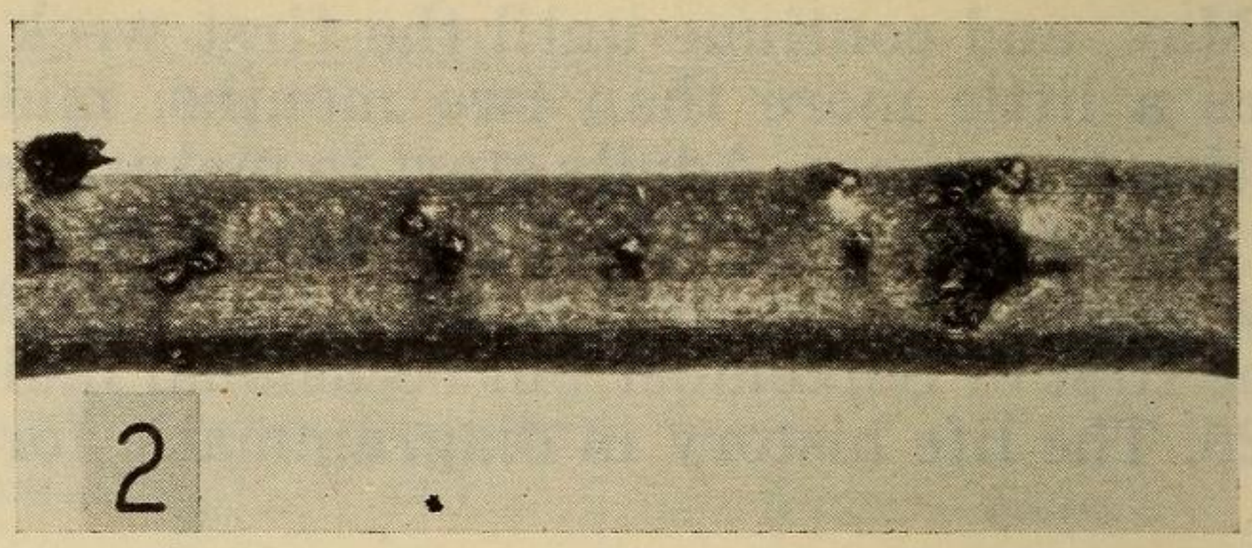
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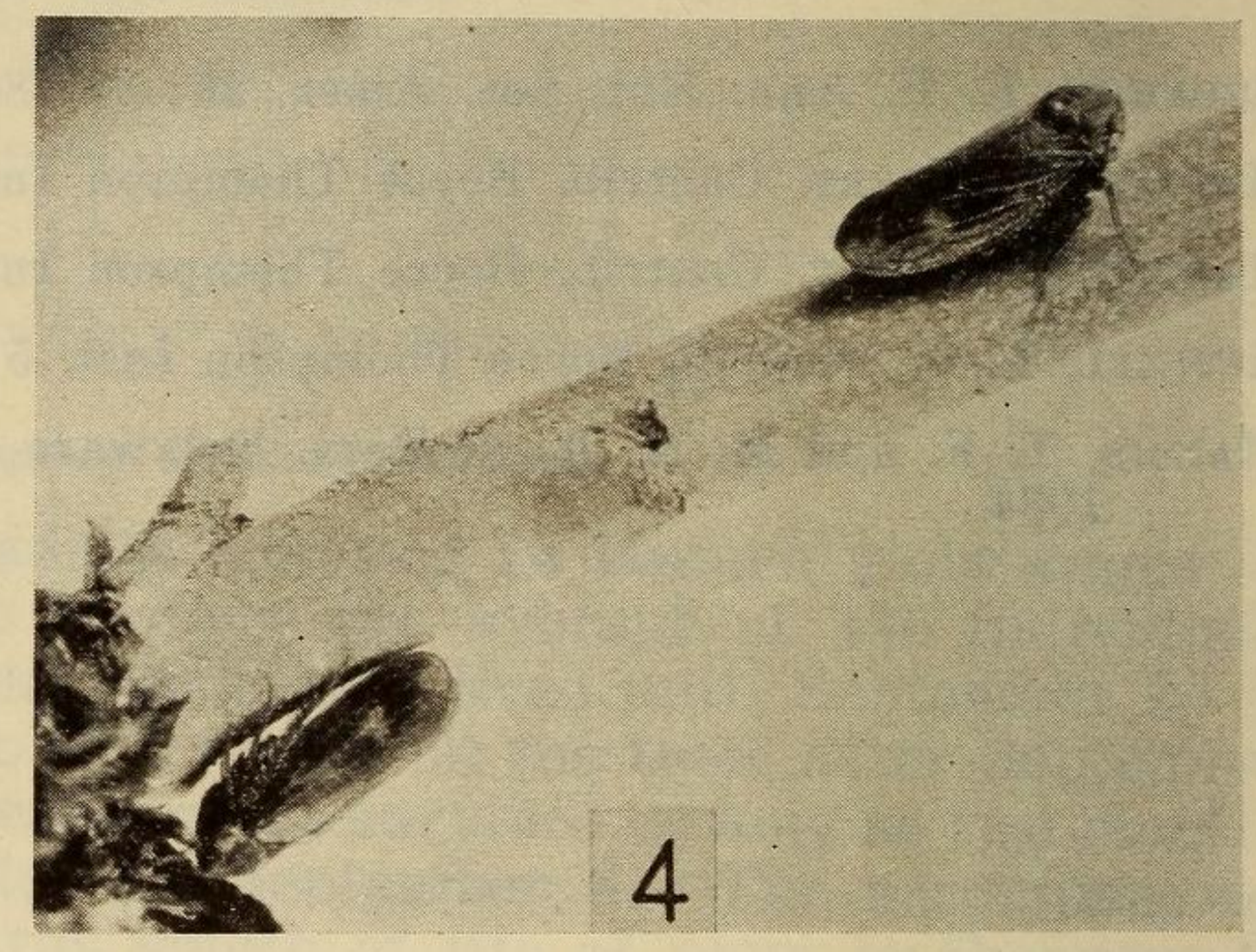
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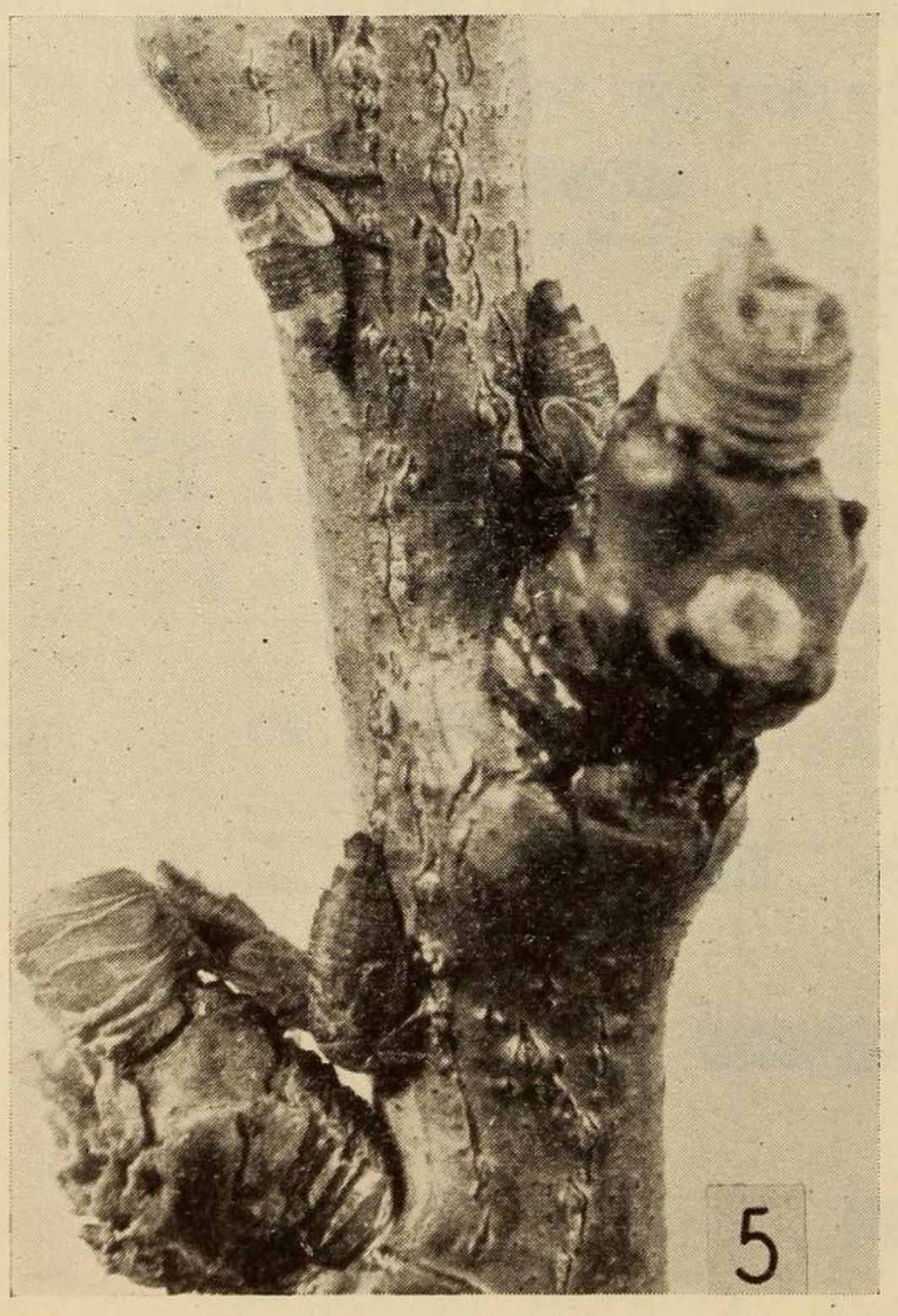
