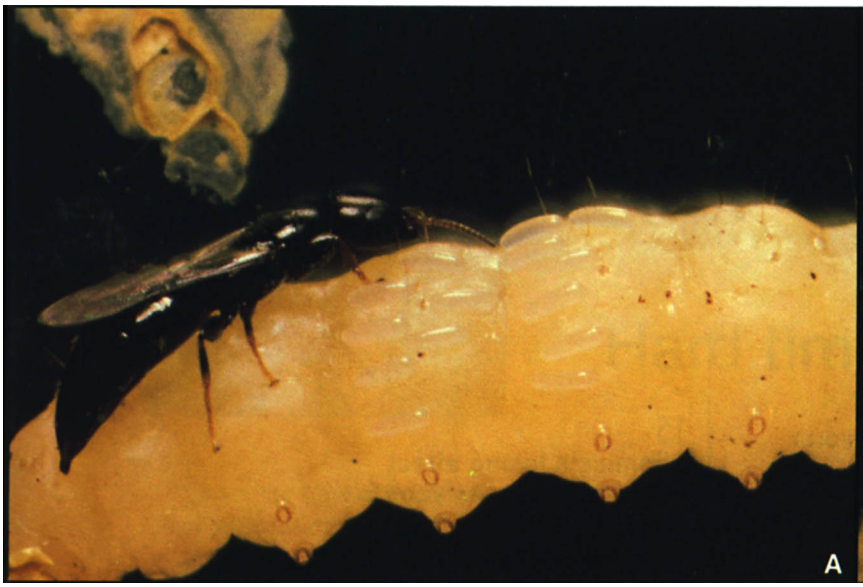
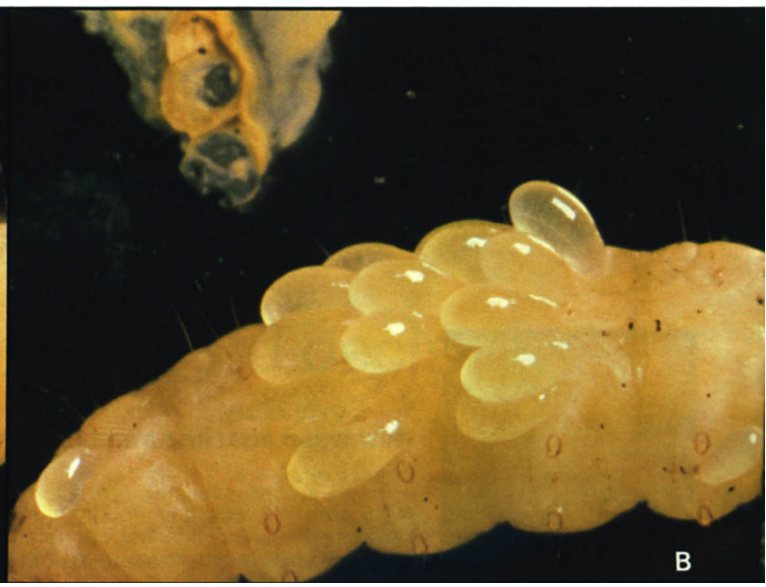




New wasp may help control navel orangeworm

E. Fred Legner □ Gordon Gordh □ Aquiles Silveira-Guido □ Max E. Badgley

Navel orangeworm, perhaps the most important pest of almonds in California, has plagued growers for the past 25 years and continues to do so. A renewed quest for effective natural enemies throughout the native range of navel orangeworm, *Amyelois transitella* (Walker), in Texas and Central and South America resulted in discovery of a parasitic wasp, *Goniozus legneri* Gordh, attacking this insect in southern Uruguay and Argentina, where climatic similarities with California's Central Valley are great.

Parasite liberations begun in 1979 in numerous unsprayed California almond orchards yielded significant experimental data that showed the wasp's potential for economic control of navel orangeworm. The strongest evidence for this potential role includes the following: (1) navel orangeworm parasitism by the wasp was easily effected in all inoculated trees within 1 month of initial inoculation, the parasitism always spreading to at least eight surrounding trees within 3 months, and up to a measured distance of 1,000 feet within 7½ months at experimental sites in Chico, Chowchilla, Wasco, and Riverside; (2) the wasp overwintered in 1979, 1980, and 1981 in all inoculated orchards where no spring or summer broad-spectrum insecticides were applied; and (3) the regulatory impact of the wasp against navel orangeworm was measured within 3 months of inoculation in August 1979 and 1980 at all established sites, the parasite showing a significant capacity (1 percent level) to increase its attack rate when confronted with comparatively higher navel orangeworm densities in trees versus lower densities. The three years of observations strongly point to the wasp's ability to aid materially in depressing navel orangeworm densities to below economically significant levels.

