HILGARDIA

A Journal of Agricultural Science Published by the California Agricultural Experiment Station

VOLUME 18 NOVEMBER, 1948 NUMBER 16

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BIOLOGY OF THE FIG SCALE IN CALIFORNIA[1]

E. M. STAFFORD[2] and D. F. BARNES[3]

INTRODUCTION

SINCE its introduction into California, the fig scale, *Lepidosaphes ficus* (Signoret), has become widespread in the fig-growing areas of the Central Valley. Although the scale has been tolerated, especially on dried figs, heavy infestations are now recognized as definitely injurious to the fruit, with a resulting financial loss to the grower. In the fig-canning industry, for instance, the need for clean fruit can be easily recognized. Knowledge of control measures was essential, and this was gathered largely from the experience of the growers. The program was handicapped, however, by lack of information on the life history of the pest. The present study, with most of the work done in the vicinity of Fresno, was made in answer to the demand for more exact information in California.

DISTRIBUTION

According to Ferris (1937),[4] the fig scale was originally described in France from cultivated figs growing at Cannes. Newstead (1901) quoted a record of its presence in England on figs imported from France in 1875. It was reported in Italy by Berlese (1903), Leonardi (1920), Silvestri (1940), and Lupo (1942). Other references to the fig scale were made by Colvée (1881), Fernald (1903), MacGillivray (1921), and others. Umnov (1940) reported it to be a minor pest of figs in the Crimea, and Kuwana (1925) reported it on pears in Japan.

The fig scale is thought to have been imported in California in 1905 with fig cuttings from Algeria. The infestation started at Fresno and spread somewhat slowly at first. In 1917, Roullard reported that the infestation was confined within a radius of about ¾ mile, where some 500 trees were involved. In 1931, Simmons, Reed, and McGregor reported that the scale had spread to a point about 60 miles south-southeast of the original infestation. The prevailing winds blow in this direction.

Evidence was also presented to show that the fig scale could be spread to Calimyrna fig trees in caprification by the use of infested caprifigs. Attention

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[4] See "Literature Cited" at the end of this paper for complete data on citations, referred to in the text by author and date of publication.

was again directed to this method of spread by Kinsley in 1938. He revealed that in 1936 a survey of 36 square miles in Merced County showed fig scale infestation only in the area exposed to infested caprifigs in 1932. Two years later the original infestation had spread ¾ mile south and west, but very little to the north and east. At that time in Merced County some 495 acres of figs, including Mission, Adriatic, and Calimyrna—but not Kadota—varieties were infested with fig scale.

Since 1938, the fig scale has attacked all varieties of figs in Merced County, and has spread north to Stanislaus County and to Stockton in San Joaquin County. However, the agricultural commissioners of the counties bordering

Fig. 1.—Fig scale on leaf and ripening fruit of Adriatic fig.

San Joaquin County on the west and north—Alameda, Contra Costa, Sacramento, Solano, and Yolo—have no records of the fig scale in their areas. In 1946, the writers surveyed two Kadota fig orchards in Brentwood, Contra Costa County, but found no scale. The State Bureau of Entomology and Plant Quarantine has specimens from San Jose, Santa Clara County.

What is believed to be an isolated infestation has existed in Glenn County for several years. A survey made in October, 1946, showed heavy infestations close to the city of Orland. Very light infestations were found at distances of 1 mile north, 3 miles west, about 2½ miles east, and 2 miles south of Orland. At greater distances from Orland, but within Glenn County, scale was not found. The nearest known infestation from Orland is some 130 miles distant.

The most southernly general fig scale infestation in California is in Tulare County, where the degree of infestation varies from heavy near Dinuba and Orosi to light at the southern boundary. The State Bureau of Entomology and Plant Quarantine has several records of the occurrence of fig scale in both Kings and Kern counties.

NATURE AND IMPORTANCE OF INJURY

Fig scales on the leaves (fig. 1) often cause the area just beneath the scale to become chlorotic. Heavily infested leaves generally appear to be a lighter green than scale-free leaves. The greatest number of scales found on a single leaf was 1,042. Many growers believe that the scale causes the leaves to drop prematurely. The evidence supporting this belief is meager, however, as no study of such reaction has been made. On the twigs, fig scale populations may become so great as to almost encrust the newest growth. The effect of fig scale on the tree's vitality and its ability to set a crop has not been measured.

When light-colored varieties of fruit infested with fig scale approach maturity, the part beneath and immediately surrounding the scale remains dark green as the rest of the fig turns light green and yellowish (fig. 1). On Mission figs a red spot, lighter than the dark skin, appears beneath the scale. This spot remains light and conspicuous on the dried fruit. As the fruit becomes fully mature and begins to shrivel, the area beneath the scale loses its dark color and very often remains firm. This makes the dried fruit look warty. In contrast to normal dried Adriatic figs (fig. 2 *A*) the infested fruits are small, shriveled, spotted, and light in weight (fig. 2 *B*).

The dark-green spots which form beneath the scale during the ripening of canning figs will not cook out in processing. Fruit with more than three such marks is culled and put into jam stock, with a consequent loss of value. In 1944, when canning figs brought $125 per ton and jam-stock figs $85 per ton, this loss amounted to $40 per ton. Since at present no regulations within the dried-fig industry require scale-free fruit, the amount saved financially by control of fig scale on drying figs is difficult to estimate. Nevertheless, the packers are becoming less interested in buying infested fruit. As a consequence, growers are increasingly recognizing the need for fig scale control.

A survey was made by the University of California in 1942 to determine the amount of spray material needed by fig growers for the control of fig scale. The survey disclosed that approximately 87,000 gallons of dormant oil were used on an estimated 20 per cent of the California fig acreage. Since 1942, dormant oil spraying for control of fig scale has become more or less general practice in Fresno and nearby counties. This would seem to indicate that the annual amount of control work has been greatly increased.

LIFE HISTORY AND FIELD BIOLOGY

Earlier observers (Roullard, 1917; Simmons *et al.*, 1931) who worked with the fig scale in the field assumed that there was only one species involved. Roullard, however, in 1917 observed that the scale on fruit and leaves was so different from that on twigs as to suggest the occurrence of more than one species. In a recent conversation, Mr. Roullard related how R. L. Nougaret, then with the United States Department of Agriculture, Bureau of Entomology, had started experiments to settle this question but had left before the work was completed. Ferris, on the basis of habitats and morphology of the adult females, decided that two species were involved, which he designated as *Lepidosaphes ficus* (Signoret), a twig-infesting form, and *Lepidosaphes ficifoliae* (Berlese) primarily a leaf-infesting form.

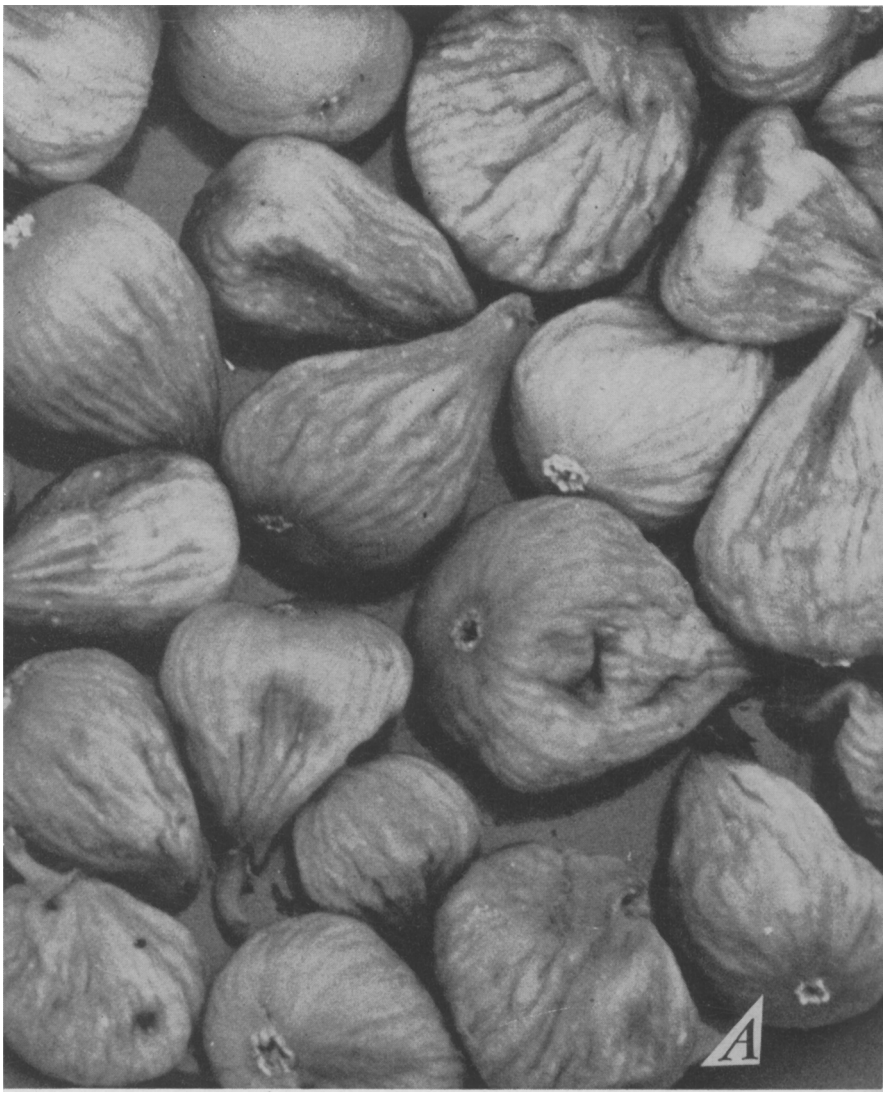

Fig. 2 *A*.—Dried Adriatic figs: Clean, uninfested fruit.

In Italy in 1943, however, Lupo showed that *L. ficifoliae* was a summer form of *L. ficus*. Although Lupo's work was published in 1943, war prevented his results from being brought to the attention of American workers until 1945. The work in this paper includes a confirmation of Lupo's conclusions.

Description. Descriptions and illustrations of the female bodies are given by Ferris (1937; 1938). The fig scale is a typical armored scale. It has a thick protective shell or scale above, and a thinner scale beneath the body.

