California Red Scale Parasites

colonization and recovery of three species introduced from the Orient in 1956–1957 indicate establishment in California

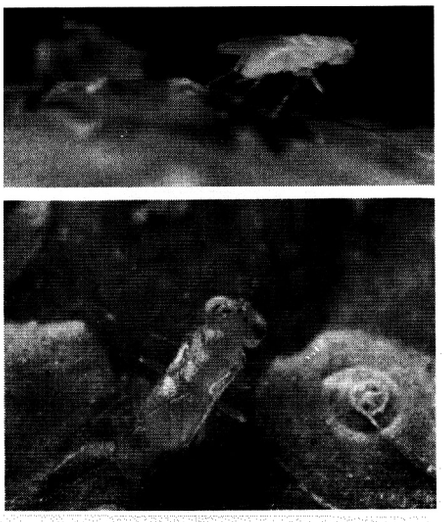
Paul DeBach and John Landi

At least five, probably more, different species of a tiny parasitic wasp—*Aphytis*—are efficient parasites of the California red scale in various portions of the area extending from southern Japan to West Pakistan.

In former years all the little yellow parasites of the genus *Aphytis*, which were found to attack the red scale in the Orient—where there is an excellent degree of biological control—were thought to be the same as a species, *Aphytis chrysomphali*, which already occurred in California.

It now appears that the golden chalcid—*Aphytis chrysomphali*—which was thought to have been an accidental introduction to California from the Orient, does not occur there at all. Instead, its home seems to be around the Mediterranean basin, where it parasitizes the California red and dictyospermum scales. *Aphytis lingnanensis*—once known as *Aphytis A*—became well established in southern California following its introduction in 1948 and is now the principal red-scale parasite in certain areas.

Other parasite species besides *Aphytis* were obtained in the Orient during 1956–1957. However, complicated biologies have resulted in loss of insectary cultures of certain of the species and in such poor production of others that field colonization has been inadequate or lacking. In the Orient *Aphytis* usually appeared to be responsible for the biological control observed.



Two poses of *Aphytis fisheri* ovipositing in California red scales on fruit. Parasites are about 3/64" in length. Photo by Lee Brown.

One species or strain of *Aphytis* designated as near-*hispanicus* from Burma was not included in the table because it originated from a species of scale other than the California red scale. It has been colonized on the red scale in substantial numbers in various counties, but no recoveries have been made. Even though this form can be reared on the red scale in the insectary, it does not successfully attack it in the field. A closely related form, designated in the table as near-*hispanicus* from Assam, is a common and dominant red-scale parasite in Assam, but shipments to California in 1957 did not produce any live adults.

Two Species Colonized

Large numbers of two of the newly introduced species—2,309,800 of *Aphytis melinus* from India and West Pakistan and 1,279,450 of *Aphytis fisheri* from Burma—have been colonized during 1957–58 in very large numbers in over 200 plots in all the red scale-infested citrus-producing counties from Fresno to San Diego. *Aphytis* near-*lingnanensis* (Khunti, India strain) has been colonized only to a limited extent—20,300—but it will receive the major colonization effort in 1959.

Recovery attempts were made by bringing to the laboratory samples of red scale from various plots, rearing the adult parasites, and then making microscopic identification. Recovery attempts were made only from plots which were established long enough for several generations of the parasites to have developed. The fact that recoveries are made

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Recovery of Newly Introduced *Aphytis* from Colonization Plots (Plots sampled up to January 1, 1959)

General climatic area	County	Species					
		A. melinus		*A. fisheri*		*A. nr. lingnanensis* (Khunti, India strain)	
		No. plots	No. recoveries	No. plots	No. recoveries	No. plots	No. recoveries
Coastal	San Diego	7	0	5	1	1	1 ?
	Orange	3	1	2	1		
	Santa Barbara	6	4	2	1		
	Total	16	5	9	3	1	1 ?[a]
	% Recoveries	31		33		..	
Interior	San Bernardino	11	8	4	1	1	0
	Riverside	11	6	14	5	2	1 ?
	Los Angeles	8	5	5	2		
	Total	30	19	23	8	3	1 ?[a]
	% Recoveries	63		35		..	
San Joaquin Valley	Kern	7	7	2	1	1	1
	Tulare	8	6	2	1		
	Fresno	4	4	12	12	2	2
	Total	19	17	16	14	3	3
	% Recoveries	90		88		100	

[a] Recoveries questionable because this form can not be distinguished from original *A. lingnanensis* which is present in the area.

Known Species or Strains of *Aphytis* Parasitic on the California Red Scale in the Orient

Name *Aphytis*	Place of origin	Introduced to Calif.
A. lingnanensis	S. China Formosa	1948
A. melinus	India W. Pakistan	1956–57
A. fisheri	Burma	1957
A. nr. hispanicus	Assam, India	1957[a]
A. nr. lingnanensis[b] (Khunti strain)	Khunti, India	1956

[a] Shipments failed to produce live adults.

