this time Bordeaux is used at the rate of 4-4-50; and lime-sulphur at the rate of 1-50. In the case of the apple and pear, arsenate of lead may be added at the rate of 3 lbs. to 50 gallons of lime-sulphur in the "pink" for apple scab, *Venturia pomi*. The arsenate of lead incorporated against the codling moth will be sufficient in subsequent sprays for the apple and pear.

EXPLANATION OF PLATES 32, 33

1. Cherries pitted and deformed by *Syneta albida* Lec.
2. Young cherries pitted and stems gnawed, adults.
3. Apple showing the characteristic work of the adults on foliage.
4. Injured and uninjured apple blossoms.

CHAIRMAN H. J. QUAYLE: The next paper will be by E. O. Essig on the chrysanthemum gall-fly.

THE CHRYSANTHEMUM GALL-FLY, DIARTHROMYIA HYPOGÆA (F. LÖW)

Cecidomyia hypogæa F. Löw, Verh. Zool.-Bot. Ges. Wien, XXXV, p. 488, 1885. (Figures 1-7)

By E. O. ESSIG, *Agricultural Experiment Station, Berkeley, California*

Though the chrysanthemum gall-fly has been known as a pest in Europe for many years it was not recorded as occurring in the United States until April 1915 when Dr. E. P. Felt received specimens from Prof. R. H. Pettit of Michigan.¹ In September of the same year Mr. C. C. Barnum, a student at the University of California, called attention to the work of a gall-fly on chrysanthemums growing in a greenhouse on the campus. From the infested plants the writer reared a large number of adults, some of which were forwarded to Dr. Felt who kindly determined them as the above and gave the published records of its previous occurrence in this country. Since that time the writer has made a general survey of the central part of the state and has found that the insect is quite abundant and destructive in the region of San Francisco Bay.

DESCRIPTION

The larvæ or maggots (Fig. 32 B) are very small, averaging only about 1.5 mm. in length and 0.8 mm. in diameter when full-grown. The shape is somewhat cylindrical with the anterior end more or less pointed and the posterior end broadly rounded. The color varies from transparent-white to pale yellow or orange.

¹ JR. ECON. ENT. VIII, p. 267, April 1915.

The pupae (Fig. 32 C) are about the same size and shape as the larvae, but are slightly larger at the anterior end. The color is white or pale-yellow with amber

Fig. 32. The chrysanthemum gall-fly, *Diarthronomyia hypogæa* (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. (Original).

markings on the anterior region. There are two pairs of prominent tooth-like projections at the head, the first pair being noticeably larger than the second. The color of these projections is somewhat darker than the surrounding tissues.

The adults or flies (Fig. 32 E) are exceedingly delicate with noticeably long and slender legs. The head, antennæ, thorax and the base of the abdomen are dusky amber; the legs light-amber with light-colored femora; the abdomen bright or pale orange-red; and the eyes very dark-red. The wings are transparent or faintly smoky and covered with many scale-like hairs. The legs are also thickly beset with similar hairs or scales which are noticeably wider at the tip or somewhat spatulate-shaped (Fig. 32 G). The palpi (Fig. 32 M) are two-jointed and the antennæ (Fig. 32 H, I, J) are 16-jointed and normally hairy. The body is slender and averages 1.5 mm. in length.

LIFE-HISTORY

The habits of the insect have been under observation for only part of a year, but long enough to gain a fair idea of the main points in the life-history. During the summer months of August, September and October the maximum development is reached and there are great numbers of all stages after which there is a gradual reduction until the following spring and summer. The adults of the summer brood give rise to a very large number of maggots which hibernate in the galls on the leaves and stems of the plants. These reach maturity in the spring and give rise to the summer brood so that there appear to be but the two broods during a year. There is some overlapping of the broods since adults may issue as late as January and a few pupæ hibernate. The writer has been informed by florists, who have been acquainted with the habits of the insect for years, that the adults swarm in the greenhouses as early as five o'clock in the morning during the summer and that during the day they are not to be found. The former observation has not been substantiated, but the latter was carefully studied and it was found that though the adults could be found at all times during the day they were usually resting on the plants and seldom ever on the wing, though they were seen to fly freely at times but only when disturbed.

