New Purple Scale Parasite

a second natural enemy of citrus pest established in California may be effective in low host infestations

Stanley E. Flanders

A second natural enemy of purple scale on citrus is established in California.

It is the parasitic wasp—*Physcus* sp. *B*—a close relative of the golden chalcid *Aphytis* sp. *X* which was established on purple scale in California two years ago.

Physcus sp. *B* has passed all biological tests to which beneficial insects, imported into California, are subjected in the Riverside insect quarantine before release.

The adult female is a slender amber-colored insect about $\frac{1}{16}''$ in length with a sharp sting for placing hypodermically one of her eggs in the host's body.

The adult male is black and usually smaller than the female. The relatively small size of the male results from the fact that usually during its growing stage it has less food to eat than does the female.

Strange Habits

Physcus sp. *B* is endowed by nature with some very strange habits, strange even for insects.

The female lays eggs before and after mating but only under very restricted conditions. Such conditions, however, are of two kinds—one for the laying of male eggs and one for the laying of female eggs. Before mating the female lays her eggs in the blood of her own species only and all eggs develop into males. After mating, her eggs are deposited in the blood of purple scale only and all progeny are females.

The offspring of a virgin female, being cannibalistic, feed on their sisters; the offspring of mated females, not being cannibalistic, feed only on the blood and internal organs of purple scale.

Timing of Releases

Because of this habit, in which male production alternates with female production, it is necessary—when establishing *Physcus* sp. *B* in a new country—to pay particular attention to the timing of the releases. The first release should consist of mated females and be timed so some of the female offspring of the second release will be in right condition to be sacrificed as hosts for the production of males. The unmated female offspring of the first release will feed on their sisters and develop into males. These males will mate with the virgin females who will then lay their eggs in purple scale.

Like other good parasites of agricultural pests the life cycle of the *Physcus* female is shorter than its hosts. It has $2\frac{1}{2}$ generations to one of purple scale. The number of eggs that a single female *Physcus* is capable of laying is not known but exceeds 20. Consequently the second generation progeny of one mated female would number 400 at least, a number four times greater than the total progeny of a single purple scale.

Mated *Physcus* females limit their attack to third stage purple scale and can complete their development in hosts that have deposited over half of their eggs. Because of this capacity there is great variation in the size of *Physcus* females. Those from scales that have not deposited eggs are twice the size of those from scales that have deposited half of their eggs.

It is much easier for a mated than for an unmated female to locate scales in which to lay her eggs. The unmated female must not only locate a scale but must find one that contains a full-fed female *Physcus* larva or pupa to serve as a host for male offspring. This means that the average female will be mated before she lays male eggs and that, within limits, the smaller the population of purple scale the higher will be the proportion of male *Physcus* and the higher the incidence of mating.

Trial Releases

The following releases of mated female *Physcus* have been made:

Releases on Citrus Trees

Orange County 1950, El Toro	**250 females**
Orange County 1950, Irvine	**1,000 females**
San Diego County 1951, Vista	**1,000 females**
San Diego County 1951, Oceanside	**3,000 females**

Recoveries of *Physcus* were made in the two San Diego County release plots, and establishment appears to have occurred in both localities.

The conditions of parasite release in the Oceanside grove were highly favorable for the establishment of *Physcus*.

1. The host, purple scale, was plentiful, but not so abundant that economic injury to the trees occurred.

2. The grower did not practice insecticide control for any insect so no lethal residues were present.

3. Releases were made in proper sequence—April, May, June, and July—so that immature stages of *Physcus*—needed as hosts for the males—were always available.

4. There was no competition with a parasite such as *Aphytis X*, an external parasite which sucks out the blood of the scale. Lack of establishment of *Physcus* at El Toro may have been the effect of competition with *Aphytis X* which had been established in that area over a year earlier.

Competition for Purple Scale

The question is under study whether—in the long run—*Physcus* or *Aphytis* is more likely to give effective control of purple scale. Under good control the purple scale will be scarce and the more effective parasite will be the species which can survive and reproduce when the host population is at the minimum.

There are indications that the ultimate control of purple scale, at its lowest densities—if such control takes place—will be the work of *Physcus* rather than that of *Aphytis*

On the basis of purple scale shipments received at Riverside from the Orient, *Physcus* sp. *B* appears to be the dominant parasite of purple scale in Formosa, and *Aphytis* sp. *X* in China. During the three-year period ending May, 1951, more than 100 shipments of purple scale were received, containing approximately 1,000 live specimens of each species of parasite.

Of the 100 shipments, 15 yielded no parasites, about 40 shipments contained only *Aphytis* sp. *X*, 30 shipments only *Physcus* sp. *B* and 15 shipments both species. In the latter case *Physcus* was usually if not always the dominant parasite.