In the winter, the female scales on the wood are dark brown with a thin waxy coating. The shape is much like that of a miniature oyster (fig. 3). At

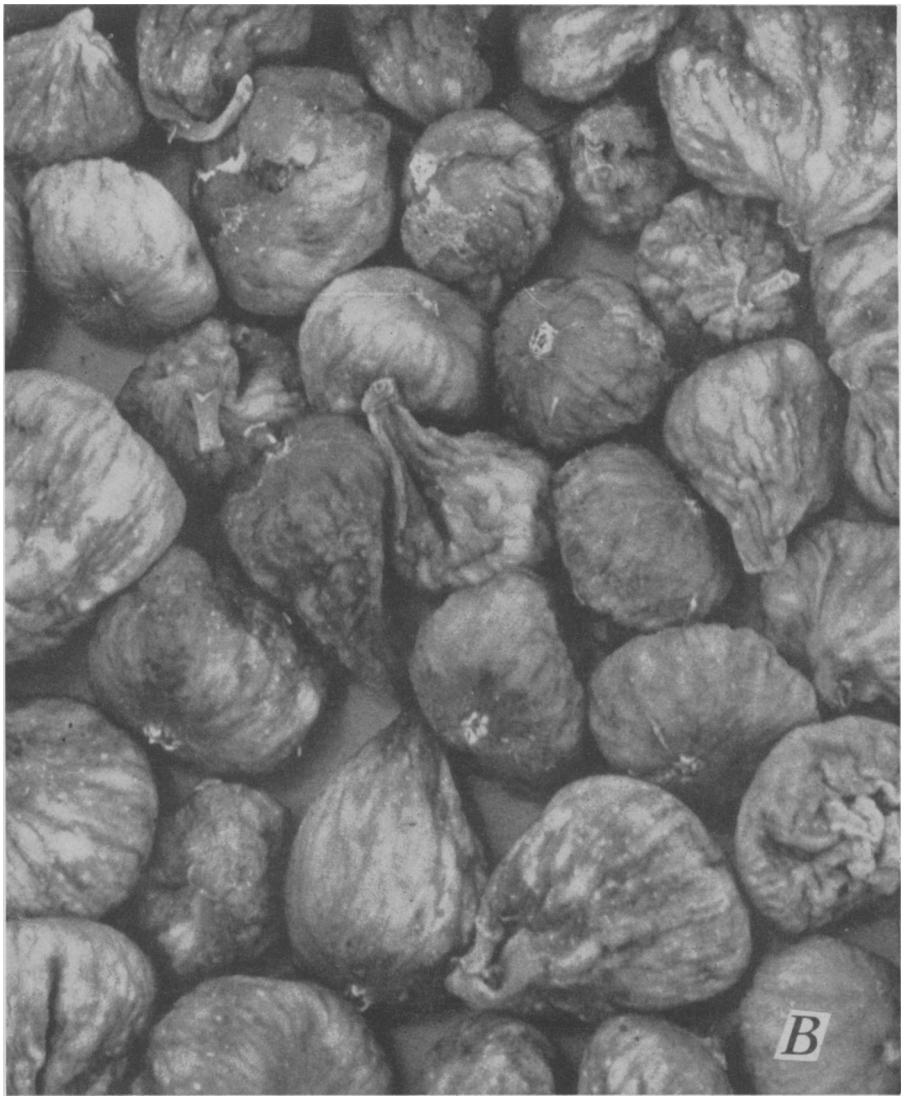

Fig. 2 *B.*—Dried Adriatic figs: Scale-infested fruit.

the narrower end of the female scale, the exuviae of the first and second stages of development may be seen. In the summer, the female scales on the leaves are much lighter and smaller than the winter scales. On the under surfaces of the leaves, the hairs and prominent veins often cause the scales to be laid down in distorted shapes. The scales on the top of the leaves are larger and darker colored than those on the lower surfaces, which are often whitish.

The males appear chiefly on the leaves. The scales of those on the upper surface are darker colored than those on the under surface. Only one exuvia appears in the scale of the male.

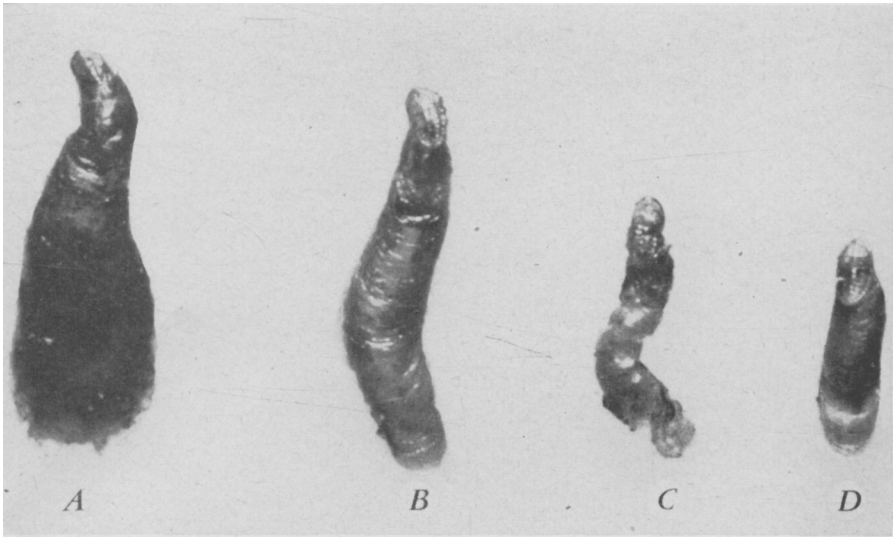

Fig. 3.—Shells of the fig scale: *A*, Overwintering female taken from a twig; *B*, Female from upper leaf surface; *C*, Female from lower leaf surface; *D*, Male from lower leaf surface. (Enlarged about 24 times.)

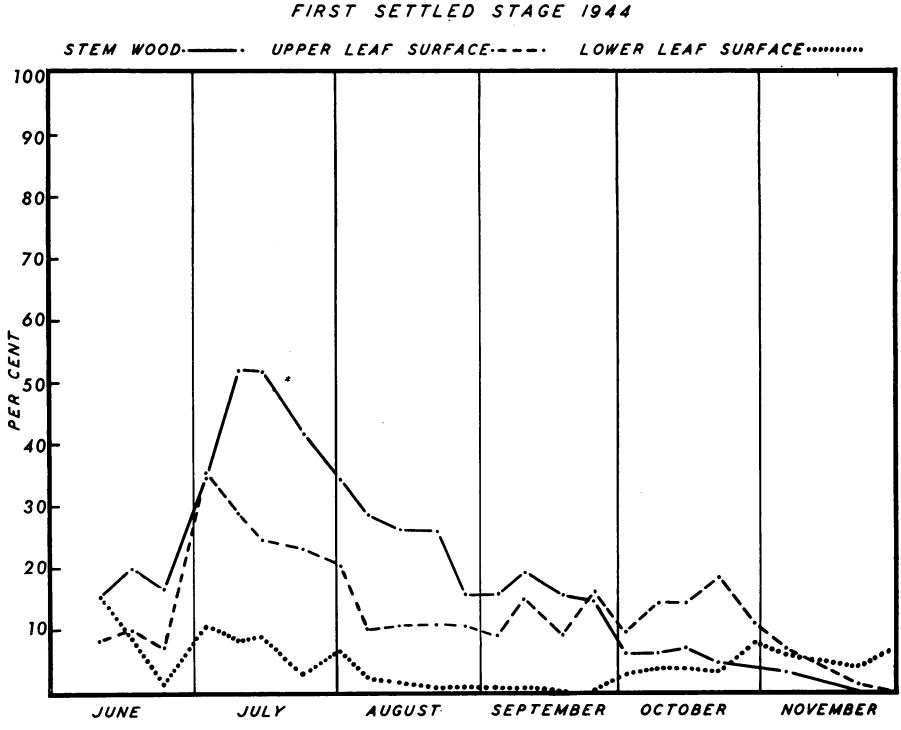

Fig. 4.—Relative abundance of the first settled stage fig scale at different locations on the tree in 1944.

Table 1 gives the length and width of scales selected at random.

TABLE 1

MEASUREMENT OF FIG SCALE SHELLS SELECTED AT RANDOM

Sex	Location on tree	Number measured	Average		Range	
			Length (mm)	Width (mm)	Length (mm)	Width (mm)
Female	Upper leaf surface	110	1.6	0.3	1.1–1.9	0.2–0.5
Female	Lower leaf surface	121	1.2	0.3	0.8–1.5	0.2–0.3
Female	Wood (in winter)	89	1.9	0.6	1.1–2.5	0.4–0.6
Male	Upper leaf surface	110	1.0	0.3	0.7–1.1	0.2–0.3

Location of Overwintering Females. In California early in 1944 observations were begun on the life history and field biology of the fig scale. First observed was the location of live and dead scales on various parts of dormant trees. Since the pruning and cultural practices for drying figs differ from the practices required for canning figs, and therefore produce a different type of new wood growth, both groups were included in the survey. Examinations were made on trees in Calimyrna, Adriatic, and Mission orchards which produced dried figs, and on trees in three Kadota orchards, one of which produced dried figs and the other two canning figs.

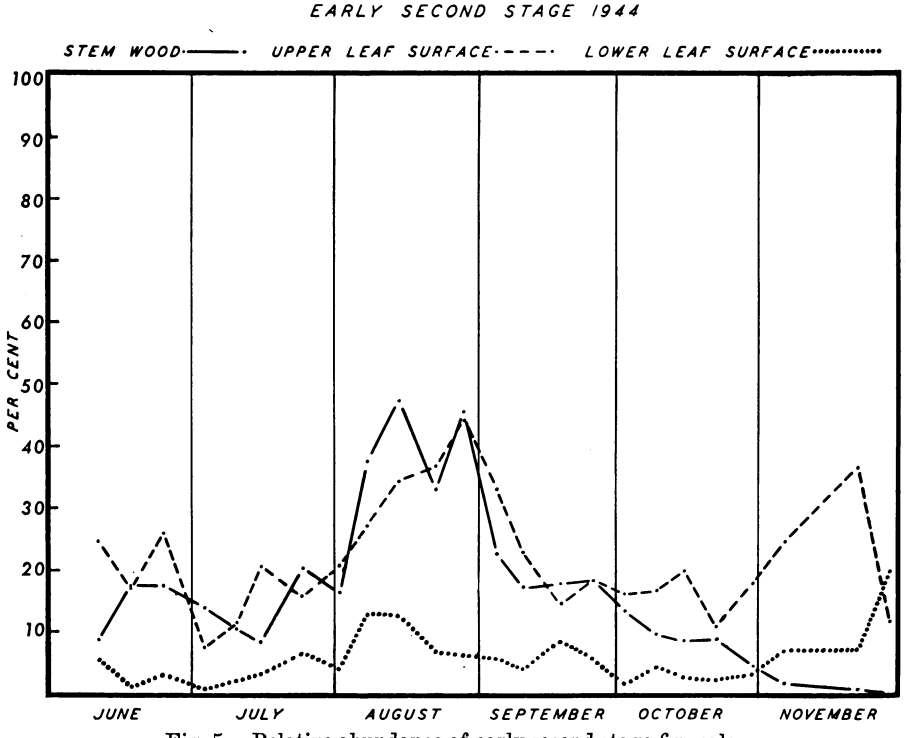

Fig. 5.—Relative abundance of early second stage fig scale at different locations on the tree in 1944.

