

# California Red Scale

## studies in possible control by employment of natural enemies

Paul DeBach, C. A. Fleschner and E. J. Dietrick

**California red scale, *Aonidiella aurantii***—the most important pest of citrus—is attacked by several natural enemies, principally the golden chalcid, the lindorus ladybird and the twice-stabbed ladybird.

Studies by the Division of Biological Control were directed early in 1948 toward the nature of factors, other than insecticidal materials, which influence the increase and decrease of red scale populations.

In the current investigation the experimental groves have of necessity been limited to those which have a history of nontreatment or which the owners have agreed not to treat for the duration of the investigations. Only in the absence of general scale treatment can the effect of natural factors on the California red scale be evaluated.

At present 14 groves in recognized severe red scale areas are under experimental study. Four are in San Diego County, two in Orange County, three in Riverside County, one in Los Angeles County, one in San Bernardino County and three in Santa Barbara County.

To measure and correlate changes in

the populations of the scale and its enemies or to make experimental comparisons involving the growth of red scale populations in the presence and absence of natural enemies, a monthly census of the red scale population and of all the species of natural enemies present was taken. In groves where the golden chalcid seemed to be the only red scale natural enemy present, the per cent parasitization apparently was too low to account for the excellent degree of control observed. There was, however, a large amount of unexplained red scale mortality associated with the presence of the golden chalcid.

Investigations determined that golden chalcid adults—like the adult black scale parasite *Metaphycus helvolus*—kill the red scale by sucking the body fluid from the scale through a straw-like wax tube which they form with the aid of the ovipositor.

To measure this parasite-caused feeding mortality in the field, which shows up only as dead scale, organly sleeve cages which are pulled over red scale infested branches are used.

One sleeve cage—of a pair—is impreg-

nated with DDT which kills the natural enemies present without affecting the scale population. It is closed so that additional enemies cannot enter after the DDT dissipates. This discloses what the red scale will do under these conditions in the absence of enemies.

The other sleeve is untreated and is left open at the ends so that natural enemies may move in and out.

Over a period of time the differences between the two sleeves give a measure of the effect of all natural enemies combined, and especially of the golden chalcid in certain groves having practically no predators.

These experiments have not yet been conducted for a sufficient length of time to permit final conclusions as to the relative effectiveness of various natural factors. However, there are some indications which, because of the importance of the problem, should be made known. The most general of these are:

1. The California red scale is under commercial control from natural causes in various untreated citrus groves scattered in some of the worst red scale areas in southern California. There is no obviously unique quality about these groves other than the fact that they have not been treated with insecticides for red scale for at least seven years.

2. Under comparable conditions the red scale on oranges is under better natural control than on lemons. This may be correlated with the activity of the golden chalcid which seems to work more efficiently on oranges than on lemons, as well as with the probability that red scale increases more rapidly on lemons and therefore attains higher populations before the natural enemies can overtake it.

3. The golden chalcid seems to be the most efficient natural enemy of the red scale since it is the only one apparent in groves having very low scale densities.

4. The twice-stabbed and lindorus ladybird beetle predators may be of importance in reducing dense red scale populations.

5. The golden chalcid may be adversely affected by a large proportion of the red scale being in a single developmental stage. For instance, it cannot parasitize adult scales, therefore, should the scale be mostly in the adult stage at any one time, the parasite would tend to be greatly reduced in numbers.

6. The golden chalcid may be adversely affected by those insecticides, such as oil sprays, which so reduce the red scale population that for months at a time there are virtually no scales to maintain the parasites, or by those insecticides with prolonged toxic residues, such as DDT.

7. When treatment is stopped in a grove which has been regularly treated for red scale, it may be expected that red

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**Left. Closed sleeve cage impregnated with DDT which will eliminate and exclude natural enemies. Right. Open check sleeve which will permit natural enemies to work as usual and make available data for the comparative study of their effectiveness in the control of red scale populations.**



## RED SCALE

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scale will increase rapidly during the first year or more since its enemies have been practically eliminated.

What has been learned thus far is encouraging. It is especially so to know that owners of some of the best producing orange groves in southern California—groves which formerly were regularly treated—have not treated for red scale for seven or eight years, while treatments were applied regularly by neighbors.

### Further Studies Needed

It is not recommended, of course, that growers abandon treatment for red scale. There is reason to hope, however, that upon the completion of these studies it will be possible in many instances for other growers to duplicate what those owners of the groves now under study have done; i.e., utilize the biological method for control of this pest.

An important factor bearing on this possibility will be the occurrence of other pests in the groves.