[b] The Khunti *lingnanensis* is nearly completely isolated reproductively from typical *lingnanensis*.

been reduced by as much as two full units. Liming of two soils where the pH values were acid—below pH 5—resulted in increased potato yields and in more vigorous and healthy appearing potato plants.

These studies have shown that frequent cropping to potatoes has been an important factor in depleting the exchangeable potassium of the soils, and potassium fertilization is becoming increasingly necessary to maintain high potato yields. With the current practice of applying copious quantities of ammonium fertilizers, soil pH has been dropping to dangerously low levels—in some soils—and corrective measures are necessary to restore the soil pH to safe levels.

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LYGUS BUGS

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counts and were higher than for other treatments in the experiments. Three factors were probably responsible for the high populations. *1.* The individual plots were bounded by less effective treatments from which heavy migrations of adults occurred. *2.* There appeared to be a large hatch of nymphs from eggs laid prior to treatment. Both Dylox and Phosdrin have a short residual life and thus had little effect upon the later hatching nymphs. *3.* It was observed that Phosdrin and Dylox practically eliminated beneficial insects and they did not return to the plots as quickly as the lygus bugs, which could increase at an unchecked rate. Control of nymphs was better when Phosdrin was combined with toxaphene than with Phosdrin alone. Initial reduction with the combination was about the same as with Phosdrin but nymph populations did not increase as rapidly.

Sevin, ethion, Thiodan and endrin did not appear to be especially effective in controlling lygus bugs in these experiments.

Although it appears that lygus bugs have developed a tolerance to toxaphene in certain areas, this does not mean that toxaphene will necessarily be ineffective early in the season or in other localities. Also, instances of poor control with toxaphene should not always be attributed to resistance. Other factors may be involved in cases of poor control, such as improper timing, poor penetration of dense vegetation, skips, poor lapping of swaths and migrations of adults. Toxaphene is still the preferred material for lygus bug control. Dylox at one pound actual per acre or Phosdrin at eight ounces per acre are promising alternates when circumstances indicate failures with toxaphene which can be attributed to insecticidal tolerance. Because of the longer residual effect of toxaphene against young nymphs and the rapid kill obtained with Phosdrin and Dylox, combinations of these materials also appear to be promising. It should be possible to achieve satisfactory control if treatments are started before heavy populations develop and entire fields are treated. Phosdrin and Dylox will not give the extended control formerly obtained with DDT or toxaphene. It is likely that if Phosdrin or Dylox are used alone, repeat applications will be necessary about one week thereafter in order to control hatching nymphs. To reduce the hazard to bees Phosdrin should be applied early in the morning before the bees are active or in the evening after the bees have left the field.

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PARASITES

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does not mean that the parasites are established permanently. A period of several years is usually the basis for judgment. However, the majority of introduced natural enemies fail to make a start at all in their new environments, so any recovery is encouraging.

The proportion of plots showing that the new parasites are taking hold is rather encouraging, especially in the San Joaquin Valley and the southern California interior areas. Actually, there has been considerable population increase and dispersal of parasites from some of the plots in those areas, and certainly at least *Aphytis melinus* and *A. fisheri* are now adequately started. If they find environmental conditions favorable, they could add appreciably to the field mortality of the red scale; if not, the parasites may disappear after a severe winter or summer. Laboratory studies offer some hope that the parasites will not disappear, for in several respects both *melinus* and *fisheri* show better temperature tolerances in controlled tests than do the already-established *Aphytis lingnanensis* and *A. chrysomphali.*

The fact that a much higher proportion of recoveries was obtained from the San Joaquin Valley and interior area plots than from coastal area plots does not necessarily mean that the physical environment is responsible for this. The proportion and abundance of recoveries correlate very closely with the abundance of already-established natural enemies in the colonization plots. In the coastal counties, natural enemies were rated as already being common to abundant in every colonization plot obtained; hence, competition for the new parasites was extreme. In the San Joaquin Valley counties already-established natural enemies were rated as being from absent to rare in nearly every plot obtained; hence, competition was virtually nil and the new parasites obtained a good foothold in nearly every case. In the interior areas already-established natural enemies were rated as being from scarce to common in most plots; hence, competition was frequently a factor and the proportion of recoveries reflects this. Regardless of the colonization area, if already-established natural enemies were rated as either none, rare, or scarce when the plot was started, over 85% recoveries were obtained; if, however, already-established natural enemies were rated as being common or abundant, then less than 40% recoveries were obtained.

Regardless of the proportion of recoveries from plots in the various areas, if a newly introduced species of *Aphytis* has significant biological advantages over an established species, such as a higher reproductive capacity and a better tolerance to temperature extremes, the new species should supplant the old one sooner or later and the result should be an increase in the amount of natural mortality of the red scale. If a new *Aphytis* proved to be especially well adapted, good biological control could result because *Aphytis*, of one species or another, seem to be principally responsible for the biological control of the California red scale in much of the Orient, as well as in favorable parts of southern California and other parts of the world with similar climates.

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Ernest B. White and Robert E. Orth, Laboratory Technicians in Biological Control, University of California, Riverside, were largely responsible for the production of the parasites used in this work.

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