TABLE 2

NUMBER OF LIVE FIG SCALE PER SQUARE INCH, AND PER CENT ALIVE ON LIMB WOOD OF DIFFERENT AGES IN JANUARY, 1944

Use	Variety	Number of live scale per square inch on wood of age indicated				Number of live scale as per cent of total scale examined on wood of age indicated				Number of live scale as per cent of total live scale on wood of age indicated				Total number of live scale examined
		One year old	Two years old	Three years old	Four years old or older	One year old	Two years old	Three years old	Four years old or older	One year old	Two years old	Three years old	Four years old or older	
Drying	Calimyrna	28.1	20.1	30.2	0.6	45.9	18.8	18.5	6.6	28.8	23.1	39.1	9.0	156
	Adriatic	22.8	21.7	3.5	2.2	85.9	60.3	34.9	47.6	65.6	29.0	3.3	2.0	4,511
	Mission	28.1	9.2	4.6	0.3	83.7	77.2	45.0	32.2	56.6	25.5	16.2	1.7	1,129
	Kadota	86.0	66.1	11.6	0.5	65.7	67.4	53.9	43.8	44.2	37.6	10.1	8.1	1,177
Canning	Kadota*	4.2	25.1	9.8	6.0	81.7	65.9	75.8	38.5	28.0	34.7	21.5	15.8	4,368
	Kadota†	27.7	41.4	14.4	3.2	92.7	88.9	53.4	39.7	40.6	40.3	4.2	14.9	1,504

* Sprayed 9 months to one year before examinations.
† Sprayed 21 months to two years before examinations.

Bark flakes from young shoots and from spots of heavy infestation on the trunks and main structural limbs were examined. The areas examined were 1,362 square inches from the limbs and 34 square inches from the trunks. Of the 20,702 scales examined—19,374 from limb wood and 1,328 from bark flakes—only 66 per cent contained living females. The scales on the youngest wood (1943) contained the largest per cent (82.5) of live females while the scales on the trunk contained only 12.3 per cent of live females. The same

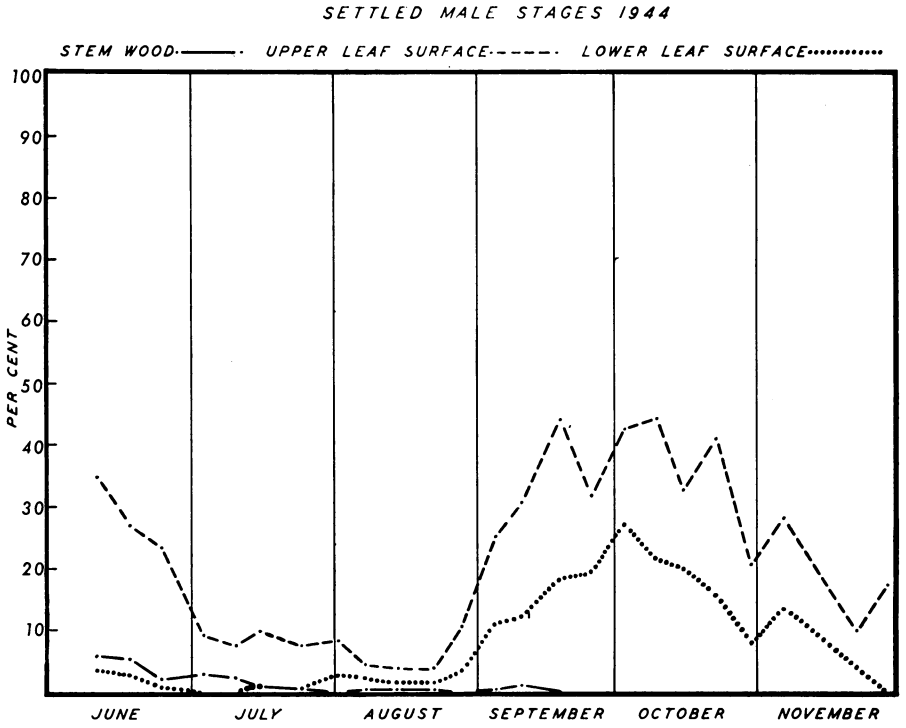

Fig. 6.—Relative abundance of settled male stages of fig scale at different locations on the tree in 1944.

observations also furnished data on the proportions and density of scale population on different parts of the tree. The observations are summarized in table 2.

The examination in January, 1944, of limb wood of different ages showed that on drying figs, about 60 per cent of the total live scale from wood of all ages was found on the youngest wood (produced during the 1943 growing season) and nearly 30 per cent on the wood produced in 1942. Similarly, on canning figs, 31 per cent of the live scale was on the wood produced in 1943 and 36 per cent on wood produced in 1942. Thus, on drying figs in the winter, one may expect to find about 90 per cent of all live scale on the wood produced during the past two growing seasons. On canning figs, however, one may expect to find only about 67 per cent of the total live scale on such wood. The live

scales on the trunk, which were restricted to the smoother and more succulent bark, made but a small per cent of the total. On the most heavily infested parts of the trunks of Calimyrna, Adriatic, and Mission varieties there were about 3 live females per square inch and on the Kadota variety about 9 per square inch.

The influence of cultural practices on the location of scale is evident when the number per square inch on the wood of the various years is examined.

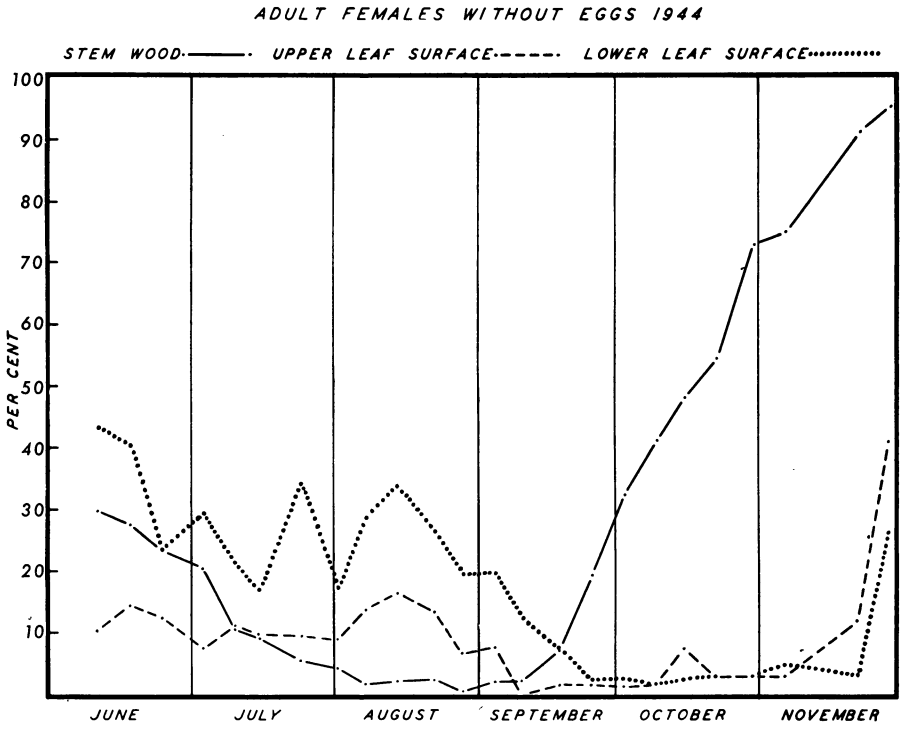

Fig. 7.—Relative abundance of adult female fig scale without eggs at different locations on the tree in 1944.

On trees which produce canning figs, most of the new wood is removed, and only a few buds are left. As a consequence, a substantial part of the infestation is removed in the pruning process. Heavy fertilization should accompany heavy pruning to induce vigorous shoot growth the following season. As a result of the removal by pruning of perhaps 40 per cent of the scale on the current season's wood, and the presentation of a large area of new wood surface to the progeny of this reduced population in the following season, the number of scales per square inch on new wood is smaller on canning than on drying figs. The greatest density occurs on the two-year-old wood.

Vigorous annual growth is not encouraged on trees producing drying figs, and little of the new wood is removed by pruning. As a result, a maximum number of scales remains on the trees, with heavy infestation on the limited amount of new wood.

The infestation figures presented indicate that live overwintering scales may be found at any point on the tree. In this study, even though the scales were heaviest on the newer wood, and decreased as the age of the wood increased, live scales could be found wherever succulent bark occurred above the ground. The necessity of covering the entire tree with dormant oil sprays in order to secure control was therefore indicated.

TABLE 3

OVIPOSITION OF OVERWINTERED FIG SCALE

Date	Locality	Scale from one- and two-year-old wood		Scale from trunk and main structural limbs	
		Number examined	Per cent with eggs	Number examined	Per cent with eggs
Observations, 1944					
February 7	Reedley	1,504	0.1	...	....
9	Fresno	1,828	0.0	...	....
10	Merced	.....	....	219	25.1
15	Fresno	1,735	0.2	...	....
17	Fresno	1,216	0.5	63	25.4
23	Fresno	1,202	0.1	293	14.3
28*	Fresno	1,326	5.1	286	51.1
March 2	Fresno	908	13.9	...	....
7†	Fresno	476	25.9	286	54.9
10	Fresno	490	55.9	...	....
13‡	Fresno	878	85.4	245	90.6
16	Fresno	1,686	88.0	...	....
20	Fresno	1,036	97.3	...	....
27§	Fresno	379	99.7	...	....
Observations, 1945					
February 20*	Fresno	300	4.7	71	46.5
26†	Fresno	650	21.9	84	50.0
March 5	Fresno	400	61.5	226	86.3
12‡	Fresno	300	92.7	48	93.8

* Almonds in general bloom.
† Apricots beginning to bloom.
‡ Apricot bloom falling. Buds ½ to 1 inch long on side of Adriatic fig trees.
§ Peaches generally in bloom. The more advanced Adriatic fig foliage 1½ to 2 inches long.

Eggs of Overwintered Scale. In an attempt to associate the egg-laying period of the overwintered female scales with phenologic events in the vicinity of Fresno, certain observations were carried on in 1944 and 1945. Separate records were made for scales from one- and two-year-old wood and for scales from the trunks and main structural limbs. The observations are summarized in table 3.

In February of both 1944 and 1945, when almonds of the region were in bloom, about 5 per cent of the scales on the twig wood were ovipositing. When apricots were in bloom, the greatest increase in the per cent of female egg-laying scales was noted. In both years, about 20 per cent of the females had

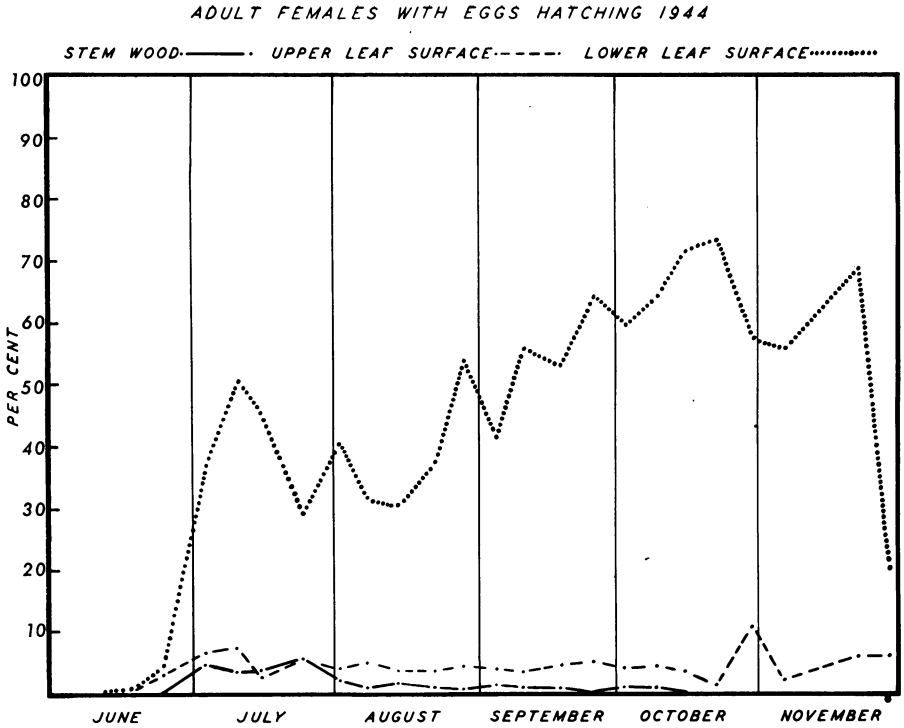

Fig. 8.—Relative abundance of adult female fig scales with eggs hatching at different locations on the tree in 1944.

