THE CHRYSANTHEMUM GALL MIDGE

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In cooperation with the College of Agriculture, Ohio State University, Columbus
In cooperation with the U. S. Department of Agriculture.
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(101)
Galls on leaves, leaf petioles and stems
THE CHrysanthemum Gall Midge

Diarthronomyia hypogaea F. Low

T. L. GUYTON

The first report of the presence of the chrysanthemum gall midge in Ohio came to the Ohio Station on February 19, 1918. Specimens were sent in for identification, and means of control were asked for. Upon visiting the greenhouse involved, the species was found to be very abundant on some varieties of chrysanthemum. Patty was heavily infested and scattered galls were found on Excelcerior, Red Pompon, Charles Razor, Fine Yellow, Holliday, Baby Marquot and Pink Show varieties.

The insect was likely brought into this country from central or southern Europe, in which places it was recorded previous to any record in this country. Dr. E. P. Felt in 1915 mentions its occurrence at Adrian, Michigan, Berkeley, California, and in Oregon. Professor E. O. Essig, of California, stated in 1916 that it was quite likely the insect was distributed throughout the state (California) wherever chrysanthemums were grown commercially.

TECHNICAL DESCRIPTION

The following description is given of the egg, larva, pupa and adult by Dr. E. P. Felt, in the Thirty-first Report of the State Entomologist of New York.

"Egg: Reddish orange, length .15 mm, diameter .13 mm, the extremities narrowly rounded.

"Gall: An irregular, oval, concolorous swelling with length about 2 mm, usually at a distinct angle to the surface of the plant tissues and frequently causing large, confluent swellings of the stem, leaf or flower head.

"Larva: Length 1 mm, yellowish or yellowish orange when full grown, moderately stout, the extremities rounded; segmentation distinct and the skin smooth.
"Pupa: Length 1.25 mm, stout, narrowly oval, the cephalic horns distinct, conical, the thorax yellowish orange, the wing pads fuscous in pupae nearly ready to transform, the leg cases dark yellowish brown, the abdomen a variable orange, narrowly rounded apically.

Fig. 1. The chrysanthemum gall-fly, Diarthronomyia hypogaea (F. Low). A, galls as they appear above the surface of the plant; B, larva; C, pupa; D, enlarged anterior projections of same; E, adult female; F, ovipositor of female; G, scales from legs; H, I, J, sections of the antenna; K, wing showing slight variations; L, genitalia of male; M, palpus. Enlarged. (After Essig.)

"Male: Length 1.75 mm. Antennae nearly as long as the body, sparsely haired, fuscous yellowish; 17 or 18 segments, the fifth with a stem about three-fourths the length of the subcylindric basal enlargement, which latter has a length about twice its diameter and a rather thick subbasal whorl of long, stout setae; terminal segment variable, usually somewhat reduced, irregular, elongate,
ovate. Palpi; the first segment subquadrate, the second narrowly oval. Mesonotum dark brown, the submedian lines yellowish. Scutellum and postscutellum fuscous yellowish, the abdomen mostly a pale yellowish orange. Wings hyaline, costa light straw, halteres yellowish transparent. Legs a pale straw, the pulvilli a little longer than the long, slender claws, the latter with a long, slender tooth basally. Genitalia; basal clasp segment moderately long, stout; terminal clasp segment short, stout, with a distinct spur; dorsal plate short, deeply and roundly emarginate, the lobes short, broad, obliquely truncate apically; ventral plate short, deeply and roundly emarginate, the lobes rather long and tapering to a narrowly rounded apex.

"Female: Length 1.75 mm. Antennae extending to the third abdominal segment, sparsely haired, fuscous yellowish; 16 to 17 segments, the fifth with a stem about one-third the length of the cylindrical basal enlargement, which latter has a length a little over twice its diameter; terminal segment reduced, sometimes compound and tapering to a narrowly rounded apex. Palpi; the first segment subquadrate, the second subconical and with a length a little greater than the first. Mesonotum fuscous brown, the submedian lines, the posterior median area, the scutellum and post scutellum mostly fuscous yellowish; the apex of the scutellum narrowly fuscous. Abdomen reddish orange, apically fuscous yellowish, the ovipositor about one-half the length of the body; terminal lobes short, broad, broadly rounded and sparsely setose apically. Other characters practically as in the male."