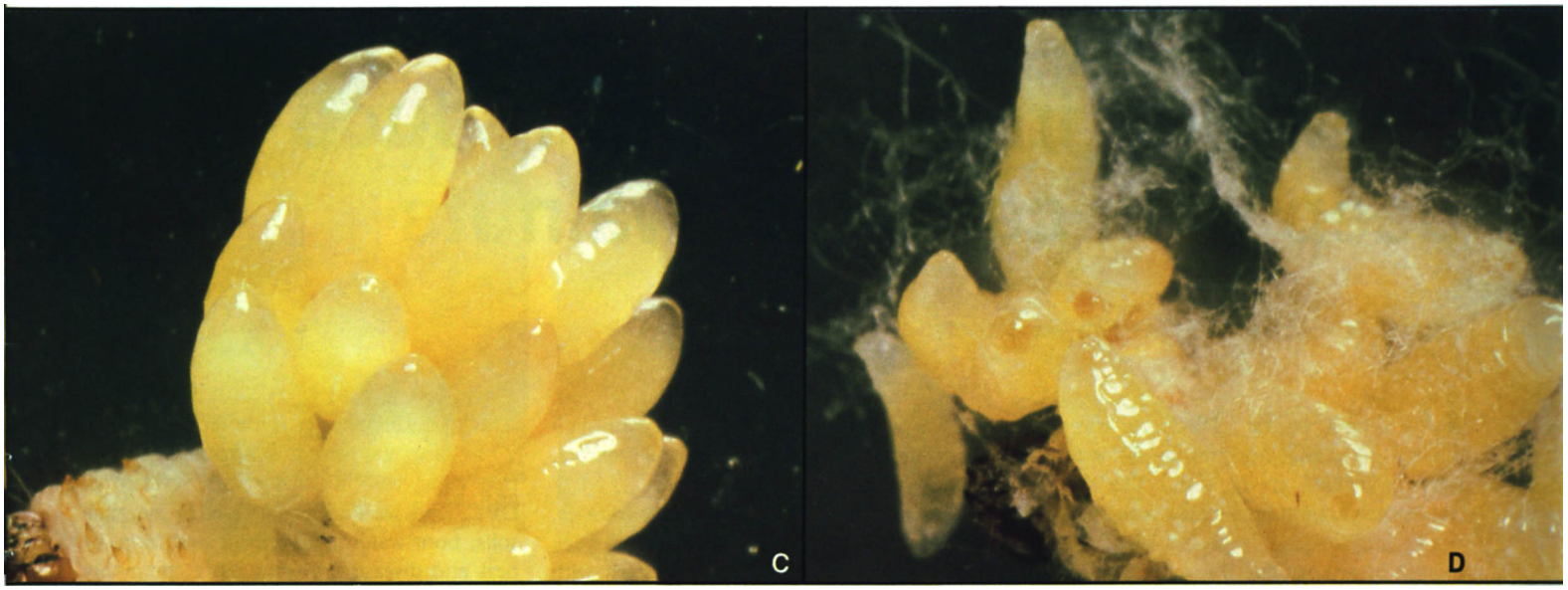
The parasitic wasp attacks navel orangeworm larvae in hullsplit almonds and almond mummies that remain in the tree after harvest. It stings and paralyzes all stages of navel orangeworm larvae immediately upon initial contact, and deposits 5 to 15 eggs superficially on its host. The number of eggs deposited is proportionate to the larva's size. Developmental time from egg to adult parasite is about 24 days at 78 °F, compared with over 50 days for the navel orangeworm feeding on almonds.

The wasp is active in orchards during warm periods of spring and autumn and throughout the summer. A winter diapause is possible but not obligatory in this species. It coexists with another wasp, *Pentalitomastix plethoricus* Caltagirone, which was introduced into California from Mexico in the 1960s and is now widespread in California. The two parasites operating together appear to cause a greater mortality of navel orangeworm than either one alone.

The strategy for use of *Goniozus legneri* in navel orangeworm control stresses wider dissemination in the state to ensure firm establishment. Following is a summary of procedures to maximize its effectiveness.