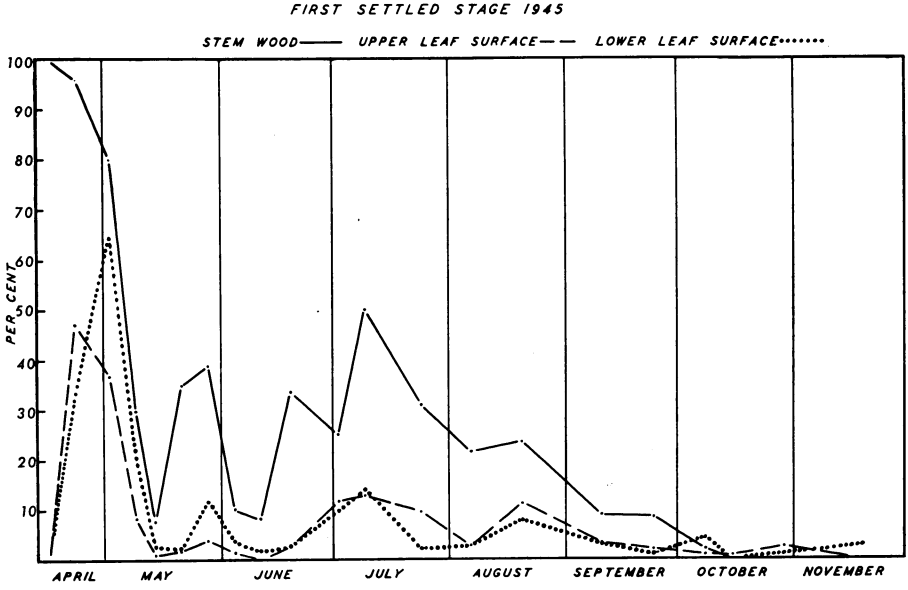

Fig. 9.—Relative abundance of first settled stage fig scale at different locations on the tree in 1945.

begun to oviposit when apricots began to bloom, and about 90 per cent were laying eggs when the bloom was falling. It was also noted that at this time the buds on the sides of Adriatic fig trees were about ¾ inch long.

The tendency for scales on the large wood to begin oviposition earlier than those on the new growth was noted in 1944 and in 1945. By mid-March, however, this difference was no longer apparent. It will be remembered, too, that the scales on the older wood form but a small part of the total overwintering population.

TABLE 4

NUMBER OF EGGS FOUND UNDER OVERWINTERED FIG SCALE ON ADRIATIC FIG TREES, 1944

Date	Number		Average number of eggs per scale
	Scales examined	Eggs found	
April 5	100	3,105	31.1
April 13	100	2,864	28.6
April 20	100	3,083	30.8
Total	300	9,052	30.2

TABLE 5

HATCHING OF FIRST SUMMER BROOD FROM EGGS OF OVERWINTERED SCALE, 1944

Date	Number		Per cent of eggs hatched	Per cent of scale with hatching complete
	Scales examined	Eggs observed		
April 5	100	3,105	4.4	0.0
13	100	2,864	14.1	0.0
20	100	3,083	20.9	0.0
26	45	1,522	37.5	0.0
May 5	50	1,681	58.4	0.0
11	14	514	63.2	0.0
19	15	470	59.4	13.3
23	20	828	72.8	10.0
June 5	17	670	75.4	17.7
12	20	629	87.6	50.0
24	10	269	96.7	90.0

Overwintering female scales were selected at random—except for those attacked by predators—and were examined in April, 1944, for number of eggs. The results are summarized in table 4. The number of eggs per scale ranged from 0 to 51 with an average of 30.2. Simmons *et al.* (1931), give 10.9 eggs as the average number laid per female. The brood observed, however, is not stated.

The hatching period of the first summer brood from eggs laid by overwintered females was longer than 11 weeks. In 1944, as shown in table 5, hatching

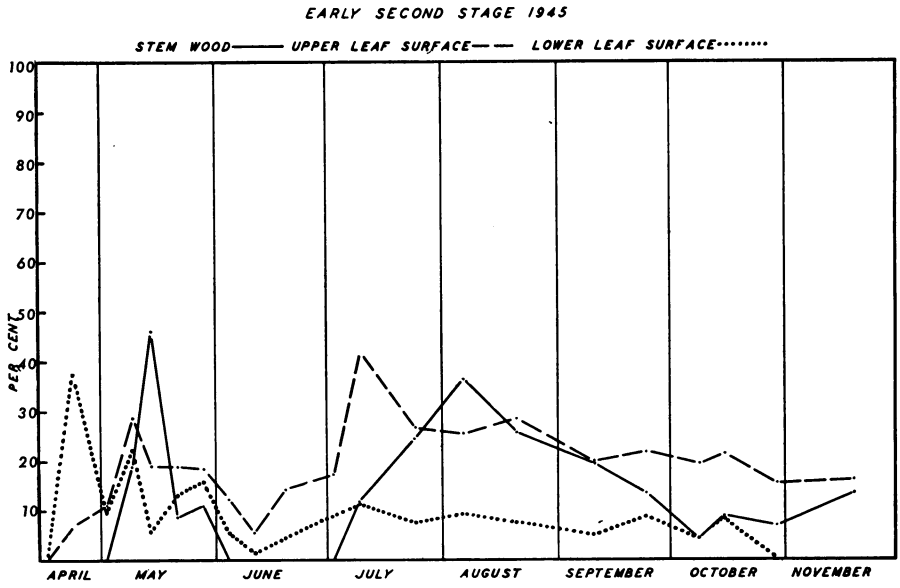

Fig. 10.—Relative abundance of early second stage fig scale at different locations on the tree in 1945.

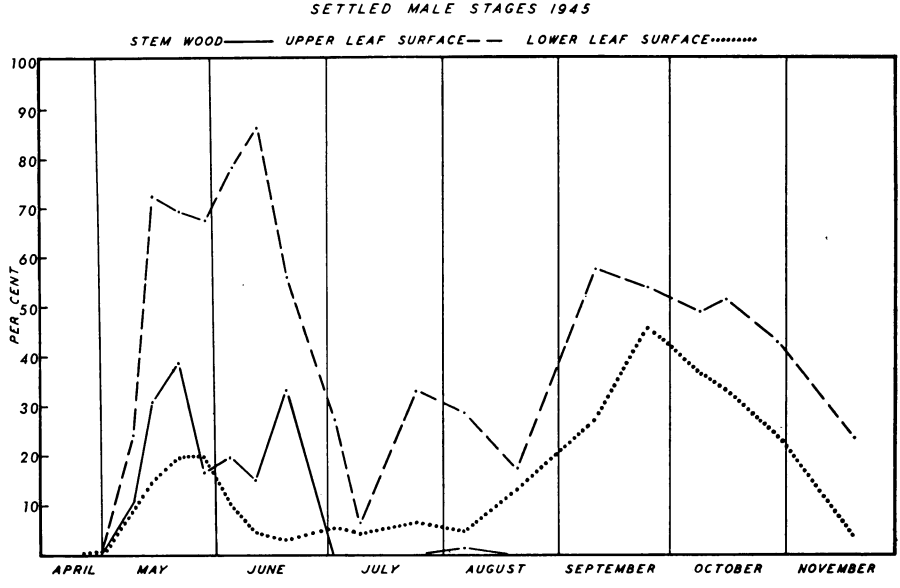

Fig. 11.—Relative abundance of settled male stages of fig scale at different locations on the tree in 1945.

had begun by April 5 and was not quite complete on June 24. The first complete hatch under a single scale was noted on May 19.

On June 24, eggs hatched from the first summer brood and the resultant second-brood crawlers were present on the leaves while the hatching of eggs from overwintered females was still incomplete. How long this overlapping had been going on is not known, but hatched eggs which had been laid by the first summer brood were first found on June 17. This fact had been previously observed by C. K. Fisher of the Bureau of Entomology and Plant Quarantine.

These observations, together with those on oviposition, showed that in 1944 the oviposition period of the overwintered females extended from February 7 to June 24.

TABLE 6

NUMBER OF EGGS FOUND UNDER FIRST SUMMER BROOD SCALE ON ADRIATIC FIGS, 1944

Date	Number		Average number of eggs per scale
	Scales examined	Eggs found	
July 17	60	692	11.5
July 24	50	643	12.8
August 1	40	508	12.7
August 7	40	505	12.6
Total	190	2,348	12.4

Eggs of First Summer Brood Scale. Observations on the number of eggs laid by the first summer brood were made in the same manner as for the overwintered females. The observations are summarized in table 6. The range was from 0 to 23, and the average was 12.4 eggs per female—only 40 per cent as great as the average for the overwintered females. These data approach the figures 10.9 average and 24 maximum presented by Simmons *et al.*, in 1931.

In addition to the fact that individual summer scales are smaller than overwintering scales, there is a difference in body size and number of eggs produced between scales on the upper and lower surfaces of the leaves. On July 3, 1944, 21 scales from the upper surface showed an average of 12.7 eggs per scale, while 17 scales from the rough pubescent lower leaf surface showed an average of 7.2 eggs per scale.

Observations on the hatching period of the second summer brood of the scale were made in the same manner as for the first brood. The period could be clearly traced for about 4 weeks. As previously noted, hatching of the second brood began between the middle and the twenty-fourth of June, before hatching of the first brood was complete. Hatching was not in active progress until after July 3 for, as shown in table 7, only about 1 per cent of the eggs observed on June 24 and July 3 had hatched. During the 4 weeks—July 3 to August 1—the percentage of hatched eggs increased uniformly. Observations were not made after August 7.

Location of Scale while Trees Are in Foliage. The location of scale on the current growth (1944) was studied on eight occasions by examination of foli-

age, second crop fruit, and current wood from six locations on a heavily infested tree. The six locations on the tree were the upper and lower center parts and the northwest, northeast, southwest, and southeast sides of the outside crown. No record was made of the number of live and dead scales. The observations are summarized in table 8.