HOST PLANTS

The gall midge was found attacking only chrysanthemum in the greenhouse in which these observations were made. Ox-eye daisy (Chrysanthemum leucanthemum) is reported as a European host plant.*

Injury to plant.—The insect does all its injury while in the larval stage by feeding on the plants at fixed points, thereby causing the plants to produce characteristic galls at such points. (Fig. 4 shows characteristic gall on leaf of host plant.)

As will be noticed on the frontispiece, the galls may occur on both sides of the leaves, on the leaf petioles, stems and developing buds. New shoots when attacked by several larvae are greatly distorted; small leaves become somewhat curled and thickened; the growth of young plants is stunted and the production of blossoms is said to be greatly reduced.

Rate of infestation.—The number of galls on a plant may be few or many. As has been previously mentioned there seems to be a difference in numbers due to the variety of chrysanthemum infested. The variety Patty had many more galls to the unit area of plant surface than other varieties in the same greenhouse. From two small plants 4 inches high, 85 and 62 adults, respectively, emerged. One hundred eight adults emerged from galls on a plant 6 inches high; and thirty-seven emerged from another plant of about the same size.

Life history.—Professor E. O. Essig gives the insect as two-brooded in California, the maximum number of individuals being reached in August, September and October. The adults of the summer brood give rise to a number of maggots which Professor Essig says hibernate in the galls on leaves and stems and give rise to the spring brood. Probably something near such a cycle occurs under greenhouse conditions. Certainly there are periods in the year when the adults are more numerous than at others. Adults of two generations and eggs for a third were observed in this study which extended from February 22 to May 6. The following data will give the length of the life cycle as observed under greenhouse conditions:

On March 11, a plant free from infestation of the gall midge was exposed in a portion of an insectary where many of the adults were emerging. On March 12, 9 o'clock a.m., the plant was heavily infested with eggs. All adults clinging to the plant were removed and it was then covered with a lamp chimney, the top end of which was covered with one thickness of cheesecloth held in place with a rubber band. Daily observations were made of the plant. March 16, two small galls were in evidence on one leaf. April 1, several small galls were noted. April 2, eleven galls were counted. (It is likely other galls were present but could not be seen because of the contorted condition of the plant.) April 20, two adult male insects emerged. April 22, one adult female insect emerged. A few emergences continued each day up to May 1, when the total emergence from the plant was 18 adults insects, 8 of which were females and 10 males. May 2, one of the females deposited several eggs. May 6, the plant died.

From the above data it will be seen that the length of the life cycle is from 40 to 50 days. In six plants, taken from the cutting room of the greenhouse, the cuttings for which had been taken from infested plants but were thought to be free from infestation, the time between the taking of the cuttings and the emergence of adult insects was from 47 to 56 days. It is quite likely that the cuttings contained eggs or very young larvae when taken.
THE CHRYSANTHEMUM GALL MIDGE

NATURAL ENEMIES

No natural enemies of the gall midge were observed in this study. Professor E. O. Essig mentions two Hymenopterous parasites attacking the midge in California.* One of these parasites belonging to the genus Amblymerus he reports as killing the larvae of the midge in not a few cases at the rate of from 80 to 90 percent. The parasite develops in the midge gall and in time completely consumes the developing midge larva. The other species mentioned by Professor Essig belongs to the genus Tetrastichus.

Fig. 2. Killed by nicotine sulphate as it was emerging from the gall

NICOTINE SULPHATE SOLUTION AS A CONTROL

Initial tests.—Experiments were tried with two strengths of nicotine sulphate and soap solutions as a spray on the galls and eggs as a means of control. The tests were first made on single infested plants and were later repeated on plots of plants in the greenhouse where the outbreak occurred. The plants used in making the first set of tests were brought from the infested greenhouse and placed in 4-inch flower pots. The top surface of the soil in the pots was covered with a layer of white quartz sand. The plants were caged by covering each one with a lamp chimney, the top end of which was closed with one thickness of cheesecloth held in place with a

*Journal Economic Entomology, Vol. 9, pp. 466-467.
rubber band. All spraying of these plants was done with a hand atomizer so constructed as to enable one to spray both the top and under side of the leaves and stems. Nicotine sulphate containing 40 percent nicotine and caustic-soda-fish-oil (Good’s product) were used in making the solutions with water. The amount of soap used was the amount necessary to make a cold saturated solution. All the plants were heavily infested, some to a greater degree than others. The following are the results of the tests:

Two plants known as Pot 2 and Pot 3 were not treated but were placed under the lamp chimney cages. The emergence of adults from these plants is given in Table I.