NATURE OF WORK

As the common name implies, this insect produces galls which are very characteristic and may be found on the leaves, leaf-petioles, stems and buds of the food plants. The galls (Fig. 32 A, and pls. 34, 35, fig. 2-5) are decidedly cone-shaped and the main axis may be at right-angles or at an acute angle to the main axis of the leaves, stems and buds. Very often they may be almost wholly enclosed within the tissues so that only the tips are exposed. The greatest numbers are to be found on the tender shoots on both sides of the leaves, on the stems near the tips and on the buds. Infested shoots are often distorted beyond recognition (Pl. 35, figure 5) and are eventually killed. The color is first somewhat lighter than the surrounding tissues, but in time become bright red or brown. The size of the fully-developed

galls is quite uniform averaging about 3 mm. in length and 1 mm. in diameter at the base. They are most abundant during the fall and winter months. In many of the chrysanthemum growing districts in the San Francisco Bay Region as much as one third of the crop is annually lost unless preventive or control measures are adopted. Two florists at Alameda who at one time grew large numbers of cut flowers claim that the fly forced them out of business. Plants grown in greenhouses are injured most, but the attacks are also very severe in lath houses. Plants growing out-of-doors in the average house garden do not appear to become infested, at least a careful inspection has so far failed to discover such, and infested plants taken from a greenhouse or a lath house rapidly recover when placed outside where there is no protection from the elements. Last August the writer secured twenty-one infested plants from a greenhouse and set them in his garden. On all of the new growth which has appeared to date (February 24) there is not a single gall to be found, while checks left in the greenhouse and removed to a lath house are either still badly infested or are entirely ruined. It is perfectly possible however to conceive of a condition outside in a particularly protected and warm place where the insect may continue to breed.

DISTRIBUTION

As previously stated the chrysanthemum gall-fly was first taken by the writer in California at Berkeley, though investigations show that it has been known to florists for over fifteen years in other places around San Francisco Bay. The writer has taken it in Alameda, San Francisco and San Mateo Counties. It probably occurs in the other counties which have not been visited. A single infested shoot of a chrysanthemum was received last fall from Mr. Arthur E. Beers, County Horticultural Commissioner, from Merced and it is not unlikely that the insect is distributed throughout the state where chrysanthemums are grown commercially.

FOOD PLANTS

The favorite food plant of this insect is the cultivated chrysanthemum, some strains of which are more susceptible to attack than others, but all appear to suffer to some extent at least. The ox-eye daisy (*Chrysanthemum leucanthemum*) is listed as a host in Europe.¹

CONTROL

The practice of growing the bulk of the chrysanthemum crop under cloth has been one of the chief means of preventing the attacks of the

¹ Kertész, C., Catalogus Dipteriorum, II, p. 69, 1902.

chrysanthemum gall-fly and is by far the most efficient and satisfactory way of handling the situation. The young clean selected plants are propagated from the beginning in these insect-proof cloth houses and every precaution is taken to keep them clean and tight.

In greenhouses the difficulties are very great. Eliminating all infested plants and using only clean cuttings have given fairly good results, but means a continual fight from the very beginning to pre-

Fig. 33. Some detail anatomical characters of *Amblymerus* sp., a parasite of the chrysanthemum gall-fly. A, wings; B, antenna; C, middle tarsus; D, tibial spur on front leg; E, tibial spur on hind leg; F, mandible. Greatly enlarged. (Original).

vent reinfestation. Some florists take only underground cuttings from infested plants and get satisfactory results when all of the old plants are destroyed before the flies begin to emerge in the spring.

In lath houses there is continual danger of infestation which can hardly be avoided. One practice which works very well where the old plants are allowed to come up again during the winter and spring is to cut back the young shoots in November or December and again in February or March and burn the trimmings. In this way most of the

hibernating larvæ are destroyed and much of the crop may mature in good condition.

Nicotine sulphate or "Black Leaf 40" used in the proportions of 1 to 1600 of water will give temporary relief if applied once or twice, but to get good results it must be used every two or three weeks from June until just before blossoming time.

Fig. 34. *Tetrastichus* sp., a parasite of the chrysanthemum gall-fly. Detail drawings: A, wings; B, last five joints of the antenna; C, middle tarsus; D, tibial spur of front leg; E, tibial spur of the hind leg; F, mandible. Greatly enlarged. (Original).