TABLE 7

HATCHING OF SECOND BROOD FIG SCALE FROM FIRST SUMMER BROOD EGGS, 1944

Date	Number		Per cent of eggs hatched	Per cent of scale with hatching complete
	Scales examined	Eggs observed		
June 24	100	688	1.3	0.0
July 3	38	348	0.6	0.0
July 17	60	692	44.7	1.7
July 24	50	643	59.6	10.0
August 1	40	508	79.7	20.0
August 7	40	505	60.2	2.5

TABLE 8

NUMBER OF SCALES AND PERCENTAGE OF POPULATION FOUND ON 1944 WOOD, FRUIT, AND FOLIAGE OF SIX TWIG SAMPLES

Date	Number of scales on				Average number of scales per fig	Total number of scales counted	Per cent of scale on			
	Wood	Fetioles	Leaves	Fruit			Wood	Petioles	Leaves	Fruit
June 7	29	44	8,073	23	1.0	8,169	0.4	0.5	98.8	0.3
27	20	62	9,468	2	1.0	9,552	0.2	0.7	99.1	0.2
July 10	23	63	8,227	230	17.7	8,543	0.3	0.7	96.3	2.7
17	66	147	8,950	345	18.2	9,508	0.7	1.6	94.1	3.6
24	56	95	10,625	452	19.8	11,226	0.5	0.8	94.6	4.0
Aug. 1	62	137	9,495	503	22.9	10,197	0.6	1.3	93.1	4.9
7	10	173	20,826	358	17.1	21,367	0.1	0.8	97.5	1.8
14	22	171	21,586	270	15.0	22,049	0.1	0.8	97.9	0.1
Total	288	892	97,248	2,183		100,611	0.3	0.9	96.7	2.2

The data show that from June to mid-August more than 90 per cent of the scales on the current season's growth was found on the leaves. Observations made early in the season in 1945 show that this situation also prevailed in late April and early May. On April 23, May 2, and May 9, 1945, the per cent of total population found on the leaves was 88.5, 98.9, and 96.3, respectively. Nearly all of the first brood of males had emerged by mid-July so that count of scales on leaves made at later dates included a great many empty male scales. Further, the data does not distinguish between live and dead scales, and since other observations showed that the proportion of dead scales increases on the leaves as the season progresses, table 8 does not serve as a record of the number of live scales present after mid-July.

Casual observations by the writers, certain fig growers, and agricultural extension workers indicated that scale infestation was often heaviest on the northwest portion of the tree. To augment these casual observations, the density of scale population on different parts of the tree was determined by an examination of foliage from six locations on five Adriatic trees on twelve dates from June 27 through September 18. On the trees selected, which were separated from adjoining trees by several feet, the well-established scale had been uncontrolled for several years. The samples were taken from the same locations in the trees as the samples used to study location of summer brood scales.

TABLE 9

NUMBER OF SCALES RECORDED ON THIRD OLDEST LEAVES OF 1944 GROWTH AT SIX STATIONS ON FIVE ADRIATIC FIG TREES FROM JUNE 27 THROUGH SEPTEMBER 18

Date	Number of scales recorded at following parts of 5 trees						Total number of scales counted	Average per leaf
	Upper center	Lower center	North-west	North-east	South-east	South-west		
June 27	1,543	553	2,286	1,147	1,564	1,055	8,148	271.6
July 10	782	1,081	1,727	1,365	987	644	6,586	219.5
17	554	1,808	2,226	1,677	1,507	800	8,572	285.7
24	719	1,505	1,761	1,346	1,460	1,035	7,826	260.8
August 1	866	1,237	1,856	1,567	1,339	766	7,631	254.3
7	2,835	3,979	2,554	2,747	2,573	1,493	16,181	539.3
14	1,748	3,375	4,040	3,790	3,609	2,522	19,082	636.0
21	2,120	4,586	3,612	2,704	3,286	2,766	19,074	635.8
28	2,725	2,443	4,138	2,224	3,435	2,796	17,761	592.0
September 4	2,322	3,355	5,213	3,268	5,071	3,910	23,139	771.3
11	3,161	3,247	3,641	2,855	4,145	3,477	29,526	984.2
18	2,964	4,326	5,540	3,535	7,455	4,821	28,641	954.7
Total	22,339	31,495	38,594	28,225	36,431	26,085	183,167	
Average per leaf	372.4	525.0	643.4	470.5	607.3	434.8		508.8

Observations consisted of recording the number of scales on the third oldest leaf of each twig sample. They are summarized in table 9. Counts were made without the aid of magnification, and number of live and dead scales was not determined.

The average population densities on the northwest and southeast sides of the trees were significantly greater statistically than those for other locations on the trees. The writers suggest that differences in temperature may cause the differences in population densities in various locations. The lower center and northeast portions of the tree thus may have temperatures below the optimum necessary for crawlers to settle and become established—especially during late August and September. On the other hand, the upper center and southwest portions of the tree may have temperatures too high to be attractive to crawlers. The northwest and southeast portions of the tree seem to have the most attractive temperatures, the southeast appearing better than the northwest in late August and September. Between the dates of August 1 and 7, an increase in general abundance was indicated, the average per leaf increasing from 254.3 to 539.3.

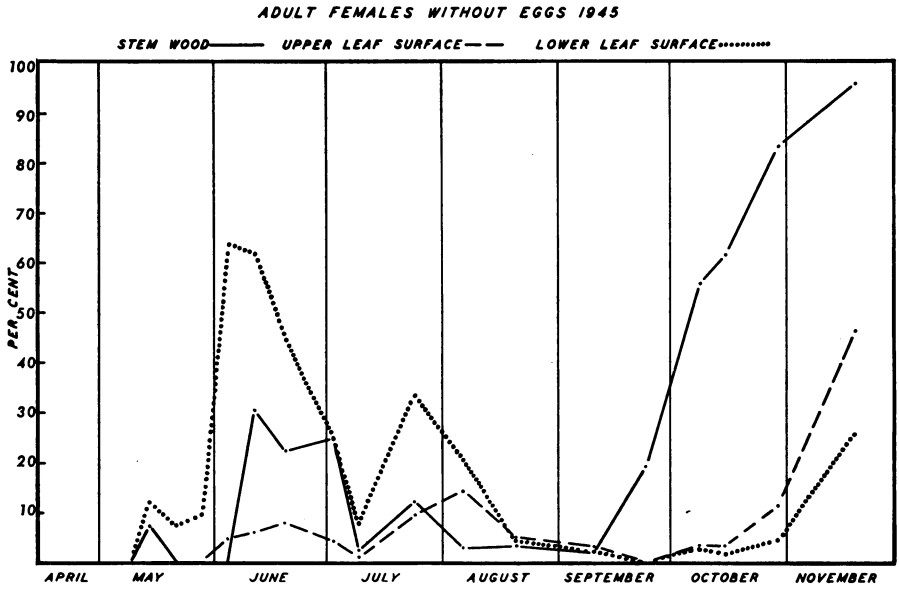

Fig. 12.—Relative abundance of adult female fig scale without eggs at different locations on the tree in 1945.

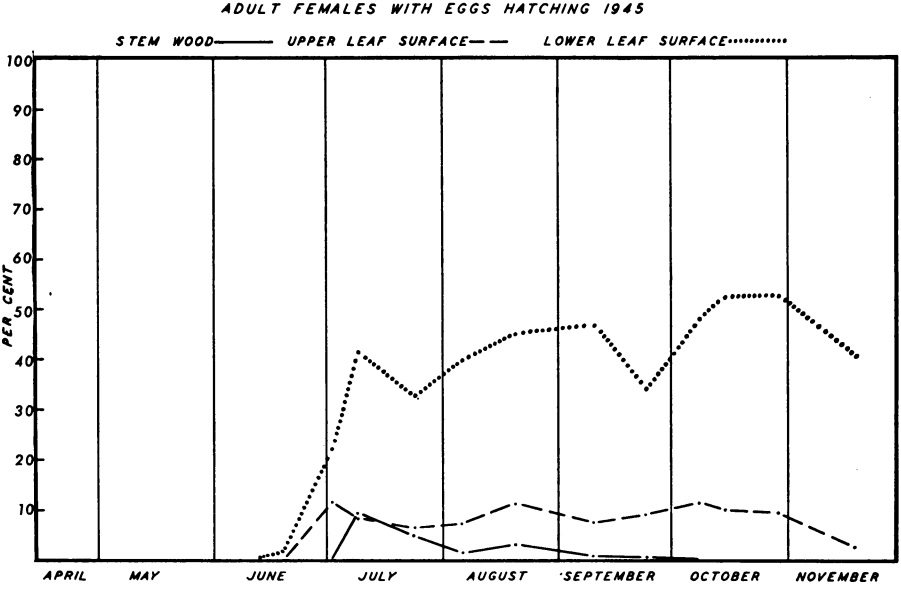

Fig. 13.—Relative abundance of adult female fig scales with eggs hatching at different locations on the tree in 1945.

On June 7, a few fruits were found to be infested with young scales. This fruit infestation must have resulted from crawlers hatched from eggs laid by overwintered scales, since the hatching of eggs laid by the first summer brood scales did not begin until mid-June. From July 10 to August 14, when the observations were discontinued, the number of scales per fruit was enough to make the fruit unattractive. Observations on leaf petioles in 1944 and on fruit in 1945 showed a rapidly increasing infestation during the latter part of August and the month of September. An increase in the rate of production of crawlers and their movement from the leaves was indicated.

Observations on the location of female scales on new wood were made between October 2 and November 20, 1944. The area of the bark examined was

TABLE 10

NUMBER OF LIVING FEMALE SCALES PER SQUARE INCH OF NEW WOOD ON SIX TWIGS BETWEEN OCTOBER 2 AND NOVEMBER 20, 1944

Date	Number of scales	
	Observed	Per square inch
October 2	2,405	75.6
October 9	1,709	62.2
October 16	1,616	59.4
October 23	826	32.3
October 30	817	30.2
November 7	881	43.6
November 13	533	20.3
November 20	385	12.4
Total	9,172	

estimated, and the number of live female scales per square inch was recorded. The results summarized in table 10 show that the observations were begun after the peak of infestation had been reached. The sharp decrease in infestation was due largely to predation. In the following year, observations on number of live male and female scales on the new wood were started in April and continued until November 19. These observations were made from a group of about ten trees, with twigs from the same six sampling locations used for the 1944 examinations. The results are summarized in table 11. It was shown that in August a rapid increase in infestation reached a peak on September 10. In October, a sharp decrease in infestation occurred, similar to that which had occurred the previous year. This decease in 1945 was again largely attributable to predation.

Natural Enemies. The predators which seemed most active during the fall were the armored scale predator, *Lindorus lophanthae* (Blaisdell), the two-stabbed ladybird beetle, *Chilocorus bivulnerus* Muls., and lacewing larvae. On January 25 and February 2 of 1945 a total of 4,352 scales was examined on the youngest wood. Of these, 2,872, or 66.1 per cent, were dead or empty. Practically all of this mortality was due to predation. Among the 1,377 scales not killed by predators, 21, or 1.4 per cent, were parasitized by a small hymenopterous parasite, *Aphytis mytilaspidis* (LeBaron) and probably also by

Aphytis chrysomphali (Mercet) which had been reported by other workers in 1943. All but 1 or 2 of the parasitized scales were still alive.

Counts of 1,800 scales each were made on January 31, February 14, March 15, and April 10 of 1944. Only scales which appeared well developed were examined. Empty scales which had resulted from attacks of predators of one kind or another were discarded. An average of 5 per cent of the scales was found to be dead.