Another plant known as Pot 1 was thoroughly sprayed with a 1 to 500 solution of 40 percent nicotine sulphate and soap solution, with the results as given in Table I.

Another plant known as Pot 4 was sprayed with a dilution of nicotine sulphate (1 to 250) and soap solution with results as given in Table I.

**TABLE I.—RESULTS OF NICOTINE SULPHATE SPRAY ON EMERGING CHRYSANTHEMUM MIDGE**

<table>
<thead>
<tr>
<th>Spraying done</th>
<th>Pot 1 sprayed with nicotine sulphate (1-500) and soap</th>
<th>Pot 2 no treatment</th>
<th>Pot 3 no treatment</th>
<th>Pot 4 sprayed with nicotine sulphate (1-250) and soap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of observation</td>
<td>Dead</td>
<td>Living</td>
<td>Dead</td>
<td>Living</td>
</tr>
<tr>
<td>February 25</td>
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<td>March 2</td>
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<td>March 14</td>
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<tr>
<td>March 15</td>
<td>0</td>
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</tbody>
</table>

Total emergence: 15 | 0 | 108 | 4 | 35 | 20 | 6

The plant in Pot 2 died March 16. It was kept under observation until March 30, with no further emergences. The total emergence as shown in the table was 108 living adults.

The plant in Pot 3 died March 18. Observations were made on it until March 25, with no additional emergences.

The plant in Pot 4 lived until March 29 and was under observation until March 30 with no additional emergences.
Fig. 3  Plants with leaves considerably deformed by galls.
The plant in Pot 1 was under observation until April 9. The plant was then in good growing condition and gave no evidence of midge infestation at that time.

**Spraying made on other trial plants.**—Two infested plants about 4 inches in height were placed under chimney cages. These seemed to be infested with about an equal number of galls. One plant was carefully sprayed with a 1 to 500 dilution of 40 percent nicotine sulphate and water with 2 ounces of caustic-soda-fish-oil soap to each gallon of water. The other plant was untreated and served as a check to the treated plant. Daily observations from March 2 to March 18 gave no living emergence in the sprayed pot but daily emergence of active adults in the check pot. The total emergence in the check was 85 active adults. In the sprayed pot 62 individuals were found at the point of emergence from the galls and several dried dead forms were found in old galls when, at the close of the observations, the galls were opened under a binocular microscope. No dried specimens were found upon examining the check pot.

**Greenhouse tests of nicotine sulphate.**—A box containing from 60 to 70 plants, of the variety Patty, heavily infested with galls, was sprayed on February 21 nicotine sulphate containing 40 percent...
nicotine, diluted with 500 parts of water, with 1 ounce of caustic-soda-fish-oil soap to each gallon of solution, and was then caged with a cheesecloth-covered frame.

On February 27 many adults were found dead on the galls from which they had emerged. Three living active adults were found under the cheesecloth cover. Three clusters of eggs were found on three terminal shoots. The plants were sprayed on this date with the same strength solution as was used for the first spray.

On March 2, J. R. Stear made the following notes: “Adults and pupae emerged from galls and dead, 22. Number of living adults, 0. Number of tips bearing eggs, 17.”

On March 8, neither eggs nor living adults could be found in the box. Another spray of the same material and strength was made at this time.

On March 13, the same notes were made as on March 8. Some of the plant leaves were spotted with a white fungus.

On March 22, the plants in this box were very carefully examined and seemed to be free from gall-midge infestation in any form.