Small shipments of purple scale presumably representing light infestations were more likely to yield *Physcus* than the larger shipments from heavy infestations.

When the purple scale is scarce, *Aphy-*

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Enemies of Avocado Pests

parasites and predators if protected by sparing use of insecticides will keep avocado pests in check

Blair Bartlett and Paul DeBach

Southern California avocado growers enjoy a singularly fortunate position with respect to insect pests.

Localized outbreaks of some pests may present serious temporary problems to individual growers on occasions, but chronic pest problems such as beset the citrus industry have been largely avoided.

This favorable condition is mainly due to a remarkable array of natural enemies which prey upon the potential pests and destroy them. The latania scale, the long-tailed mealybug, soft-scales—4 spp.—, the omnivorous looper, the avocado brown mite, and the greenhouse thrips all have important natural enemies. Often the combat between natural enemies and avocado pests gets under way long before the pests become prominent and as a result the natural control may pass unsuspected unless something happens to upset the delicate equilibrium of the opposing forces in the early stages of their battle for domination.

Biological control work on avocados attempts first to favor the dominance of natural enemies over pests by introducing new parasites and predators left behind in foreign countries when the pests immigrated to California; and second to guard against catastrophes to the established array of natural enemies that are now present. This dual approach aims at swinging the pendulum even further in favor of biological control and away from the necessity of insecticidal treatment.

There is strong evidence that on avocados, insecticide treatment once initiated can upset the natural balance and develop into a condition of increased necessity for more chemical control applications. With very few exceptions the insecticides commonly used in experimental applications to avocados have shown greater toxicities to the natural enemies than to the pests themselves. This usually causes the pest to flare back unhindered by the retarding effect of natural enemies. Furthermore, some pests formerly of rare occurrence have increased to serious proportions due to the elimination of their natural enemies by insecticides.

These upsets resulting from the use of insecticides do not necessarily mean that insecticides should never be used on avocados. But a grower should weigh carefully the immediate emergency advantages of chemical control with the possible long-range danger involved in upsetting the balance between natural enemies and the potential pests.

If a fruit crop is seriously endangered and the decision must be made in favor of chemical control, the grower should choose judiciously from those materials which are recognized as less detrimental to natural enemies and make applications at dosages just high enough to save the crop. This may at times even mean choosing materials of only moderate insecticidal effectiveness or of using dosages which will merely partially reduce the infestations without attempting their complete elimination.

If the grower risks elimination of natural enemies for extensive periods of time, he may soon find himself with insecticide control measures calling for increasingly greater insecticide expenditures.

Some of the most commonly used materials on avocados are listed below in order of decreasing hazard to certain natural enemies as determined from standard laboratory tests. The relative hazards indicated are for the dosages specified and high dosages increase and lower dosages decrease the danger. The same principle applies to frequency of application of materials. In general, the list will permit the avocado grower to restrict usage of materials most likely to upset a favorable natural balance.

1. DDT, 50% wettable power	1½ lbs. per 100 gallons
2. DDD, 50% wettable powder	2 lbs. per 100 gallons
3. Dusting sulfur, 325 mesh	100 lbs. per acre
4. DN dust D-8	100 lbs. per acre
5. Cryolite	3 lbs. per 100 gallons
6. Nicotine sulphate solution 40%	¾ pt. per 100 gallons
7. Neotran, 40% wettable powder	1½ lbs. per 100 gallons
8. Ovotran, 50% wettable powder	1½ lbs. per 100 gallons
9. Aramite, 15% wettable powder	3 lbs. per 100 gallons
10. Zinc oxide	1 lb. per 100 gallons

In addition to the judicious use of insecticides the avocado grower should practice constant ant control. An abundance of ants can be as serious an upset to natural enemies as an insecticide. Ants may be attracted to only certain pests which secrete honeydew, but they are indiscriminate in their attacks on natural enemies. Hence latania scale may increase in the presence of ants even though it is of no direct interest to the ants.

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NEMATODES

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Growers should exercise every reasonable precaution against introducing plant parasitic nematodes into uninfested land. These should include measures to minimize the possibility of carrying infested soil into a clean area on equipment that might have previously been used on infested soil and the use of planting stock grown in nematode-free soil. The use of resistant rootstocks and soil fumigation is recommended if plantings are being made on land known to be infested with root-knot or root-lesion nematode.

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SCALE

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tis may destroy many scales that would have served as food and home for its progeny. But it can build up rapidly on a high population of scale hosts.

Physcus, on the contrary, is at a disadvantage on high host populations when its per cent of parasitization is low. Under such conditions, the unmated female has to search many purple scales to find a parasitic larva in which to lay its male eggs.

The economic value of *Aphytis* and *Physcus* should be apparent to the citrus grower in coastal areas within three or four years.

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