On February 28, 1945, a similar count of 2,000 scales was made, and 6.9 per cent was found to have died from causes other than predation. Consider-

TABLE 11

NUMBER OF LIVING SCALES ON NEW WOOD OF SIX TWIGS BETWEEN APRIL 23 AND NOVEMBER 19, 1945

Date	Number of scales
April 23	50
May 2	10
May 9	37
May 14	13
May 21	23
May 28	18
June 4	10
June 11	13
June 19	9
July 2	16
July 9	42
July 24	81
August 1	419
August 20	535
September 10	1,986
September 24	1,656
October 8	1,953
October 15	784
October 29	1,071
November 19	803
Total	11,529

ing the 1944 fall observations, together with the 1945 early winter observations, 66.1 per cent of the settled population of the new wood failed to establish itself for the winter. By February 28, additional mortality accounted for 2.3 per cent more of the original settled population.

In the spring and summer other predators have been noted. One is the slow-moving mite of the *Hemisarcoptes* species which lives under the scales and feeds on the scale eggs and often on the female bodies. A much larger and more active mite of *Seiulus* species has been seen feeding on the crawlers and the very young settled scales.

Although the natural enemies of the fig scale do noticeably reduce the overwintering population, the reduction is insufficient to check the scale. Where control measures have not been applied, the scale has generally increased to damaging proportions.

Relative Abundance of Different Developmental Stages during the Year. In June of 1944, observations were begun on the life history of the fig scale in the field. Approximately weekly observations were made to determine

about what proportion of the various stages of development one might expect to find in the field on any particular date. Single twig samples were examined from the upper center, lower center, north, east, south, and west portions of the trees. Usually six different trees were used to supply the six location samples on any one sampling date. Separate records were made of insects on the upper and lower leaf surfaces, and on current stem wood. The number of scales examined depended on the relative abundance of live insects at the various locations. The developmental stages were divided into nine catagories: 1) first settled stage before first moult; 2) insects in the process of first moult; 3) insects having passed the first molt, but too young to show sex differentiation; 4) second stage females; 5) second stage males and male pupae; 6) females in process of second moult; 7) adult females without eggs; 8) females laying eggs which had not begun to hatch; and 9) females with eggs hatching. The results of these examinations are summarized in tables 12 and 13.

Five of these developmental stages for the years 1944 and 1945 are shown graphically (figures 4 to 13). In all these graphs the solid line represents the scales on the stem wood; the bar line, the scales on the upper surfaces of the leaves; and the dotted line, the scales on the lower surfaces of the leaves. The lines represent the per cent of the live developmental stage on these locations. For example, figure 9 shows that in early July, 1945, about 25 per cent of all the scales examined on the current stem wood were in the first settled stage of development. At the same time, about 10 per cent examined on both upper and lower leaf surfaces were in the first settled stage of development.

In general, the graphs show two peaks of relative abundance for each developmental stage. Observations were begun so late in 1944 that, in most instances, the graphs for that year show only the second peaks. For the first settled stage (figures 4 and 9) the first peak was distinct while the second peak was much less so, especially on the leaves in 1945. The first peak for the early second stage (fig. 10) was not so distinct as that for the first settled stage. The second peaks for the early second stage (figures 5 and 10) were especially distinct for the upper leaf surface and stem wood. Figures 6 and 11 show, as previous workers have noted, that in the first brood up to July the proportion of males on the upper surfaces of the leaves was greater than on the lower surfaces. Just the reverse was true of the females (figures 7 and 12). Later in the season, however, a large percentage of the males settled on the lower leaf surfaces (figures 7 and 12). A superficial examination would not reveal this fact, since most of the empty shells remain on the upper surfaces of the leaves after the emergence of males.

The second peak of relative abundance of male scales occurred in late September in 1944 and 1945. The steady decrease in the percentage of males on the leaves in October and early November is explained by the emergence of adult males. At the same time that the males emerged, a rapid rise in the percentage of young adult female scales on the stem wood (figures 7 and 12) occurred. These became the overwintering generation. The fact that the males were emerging at the time the females were maturing indicated that the females must overwinter in a fertilized condition. In fact, mating on the stem wood has been repeatedly observed in October and early November, but males have not been found in the winter or early spring.

TABLE 12

Fig Scale on Adriatic Figs, Fresno, 1944

(Stage of development as per cent of total scales examined on each location for each date)

Date	Location	First settled stages	In process of first moult	Early second stage	Second stage, female	Settled stages, male	Females in process of second moult	Females without eggs	Females with eggs not hatching	Females with hatching eggs	Total number scales examined
June 10, 1944	Stem wood	15.4	21.4	8.5	5.1	5.9	13.7	30.0	0.0	0.0	117
	Upper leaf surface	8.2	14.8	24.8	1.6	34.9	4.2	10.3	1.2	0.0	243
	Lower leaf surface	15.4	4.2	5.4	7.6	3.7	10.0	43.3	10.4	0.0	240
June 17, 1944	Stem wood	20.1	14.8	17.7	4.1	5.4	8.3	27.8	1.8	0.0	169
	Upper leaf surface	10.1	15.1	17.0	7.4	27.1	3.6	14.7	5.0	0.0	217
	Lower leaf surface	8.4	5.6	.9	5.6	2.8	11.2	40.2	24.8	0.5	214
June 24, 1944	Stem wood	16.7	16.1	17.7	8.3	2.1	11.5	23.4	4.2	0.0	192
	Upper leaf surface	6.9	10.4	26.0	3.9	23.5	5.4	12.7	8.3	2.9	204
	Lower leaf surface	1.0	2.0	2.9	6.9	0.5	11.3	23.5	47.5	4.4	204
July 3, 1944	Stem wood	34.6	6.7	13.9	2.4	3.0	4.8	20.6	9.2	4.8	165
	Upper leaf surface	35.6	23.3	7.3	5.0	9.1	3.2	7.3	2.3	6.8	219
	Lower leaf surface	10.6	2.3	0.5	0.0	0.0	1.9	29.7	18.0	37.0	216
July 10, 1944	Stem wood	52.2	9.0	10.7	4.5	2.2	5.1	10.7	2.2	3.4	178
	Upper leaf surface	28.9	21.2	11.4	3.3	7.6	4.3	11.4	4.3	7.6	211
	Lower leaf surface	8.0	2.4	1.9	1.9	0.0	4.3	21.8	9.0	50.7	211
July 15, 1944	Stem wood	51.8	20.3	8.1	3.0	1.0	2.0	9.1	1.0	3.6	197
	Upper leaf surface	24.3	27.7	20.7	1.0	9.9	1.0	9.9	3.0	2.5	202
	Lower leaf surface	8.9	7.0	3.0	5.4	1.0	3.5	16.9	9.0	45.3	201
July 24, 1944	Stem wood	41.8	20.6	20.6	1.3	0.4	2.6	5.7	1.3	5.7	228
	Upper leaf surface	23.1	25.3	15.6	4.3	7.6	3.8	9.7	5.4	5.4	186
	Lower leaf surface	2.7	6.5	6.5	4.8	0.5	5.9	34.3	9.8	29.0	186
August 1, 1944	Stem wood	34.3	38.4	16.2	3.3	0.0	1.2	4.2	.4	2.0	240
	Upper leaf surface	20.6	26.0	20.6	3.9	8.3	6.7	8.9	1.1	3.9	180
	Lower leaf surface	6.7	7.8	3.9	5.6	2.8	11.0	17.2	4.4	40.6	180

August 7, 1944	Stem wood	28.7	27.5	37.6	2.5	.4	.4	1.7	.4	.8	240
	Upper leaf surface	10.0	27.8	27.2	5.6	4.4	3.3	13.9	2.8	5.0	180
	Lower leaf surface	2.2	5.0	12.8	3.9	2.2	5.6	28.8	7.8	31.7	180
August 14, 1944	Stem wood	26.1	18.8	47.8	1.7	.4	1.3	2.2	0.0	1.7	230
	Upper leaf surface	10.7	17.2	34.5	3.9	3.9	6.5	16.8	2.7	3.8	185
	Lower leaf surface	1.6	3.9	12.4	2.7	1.6	6.5	34.0	7.0	30.3	185
August 22, 1944	Stem wood	26.0	18.2	32.9	18.6	.4	0.0	2.6	.4	.9	231
	Upper leaf surface	10.8	20.5	36.8	1.1	3.8	4.8	13.5	4.9	3.8	185
	Lower leaf surface	.5	6.0	6.5	3.8	1.6	6.5	26.7	10.9	37.5	184
August 28, 1944	Stem wood	15.5	15.5	45.8	21.2	0.0	1.2	.4	0.0	.4	240
	Upper leaf surface	10.6	18.8	44.4	.6	10.6	2.8	6.7	1.1	4.4	180
	Lower leaf surface	.6	2.8	6.1	2.8	3.3	2.2	19.4	8.9	53.9	180
September 4, 1944	Stem wood	15.7	16.6	22.8	33.3	.4	7.9	2.1	0.0	1.2	240
	Upper leaf surface	8.8	16.8	33.0	.6	25.1	.6	7.8	3.4	3.9	179
	Lower leaf surface	.6	1.1	5.5	3.3	11.1	2.2	19.9	14.9	41.4	181
September 10, 1944	Stem wood	19.2	13.7	17.1	33.8	1.2	12.1	2.1	0.0	.8	240
	Upper leaf surface	15.0	22.2	22.8	0.0	30.6	2.2	0.0	3.9	3.3	180
	Lower leaf surface	.6	2.8	3.9	.6	12.2	1.1	12.2	10.6	56.0	180
September 18, 1944	Stem wood	15.4	19.6	17.9	28.2	0.0	11.2	7.1	0.0	.6	240
	Upper leaf surface	8.9	22.3	14.5	0.0	44.2	2.8	1.7	1.1	4.5	179
	Lower leaf surface	0.0	5.5	8.3	0.0	18.3	1.1	7.7	6.1	53.0	181
September 25, 1944	Stem wood	14.6	12.9	18.3	15.0	0.0	19.6	19.6	0.0	0.0	240
	Upper leaf surface	16.1	23.9	18.3	.5	31.7	1.1	1.7	1.7	5.0	180
	Lower leaf surface	0.0	3.3	5.6	0.0	19.4	1.1	2.2	3.9	64.5	180
October 2, 1944	Stem wood	6.0	13.9	13.3	18.8	0.0	16.0	32.3	0.0	.7	300
	Upper leaf surface	9.3	23.3	16.0	.7	42.7	2.7	1.3	0.0	4.0	150
	Lower leaf surface	2.7	5.3	1.3	0.0	27.4	0.0	2.7	1.3	59.3	150
October 9, 1944	Stem wood	6.1	8.0	9.7	13.9	.3	20.0	41.1	.3	.6	360
	Upper leaf surface	14.2	18.2	16.7	0.0	44.2	.8	1.7	0.0	4.2	120
	Lower leaf surface	3.3	0.0	4.2	0.0	21.6	.8	1.7	4.2	64.2	120