**Trial under greenhouse conditions.**—A bench about 20 feet long and 3 feet wide, containing 250 plants of a number of varieties of chrysanthemums, all infested with galls of the midge, was set apart to be used in a trial. The plants on this bench were the only chrysanthemums in this particular room of the greenhouse, and they were cared for according to the usual practice of the caretakers. The plants on this bench were sprayed with a dilution (1 to 500) of nicotine sulphate and water to which 1 ounce of caustic-soda-fish-oil soap had been added to each gallon of solution. The spraying was repeated with the same solution on March 13, 18 and 22. The sprayings on March 28 and April 3 were done with the same dilution of nicotine sulphate, but caustic-potash-fish-oil soap was used in place of the caustic-soda soap.

The following observations were subsequently made:

- **On March 13,** three scattered egg-masses were found. Many dead adults. On March 18, two egg masses were found, one of three, the other of 100 eggs. Many dead adults.
- **On March 28,** one living adult was found on the surface of the bench in a helpless condition. One cluster of eggs was found. Many adults dead.
- **On March 28,** vigorous searching failed to find eggs or living adults.
- **On April 3,** no living adults or eggs were found.
- **On April 10,** no eggs or adults were found. Six plants had galls upon them from which emergence had not taken place. Examination under the binocular microscope showed the larvae to be blackened and somewhat soft.

Check plants in another room of the greenhouse were infested with eggs, galls and adult forms throughout the time of treatment.

Especial notice was taken of the effect of the spray solution upon the plants. On March 28, there seemed to be some slight evidence of foliage burning. This was the only time anything of the kind was noticed, and when the work was finished, April 10, the plants were in good growing condition.
Many examinations of the galls during the time of the treatment showed that in numerous cases the larvae and pupae were not killed by the spray with nicotine sulphate, but that the emerging adult was killed, probably because the moisture on its body came in contact with the dry spray material on the outside of the gall. Thus, to be effective in killing the midge, the spray mixture should be present throughout the period of emergence.

There is some evidence that at least a part of the eggs of the midge are destroyed by the spray solution. In the greenhouse treatments, no young galls were seen to develop on plants upon which the eggs had been laid after the spray was applied. One plant kept in an insectary was sprayed after it was heavily infested with eggs. The solution used was a dilution (1 to 500) of 40 percent nicotine sulphate to which 1 ounce of caustic-soda-fish-oil soap had been added to each gallon of solution. The plant was sprayed March 11, and also on the 14 and 26. No evidence of hatching was noticed by subsequent daily examinations with a 15x hand lens. On April 15, the plant was examined with a binocular microscope. Three small galls were found. About 150 shrunken and dried eggs were found upon the surface of the plant. Of course the fertility of the eggs was not definitely known. They were deposited by females emerging in a room where large numbers of adults of both sexes were emerging.

**MANNER OF DISPERESAL**

The insect is spread from greenhouse to greenhouse by means of transfer cuttings or other forms of chrysanthemum plants. There is no evidence to show that the insect is able to pass through
Fig. 6. Arrows point to eggs laid among the hairs on the stems
winter out-of-doors in Ohio. Dr. E. P. Felt says the insects are comparatively inactive in the greenhouse when the temperature is at about 50 degrees and that the insect probably passes periods of hibernation or aestivation on slowly-developing subterranean, presumably root-stalk galls. Many roots and underground stems were examined by the writer; no galls of any form were found.

CONCLUSIONS AND RECOMMENDATIONS

It is the belief of the writer that the chrysanthemum gall midge can be successfully controlled at the time of emergence of the adult by spraying with a solution made of 1 part nicotine-sulphate solution containing 40 percent nicotine to 500 parts of water to which fish-oil soap has been added at the rate of 1 ounce to each gallon of solution.

Since all the adults do not emerge at the same time, the treatment must be repeated every 4 or 5 days as long as any living forms of the midge remain in the galls.

The spraying must be well done. An attempt should be made to cover every gall on the infested plant, remembering that the galls occur on the under as well as the top surface of the plant.

Since it is likely that infestation is introduced into a greenhouse by the entrance of the pest on new stock, such stock should be carefully inspected. It would be wise to keep new stock in a separate room of the greenhouse for some time, where a careful watch for developing galls should be kept.

Where the infestation is confined to a few plants, the safest treatment is to burn such plants as soon as discovered.

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