The natural control of red scale seems to be a rather finely adjusted balance which may be upset rather easily, and it is probable that considerable management by man—including insectary culture and periodic colonization in the groves of the golden chalcid or other natural enemies—may be necessary. It may be that in some localities environmental conditions are so favorable to red scale that under no conditions can such a program be adopted.

The object of this investigation is, in general, to find out why red scale control by use of insecticides can be abandoned in some groves with satisfactory results, and then to learn how generally it is safe to follow such a program.

The red scale is a dangerous pest and to let it escape from control can result in severe injury to the citrus trees.

*Paul DeBach is Assistant Entomologist in the Experiment Station, Riverside.*

*C. A. Fleschner is Junior Entomologist in the Experiment Station, Riverside.*

*E. J. Dietrick is Principal Laboratory Technician in the Experiment Station, Riverside.*

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## COLD DAMAGE

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The 1932 cold weather came before some walnut trees were thoroughly dormant and there was some crotch injury. A repetition of this damage in 1949 is not likely since the cold weather occurred about a month later than in 1932.

In midwinter although flower buds are somewhat less resistant to cold than leaf buds or cambium, nevertheless flower buds of the most tender kinds such as the peach, the apricot, and the almond will withstand temperatures as low as  $-13^{\circ}$  F to  $-22^{\circ}$  F. Consequently it must be concluded that no damage was done and normal crops in 1949 may be expected—unless frosts or other unfavorable climatic conditions exist at time of bloom and fruit setting.

Flower buds of deciduous fruit trees which produce a fruit crop any one year are initiated the preceding summer and continue their development during succeeding months and only open after two conditions are met: 1. sufficient chilling weather must have existed during the winter months to break the rest and 2. temperatures must be high enough to start growth in the spring.

It is no accident that the California deciduous tree fruit industry is concentrated north of the Tehachapi mountains. Spring temperatures in southern California are ideal but unfortunately the mild winter climate often results in delayed foliation of fruit trees and the shedding of most flower buds of apricots, peaches, and Japanese plums with resultant delay in maturity and greatly reduced yields.

Fruit trees have a chilling requirement which must be fulfilled before blossoming can take place. If this were not so, the frost hazards would be greatly increased since during many years, temperatures in January throughout northern California are high enough to initiate growth and blossoming.

There is a wide variation between species and varieties as to their chilling requirements. The fig needs the least chilling of all the deciduous tree fruits and nuts and is followed in turn by the almond, English walnut—southern California varieties—apricot, Japanese plum, European plum—which vary widely—sour cherry, peach, sweet cherry, pear, English walnut—northern California varieties—and apple, which needs the most chilling.

Temperatures under  $45^{\circ}$  F are considered to be effective in breaking the rest and cold hours are calculated as so many hours where the temperature in a standard weather bureau shelter is  $45^{\circ}$  F or below.

As of the end of the third week in January 1949, 1,287 cold hours had accumu-

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## CASTOR BEANS

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has not been a successful practice. A stand of one plant every 30 inches is desired.

3. Cultivation is similar to that for cotton or corn.

4. Irrigation should be sufficient to keep the plants healthy. Too much water on fertile soils will cause excessive vegetative development. Water should be withheld from the crop for a period of a month to six weeks prior to harvest.

5. Fertilizer requirements are not too well known. Higher yields have been obtained with applications of nitrogen to soils low in this plant nutrient, but similar applications to soils high in nitrogen have given vegetative development rather than seed production.

6. Diseases and insect damage have not been serious in California. Castor beans are not resistant to nematodes.

7. Hand harvesting—the only alterna-

tive to the use of a specially designed mechanical harvester—will cost an estimated 1.5 cents a pound of seed where the yields are good. Because the crop matures over a long period, two or three harvestings may be necessary.

Castor beans have been selling for about seven to eight cents a pound of seed, with the price dependent upon world supplies. Anyone contemplating the growing of this crop should make prior arrangements with a processor of castor beans for disposal of the crop. Processors are the only known source of commercial quantities of seed.

All plant parts of castor beans are poisonous to humans and to livestock. The seed meal remaining after oil extraction can be used only as fertilizer.

*P. F. Knowles is Assistant Professor of Agronomy and Assistant Agronomist in the Experiment Station, Davis.*

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Results of Castor Bean Yield Tests at Davis

Variety	Height in inches			Yield in pounds per acre		
	1947	1948	Average	1947	1948	Average
Conner	76	96	86	2342	2497	2420
Wieman	80			1917		
Kentucky 38	54	63	58	2062	2332	2197
Illinois No. 1		74			2755	
Nebraska 51-1-1		66			2996	
No. 93	51	58	54	2692	2657	2674
No. 72		90			2307	
R-2		52			3058	
R-3		69			2442	
R-6		66			2504	