TABLE 12—*Continued*

Date	Location	First settled stages	In process of first moult	Early second stage	Second stage, female	Settled stages, male	Females in process of second moult	Females without eggs	Females with eggs not hatching	Females with hatching eggs	Total number scales examined
October 15, 1944	Stem wood	6.9	6.7	8.3	10.0	0.0	20.0	48.1	0.0	0.0	360
	Upper leaf surface	14.2	20.8	20.0	.8	32.6	.8	7.5	0.0	3.3	120
	Lower leaf surface	3.3	0.0	2.5	0.0	20.0	0.0	2.5	0.0	71.7	120
October 22, 1944	Stem wood	4.5	8.1	8.6	10.9	0.0	13.6	54.3	0.0	0.0	396
	Upper leaf surface	18.6	24.5	10.8	0.0	41.2	1.0	2.9	0.0	1.0	102
	Lower leaf surface	2.9	1.0	2.0	0.0	15.7	1.0	2.9	1.0	73.5	102
October 30, 1944	Stem wood	1.3	2.0	4.5	6.3	0.0	12.4	73.0	0.0	.5	396
	Upper leaf surface	10.9	33.7	17.8	0.0	20.7	2.0	3.0	1.0	10.9	101
	Lower leaf surface	7.8	11.7	2.9	0.0	7.8	9.7	2.9	0.0	57.2	103
November 6, 1944	Stem wood	3.0	3.3	1.5	7.1	0.0	10.1	75.0	0.0	0.0	396
	Upper leaf surface	6.9	24.5	24.5	4.9	28.4	5.9	2.9	0.0	2.0	102
	Lower leaf surface	5.9	5.9	6.9	3.9	13.7	2.0	4.9	1.0	.55.8	102
November 22, 1944	Stem wood	0.0	1.0	.5	1.5	0.0	5.8	91.2	0.0	0.0	396
	Upper leaf surface	1.0	24.7	36.7	2.0	9.9	7.9	11.9	0.0	5.9	101
	Lower leaf surface	3.9	6.8	6.8	1.9	3.9	2.9	2.9	1.9	69.0	103
November 29, 1944	Stem wood	0.0	0.0	.2	.7	0.0	3.9	95.2	0.0	0.0	440
	Upper leaf surface	0.0	11.8	11.8	5.9	17.5	5.9	41.2	0.0	5.9	17
	Lower leaf surface	6.7	6.7	20.0	13.3	0.0	6.7	26.6	0.0	20.0	15

Hatching of eggs of the first summer brood females was first observed on June 17, 1944 and on June 19, 1945 (figures 8 and 13). Beginning in late June, there was a rapid rise in the per cent of females with hatching eggs on the lower surfaces of the leaves. The percentage of females with hatching eggs was low on the stems (under 10 per cent) and upper leaf surfaces (under 12 per cent) for the entire season.

In contrast, the percentage of females with hatching eggs on the lower leaf surfaces remained above 30 per cent until observations were discontinued in November. Two possible explanations are suggested for this latter occurrence: 1) female crawlers settle on the lower leaf surfaces over a long period in the spring where they remain alive for three or four months; and 2) a certain portion of the female progeny of the first summer brood females may settle on the leaves. The writers believe the second explanation to be the more logical one. The data then show an overwintering brood of fertilized females, a summer brood of widely overlapping developmental stages, and a partial late summer or early fall brood. The writers suggest that the first progeny of the summer brood forms the partial second summer brood, and that the later progeny, together with the progeny of the second summer brood, become the overwintering generation.

These data in themselves constitute strong evidence that only one species of fig scale was involved. Just before growth of the fig tree started in the spring, the scale population was—so far as could be observed—composed entirely of *ficus*-form females. As soon as the leaves began to grow, the eggs of these females began to hatch, and a *ficifoliae*-form female infestation appeared on the leaves. Increased infestation on both new and old wood was negligible.

In early August all the overwintered females were dead. Very few adult *ficus*-form females could be found on the twig wood and none was observed on the leaves. Yet it was in August that large numbers of crawlers began to settle on the twig wood and later became overwintering *ficus*-form females.

Location of Ficus- and Ficifoliae-Form Females. In the winter of 1944–1945 all the females that were taken from the wood, mounted, and examined under the microscope were observed to be the *ficus* form, as illustrated by Ferris (1937, 1938). In the winter of 1943–1944 the writers observed on rare occasions one or two females per twig that were about the size and color of the *ficifoliae*-form female. These scales were usually found near the terminal buds. In contrast to the overwintering *ficus* form in midwinter, all of these smaller, narrower, lighter-colored females contained eggs, a majority of which had already hatched. Unfortunately, none of these scales was mounted for microscopic examination. Live *ficus*-form females could be found on the previous season's wood growth as late as mid-June.

Based on the shape of the pygidial lobes, both *ficus*- and *ficifoliae*-form females were found on the youngest twig growth in mid-July. The presence of elongated scleroses arising from the base of the median lobes on the ventral side is the "key character" given by Ferris for the separation of the two forms. Where the lobes were *ficifoliae* shaped these scleroses were always present, but where the pygidial lobes were *ficus* shaped no such scleroses were observed. On the current twig wood in July, the adult females with *ficus*-shaped lobes were smaller and a lighter brown than the overwintering scales.

TABLE 13

Fig Scale on Adriatic Figs, Fresno, 1945

(Stage of development as per cent of total scale examined on each location for each date)

Date	Location	First settled stages	In process of first moult	Early second stage	Second stage, female	Settled stages, male	Females in process of second moult	Females without eggs	Females with eggs not hatching	Females with hatching eggs	Total number scales examined
April 3, 1945	Stem wood	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
	Upper leaf surface	....	....	....	....	....	....	....	....	....	0
	Lower leaf surface	....	....	....	....	....	....	....	....	....	0
April 16, 1945	Stem wood	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
	Upper leaf surface	....	....	....	....	....	....	....	....	....	0
	Lower leaf surface	....	....	....	....	....	....	....	....	....	0
April 23, 1945	Stem wood	96.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50
	Upper leaf surface	47.2	45.8	7.0	0.0	0.0	0.0	0.0	0.0	0.0	288
	Lower leaf surface	33.3	29.2	37.5	0.0	0.0	0.0	0.0	0.0	0.0	96
May 2, 1945	Stem wood	80.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10
	Upper leaf surface	36.8	51.8	11.2	0.2	0.0	0.0	0.0	0.0	0.0	529
	Lower leaf surface	64.4	24.0	9.6	1.1	0.9	0.0	0.0	0.0	0.0	363
May 9, 1945	Stem wood	29.9	35.0	18.9	2.7	10.8	2.7	0.0	0.0	0.0	37
	Upper leaf surface	8.3	34.9	28.8	3.4	24.4	0.2	0.0	0.0	0.0	525
	Lower leaf surface	20.7	28.6	22.4	10.6	10.6	7.1	0.0	0.0	0.0	434
May 14, 1945	Stem wood	7.7	7.7	46.1	0.0	30.8	0.0	7.7	0.0	0.0	13
	Upper leaf surface	0.8	4.0	19.2	0.0	72.8	3.2	0.0	0.0	0.0	125
	Lower leaf surface	2.4	0.8	5.7	35.0	14.6	29.3	12.2	0.0	0.0	123
May 21, 1945	Stem wood	34.8	4.3	8.7	8.7	39.2	4.3	0.0	0.0	0.0	23
	Upper leaf surface	1.6	9.6	19.2	0.0	69.6	0.0	0.0	0.0	0.0	125
	Lower leaf surface	1.9	2.8	13.2	23.7	19.8	31.1	7.5	0.0	0.0	106
May 28, 1945	Stem wood	38.9	11.1	11.1	11.1	16.7	11.1	0.0	0.0	0.0	18
	Upper leaf surface	4.1	7.6	18.6	0.0	67.6	2.1	0.0	0.0	0.0	145
	Lower leaf surface	11.8	2.1	16.0	5.6	20.1	34.7	9.7	0.0	0.0	144

June 4, 1945	Stem wood	10.1	0.0	0.0	70.0	20.0	0.0	0.0	0.0	0.0	10
	Upper leaf surface	1.4	0.7	12.5	0.0	78.4	2.1	4.9	0.0	0.0	144
	Lower leaf surface	3.5	1.4	5.7	5.0	10.6	6.4	63.9	3.5	0.0	141
June 11, 1945	Stem wood	7.8	23.1	0.0	0.0	15.3	23.1	30.7	0.0	0.0	13
	Upper leaf surface	0.0	0.8	5.5	0.0	86.7	0.0	6.2	0.8	0.0	128
	Lower leaf surface	1.6	0.0	1.6	4.8	4.8	3.2	61.8	22.2	0.0	126
June 19, 1945	Stem wood	33.3	11.1	0.0	0.0	33.3	0.0	22.3	0.0	0.0	9
	Upper leaf surface	2.7	3.7	14.7	0.0	56.0	0.0	8.2	14.7	0.0	109
	Lower leaf surface	2.3	0.0	4.6	0.8	3.1	6.2	44.6	36.9	1.5	130
July 2, 1945	Stem wood	25.0	37.6	0.0	0.0	0.0	6.2	25.0	6.2	0.0	16
	Upper leaf surface	11.6	18.8	17.4	0.0	27.6	0.0	4.3	8.7	11.6	69
	Lower leaf surface	10.1	1.8	0.0	0.9	5.5	4.6	24.8	30.3	22.0	109
July 9, 1945	Stem wood	50.0	19.0	11.9	4.8	0.0	2.4	2.4	0.0	9.5	42
	Upper leaf surface	12.8	25.8	42.2	1.8	6.4	1.8	0.9	0.0	8.3	109
	Lower leaf surface	13.9	10.5	11.4	3.5	4.3	1.7	7.8	5.2	41.7	115
July 24, 1945	Stem wood	30.9	22.2	24.7	2.5	0.0	2.5	12.3	0.0	4.9	81
	Upper leaf surface	9.7	7.5	26.8	1.1	33.3	4.3	9.7	1.1	6.5	93
	Lower leaf surface	2.2	1.1	7.6	7.6	6.5	7.6	33.7	1.1	32.6	92
August 6, 1945	Stem wood	21.5	26.7	36.5	8.1	1.7	0.2	2.9	1.0	1.4	419
	Upper leaf surface	2.4	8.4	25.4	1.2	28.9	1.2	14.5	10.8	7.2	83
	Lower leaf surface	2.4	3.6	9.6	0.0	4.8	2.4	20.5	16.9	39.8	83
August 20, 1945	Stem wood	23.4	21.8	26.0	19.2	.2	.9	3.2	2.1	3.2	535
	Upper leaf surface	11.3	18.3	28.7	1.7	17.4	0.0	5.2	6.1	11.3	115
	Lower leaf surface	7.8	4.3	7.8	7.8	13.1	0.0	4.3	9.7	45.2	115
September 10, 1945	Stem wood	8.8	29.6	19.6	24.5	.1	14.6	2.0	0.0	.8	1,986
	Upper leaf surface	3.2	5.3	20.0	3.2	57.8	0.0	3.2	0.0	7.3	95
	Lower leaf surface	3.1	4.2	5.2	8.3	27.1	0.0	2.1	3.1	46.9	96