PARASITES

During the summer a large number of parasites were reared from infested plants and one species in particular did excellent work in the University greenhouse. The material was sent away for determination and a few observations made as follows:

Amblymerus sp. This hymenopterous parasite has been described by Mr. A. A. Girault, through the kindness of Dr. L. O. Howard, and

a description is to appear elsewhere. The adults are black with yellow markings on the legs. The females vary from 1 mm. to 1.2 mm. in length and the males are somewhat smaller. Some of the details in figure 33 will aid in distinguishing it. The larvæ live within the galls alongside the maggots of the gall-fly which they gradually consume. They remain within the galls until mature when they emerge through small circular holes. This species is the most abundant during the summer months and all of the adults were reared during August, September and October. In not a few cases as high as 80 per cent to 90 per cent of the maggots were destroyed.

Tetrastichus sp. (Fig. 34). The generic determination of this insect was made by Mr. Harry S. Smith, Superintendent of the State Insectary, Sacramento, California. It is also a small black parasite somewhat larger than the former and easily distinguished from it by the four-jointed tarsi and other characters shown in the accompanying drawings.

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¹ Since preparing this article some months ago the writer has received a copy of the 31st Report of the State Entomologist of the State of New York, June 1, 1916, from Dr. Felt and finds that the subject matter is much more thoroughly handled and that this paper would not be worth printing were it not for the local interest to California.

The above bibliography is taken entirely from Dr. Felt's paper with a rearrangement and a few minor changes.

Other localities given in Dr. Felt's paper are Oregon, and Ottawa, Canada, and the additional European host plants: *Chrysanthemum corymbosum*, *C. atratum*, *C. japonicum* and *C. myconis*. The varieties of *C. japonicum* are very generally infested in this district.

The technical description of the various stages is very complete in the above mentioned paper.

EXPLANATION OF PLATES 34, 35

Fig. 2. Chrysanthemum leaf showing newly formed galls of the chrysanthemum gall-fly on the under surface. Enlarged. (Original. Photo by Dept. Sci. Illust., U.C.).

Fig. 3. Stem of chrysanthemum showing the galls made by the chrysanthemum gall-fly. The round holes were made by parasites. Enlarged. (Original. Photo by Dept. Sci. Illust., U. C.).

Fig. 4. Tip of young chrysanthemum plant showing fully-developed galls of the chrysanthemum gall-fly. The galls were dark red and mostly on the upper surfaces of the leaves. (Original. Photo by Dept. Sci. Illust., U. C.).

Fig. 5. Young shoot of chrysanthemum plant showing the deformity due to the galls made by the chrysanthemum gall-fly. This is a fair example of the work in greenhouses and lath houses when control measures are not employed. Enlarged. (Original. Photo by Dept. Sci. Illust., U. C.).

CHAIRMAN H. J. QUALE: The next paper by Mr. E. Ralph de Ong on the Municipal Control of the Argentine Ant will be read by the secretary.

MUNICIPAL CONTROL OF THE ARGENTINE ANT

By E. RALPH DE ONG, *Instructor in Entomology, University of California*

The Argentine Ant was first recognized in California about 1908, at only eight points in the state but has since spread to most of the larger cities on the coast. The list of known infested towns in 1916 being as follows; San Diego, Corona, Riverside, Upland, Claremont, Azusa, Monrovia, Los Angeles, Montecito, Santa Barbara, Santa Maria, Salinas, San Jose, Cupertino, Saratoga, Redwood City, San Mateo, Burlingame, San Francisco, Alameda, Berkeley, Oakland, Piedmont, Stege, Martinez, Byron Hot Springs, Stockton, Sacramento, and St. Helena. In many of these towns the infested area is comparatively small but steadily increasing while in others, for instance Alameda, practically the entire town is infested.

Here is an example of a most annoying house pest spreading in a few years' time in scattering colonies over a strip of territory, 700 miles long, without any systematic effort being made to check its invasion. Carried from city to city by commerce they gain a foothold and slowly but surely spread out on every side in spite of the thousands of dollars spent by the householders and the hosts of ant remedies for sale; even a list of which is too cumbersome for this paper. Thirty-nine arsenical ant remedies have been recorded in this state alone, the percentage of metallic arsenic ranging from 12 per cent to .2 per cent. The great majority of these are strong percentages of arsenic which are not effective in control work on this ant and are unsafe to have on the premises, especially where there are children.