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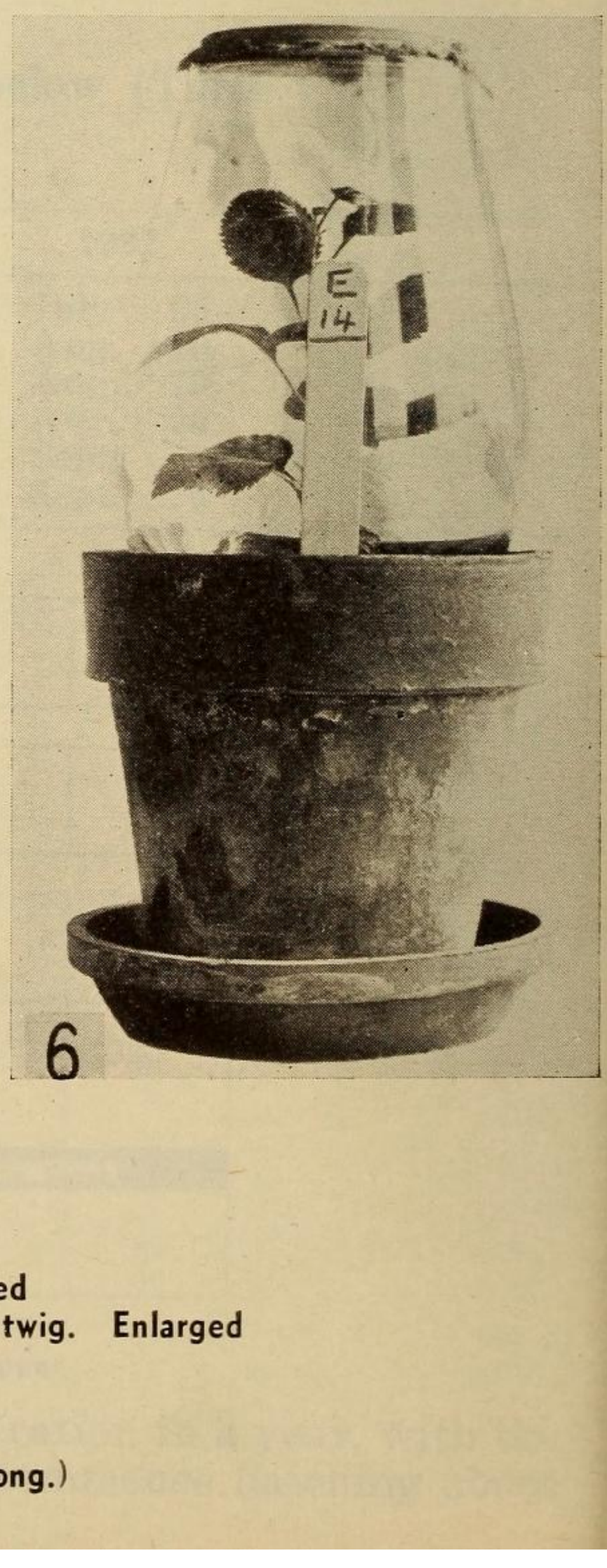

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PLATE 1

PLUM LEAFHOPPER

Fig. 1.—Fifth exuviae on midrib of leaf. Enlarged
Fig. 2.—Egg punctures on peach twig, after hatching. Enlarged
Fig. 3.—Third instar nypmh in characteristic position on plum twig. Enlarged
Fig. 4.—Adult female plum leafhoppers. Enlarged
Fig. 5.—Fifth instar nymphs on plum twig. Enlarged
Fig. 6.—Cage used in rearing plum leafhopper.

(Photographs by T. Armstrong.)