In areas where other pests such as peach twig borer, San Jose scale, and European red or brown mites pose a special threat, dormant insecticide and oil treatments should be applied thoroughly to keep these pests in check. No adverse effects on the persistence of *Goniozus* or *Pentalitomastix* have been noted from these dormant treatments. However, most broad-spectrum residual insecticide sprays applied during the active growing season from mid-April through late autumn can interfere with parasites, thereby greatly reducing their impact on navel orangeworm suppression, and in some cases, eradicating both parasites from the orchard. Reinvasion of parasites depends on the proximity of reservoir populations in neighboring commercial orchards and backyard plantings.

Annual inoculative releases of *Goniozus legneri* result in local reproduction and direct navel orangeworm mortality. The degree of mortality depends on the numbers released and the thoroughness with which the parasites are manually spread in the orchard.



After she stings and paralyzes NOW larva (A), wasp deposits eggs, which develop quickly (B), and in a few days are near maturity (C) and ready to hatch (D). When mature, adult wasps will fly or crawl to other NOW larvae to start the process again. (14X life-size)

Discovered in South America, the wasp attacks navel orangeworm larvae in hullsplit and mummy almonds.

Ideally, each tree containing almond mummies should be inoculated, and a minimum of 1,000 *Goniozus legneri* applied per acre.

The parasites are enclosed in gelatin capsules, where they develop to the adult stage for release. The capsules are placed directly in convenient crevices of the tree scaffold at arm's height and then opened so that the mature wasps can crawl or fly out to mummy almonds.

Releases may begin when daytime orchard temperatures reach 70°F (mid-April). At higher release rates of more than 1,000 parasites per acre, liberations could start earlier, when temperatures are in the high 60s. July releases are also effective, but there is less time for field-reproduced offspring to affect navel orangeworms before harvest.

Releases should continue after harvest and through the warm months of autumn. These give parasites several additional months for field multiplication and navel orangeworm destruction on mummy almonds, and a subsequent greater control potential for the next growing season. As a management practice, parasite releases in autumn would supplement mummy removal by destroying larvae in the mummies.

Mummy almonds removed from the trees during the dormant season should not be taken from the orchard but, as has been recommended for *Pentalitomastix* establishment, should be placed in window-screened, water-protected containers and hung in tree scaffolds throughout the orchard. The smaller parasites can escape through the screen, leaving the larger navel orangeworm moths behind. Care should be taken to protect these containers from the direct blast of dormant sprays in winter.

At least two years of parasite releases will probably be necessary for maximum effectiveness. However, effects of the first year's release should be noticeable at the first harvest. Navel orangeworm infestations within three to four weeks of hullsplit averaged 6.2, 5.6, 6.1, 8.0, 8.3, 1.7, and 7.4 percent at seven experimental sites in Chico; 2.1, 2.1, and 3.7 percent at three sites in Chowchilla; and 1.1, 1.2, 0.8, and 0.2 percent at four sites in Wasco. These results were obtained after three months of parasite releases at final rates of about 1,000 per acre in orchards where trees bore a substantial mummy almond density ranging from 10 to 150 mummies per tree.

Percentage of parasitism varied with navel orangeworm density, but generally ranged between 20 and 40 percent by *Pentalitomastix plethoricus* and 22 and 50 percent by *Goniozus legneri* in the experimental areas. However, it has been observed that the latter parasite kills more host larvae by stinging and paralysis than are used for reproduction, so that field estimates of percent parasitism, based on emerging parasites, underestimate the total mortality caused by this species.

Permanent parasite establishment will depend to a great extent on the amount of insecticidal drift from neighbors. Drift can be serious, especially if the almond orchard is less than 15 acres and if stone fruits, grapes, cotton, sweet corn, or other similar crops receiving summer insecticidal treatments surround the orchard. *Goniozus legneri* needs to be colonized in large enough areas to enable it to express its potential by minimizing the effect of navel orangeworm immigration from neighboring areas where the parasite is not established. The requirement for continuous yearly parasite releases will depend in part on such factors.

Parasites should be available through commercial insectaries for the 1982 growing season.

E. Fred Legner is Professor of Biological Control, Gordon Gordh is Associate Professor of Entomology, and Max E. Badgley is Staff Research Associate, Division of Biological Control, University of California, Riverside. Aquiles Silveira-Guido is Professor of Entomology, Escuela Agricola Jackson, Montevideo, Uruguay. *The research is supported in part by the Almond Board of California.*