TABLE 13—*Continued*

Date	Location	First settled stages	In process of first moult	Early second stage	Second stage, female	Settled stages, male	Females in process of second moult	Females without eggs	Females with eggs not hatching	Females with hatching eggs	Total number scales examined
September 24, 1945	Stem wood	8.5	13.1	13.8	16.7	0.0	27.8	19.4	0.0	.7	1,656
	Upper leaf surface	2.0	10.0	22.0	2.0	54.0	1.0	0.0	0.0	9.0	100
	Lower leaf surface	1.0	5.0	9.0	4.0	46.0	0.0	0.0	2.0	34.0	101
October 8, 1945	Stem wood	2.0	4.6	4.4	13.0	.3	19.5	56.0	0.0	0.2	1,953
	Upper leaf surface	.9	15.2	19.6	0.0	49.1	0.0	3.6	0.0	11.6	112
	Lower leaf surface	4.4	3.6	4.5	0.0	36.6	0.0	2.7	0.0	48.2	112
October 15, 1945	Stem wood	0.0	8.4	8.7	9.2	.2	11.9	61.6	0.0	0.0	784
	Upper leaf surface	.8	10.8	21.7	1.7	51.7	0.0	3.3	0.0	10.0	120
	Lower leaf surface	0.0	.8	9.2	1.7	33.3	0.0	1.7	.8	52.5	120
October 29, 1945	Stem wood	0.0	.1	.4	9.4	0.0	6.9	83.2	0.0	0.0	1,071
	Upper leaf surface	2.6	16.4	15.5	0.0	43.1	1.7	11.2	0.0	9.5	116
	Lower leaf surface	.9	8.6	6.9	.9	24.1	1.7	4.3	0.0	52.6	116
November 19, 1945	Stem wood	0.0	0.0	0.0	2.5	0.0	1.6	95.9	0.0	0.0	803
	Upper leaf surface	0.0	6.2	16.2	5.0	23.8	0.0	46.3	0.0	2.5	80
	Lower leaf surface	2.7	5.4	13.5	0.0	4.1	8.1	25.7	0.0	40.5	74

On the leaves through spring and summer until October, all female scales, either in external appearance or when mounted and examined under the microscope, were observed to be *ficifoliae* form. After October, both *ficus*-form and *ficifoliae*-form females were found on the leaves, the former easily distinguished by their wider, darker-colored coverings. Nearly all of the *ficifoliae*-form females on the leaves in October were laying eggs. *Ficus*-form females on the leaves had never been observed to be laying eggs until October 1, 1946. On that date, females with *ficus*-shaped lobes were found to be laying eggs under scales that were only slightly larger and darker than the typical *ficifoliae* form.

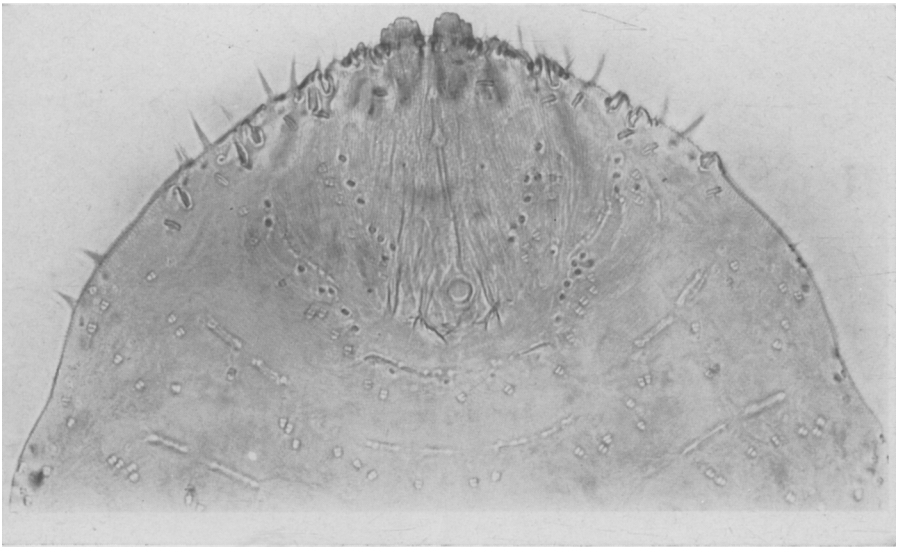

Fig. 14.—Pygidium of *ficus*-form female fig scale. (Enlarged about 330 times.)

The writers have never found a heavy midsummer infestation of *ficifoliae*-form females on the leaves without finding the empty scales of overwintered *ficus* females on the wood of the previous season.

Egg Transfer Experiments. In the spring of 1945 many experiments were made in which eggs from a single overwintered female were transferred to a small cellophane cage fastened with paraffin to a fig leaf. After the transfer, the cage was closed by means of a glass coverslip fastened with paraffin to the cage. The female body was mounted on a glass slide. The eggs hatched but only males developed.

In the fall of 1945, eggs from several females taken from fig leaves were transferred to a fig leaf on an uninfested isolated fig plant. The section of the stem bearing this leaf was isolated by two tanglefoot bands. The procedure was repeated with a second leaf on the plant. The female bodies were mounted on glass slides. Subsequent examination showed all to be of typical *ficifoliae* form. Both *ficus*- and *ficifoliae*-form females developed on the leaf surface. Only *ficus*-form females appeared on the leaf petioles and stem wood.

Egg transfers from overwintered *ficus*-form females were again made in the spring of 1946. Eggs from a single female were transferred to a leaf on an uninfested plant, and the female body was mounted on a glass slide (fig. 14). The part of the stem bearing the leaf was isolated with tanglefoot bands. Typical *ficifoliae*-form females (confirmed by microscopic examination of mounted specimens) developed on the leaves (fig. 15). These experiments are a confirmation of the work of Lupo (1943), who first stated that *Lepidosaphes ficifoliae* was but a summer form of *L. ficus*.

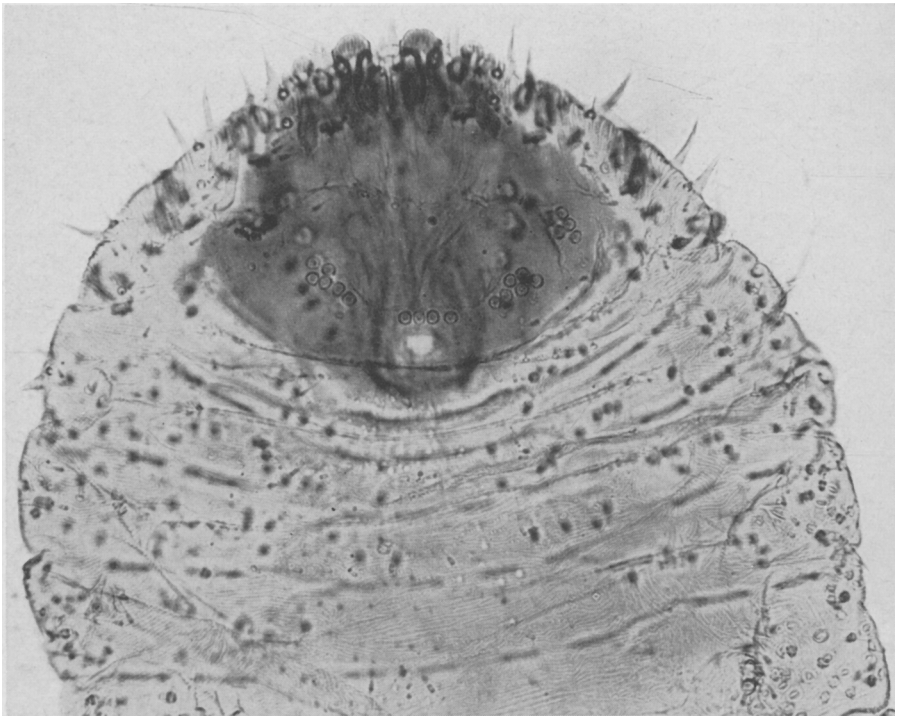

Fig. 15.—Pygidium of *ficifoliae*-form scale. This female was one of the progeny of the female pictured in figure 14. (Enlarged about 330 times.)

SUMMARY

The fig scale, long a pest of cultivated figs in the Mediterranean area, was probably brought to California in 1905. The insect now occurs from Tulare County in the south to San Joaquin County in the north central part of the state. An isolated infestation occurs in Glenn County.

The warty appearance of infested dried figs is unsightly. Heavily infested figs are small, shriveled, and light in weight. The dark green spots beneath scales on ripe canning figs remain after processing. The presence of these scale marks lowers the ripe figs from top, or canning grade, to jam grade, with consequent reduction in value.

The winter of the scale is spent as fertilized adult females. By far the greatest percentage of live scale is found on the one- and two-year-old wood, but

live scale may occur on succulent bark on any part of the tree above the ground. Only 60 to 70 per cent of the scales on the dormant trees contain live females.

Egg laying by overwintering females starts in February, the scale on older wood and trunk being first to oviposit. About 20 per cent of the living scales have begun to lay eggs when apricots begin to bloom, and about 90 per cent are laying eggs when the apricot bloom is falling. At this time the buds on the side branches of Adriatic fig trees have elongated from ½ to 1 inch. On the average, each overwintered female lays about 30 eggs. Hatching starts around the first of April, and egg laying and hatching continue so that the crawlers from overwintered females are produced into late June. In 1944, eggs were present from February 7 to June 24.

The male crawlers from the overwintered female eggs settle mostly on the upper surfaces of the leaves, the female crawlers largely on the lower leaf surfaces. Well over 90 per cent of all crawlers settle on the leaves, less than 2 per cent on the leaf petioles, less than 1 per cent on the new wood growth, and about 2 per cent on the second crop figs.

Female scales found on the leaves throughout the summer are shorter, narrower, and lighter colored than the overwintering form. On the upper leaf surfaces the female scales are somewhat larger and less deformed than those on the lower surfaces.

Egg laying by the first summer brood females on the leaves starts in early June. On the average, each female lays about 12 eggs. In 1944, hatching was first observed on June 17, and in 1945, on June 19. These dates were previous to the completion of hatching of eggs of the overwintered scales. By mid-July of 1945 over half of the eggs under female scales on the leaves had hatched.

Male crawlers from eggs produced by the first summer brood females on the leaves tend to settle uniformly on the upper and lower leaf surfaces. In late summer, female crawlers migrate to the stems, and settle for the most part on the current season's wood. In mid-August, the rise in number of scales per twig is rapid until early October. Nearly all the scales settling on the stems develop into females which overwinter. Mating takes place in the fall. From July through the autumn months a large proportion of the live scale on the lower leaf surfaces is composed of females which are laying eggs. An overwintering, a first summer, and a partial second summer brood are indicated.

The overwintering females on the twig wood are so different in size and body characters that they have been thought to be a different species from the fig scale infesting the leaves in the summer. The former has been named *Lepidosaphes ficus* and the latter *L. ficifoliae*. The designation of two distinct species does not agree with the observations made in the field, however. Egg transfer experiments showed that *ficifoliae*-form females arise from eggs laid by the *ficus* form and that *ficus*-form females arise from eggs laid by the *ficifoliae*-form females. The result of these experiments confirms Lupo's work (1943). During the summer all of the female scales on the leaves were typical *ficifoliae* form. In October, a few *ficus*-form females were found on the leaves. These were generally easily distinguished by their shape and color. They were rarely found to be laying eggs.

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4*m*–12,'48(B759) 141

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