

Pest and Diseases

Survey for Armored Scales and their Natural Enemies on California Avocados

Joseph Morse and Richard Stouthamer
UC Riverside

Cooperators: Lindsay Robinson, Alan Urena, and Paul Rugman-Jones – UC Riverside

SUMMARY OF THE PROBLEM:

Between 1914 and 2007, a quarantine protected California avocado groves from pests that might be introduced into the state along with fresh, imported avocados. Soon after Mexican avocados were first allowed entry on 1 February 2007, live specimens of several species of armored scales (Family Diaspididae) not believed to be present in California were detected on Hass avocados entering the state from Mexico. In order to determine if this was a dangerous situation, we examined fruit entering California via the Blythe border station and found eight species of scales, seven of which are believed to be exotic to the state (Morse et al. 2009). Over an 8-month period, September 2007 - April 2008, we estimated that 67 million Mexican Hass avocados entered California and based on samples from 140 trucks containing 15.6% of the total volume of fruit entering the state, approximately 47.6 million live, sessile scales (first instars and older that can't move from where they are attached; including females which can produce more crawlers) and an additional 20.1 million live eggs and crawlers (the life stages that can establish new populations; some species produce eggs and other species hatch eggs internally and birth live crawlers) were imported. The only species found on Mexican avocados believed to already be present in California was latania scale (*Hemiberlesia lataniae*), which is a parthenogenetic species (females only). Interestingly, latania scale was relatively rare on Mexican avocados but a common species (and one that was previously unknown) was the very similar *Hemiberlesia* sp. near *lataniae*, which is a sexually reproducing species. The other 6 exotic species found were *Abgrallaspis aguacatae*, *Abgrallaspis perseae*, *Acutaspis albopicta*, *Diaspis miranda*, *Diaspis* sp. near *miranda*, and *Pinnaspis strachani*.

How dangerous a situation is this? USDA-APHIS allowed the fruit importations because they believe live scales on fruit pose a "low risk" to pest establishment. We disagree with this assessment, partly because we have determined that scale crawlers can disperse to new environments by hitch-hiking on flying insects (see the report for Project 65102, Survey of Scale Insects Found on Imported Avocado and Dispersal of Scale Insects from Fruit to Host Plants).

If one or more of these exotic armored scales were to establish on California avocados, how serious a pest would they be? We don't really know the answer to this. On many crops, armored scales can be severe pests unless they are controlled by natural enemies (e.g., California red scale on citrus, San Jose scale on many deciduous crops). In some cases, it is possible to return to the country the scale originated from and find natural enemies, which can control it effectively. However, in the absence of good biological control, exotic armored scales could be severe pests on California avocados and would be difficult to control chemically, especially with treatments applied by helicopter (in contrast to many pests, thorough spray coverage is often needed for effective control of armored scales).

OUR RESEARCH APPROACH:

If one or more of the exotic armored scales found on Mexican avocados were to establish in California to a degree such that eradication is not feasible, a preferred method of management would be biological control. For example, latania scale was once quite common on California avocados (38% of 27,868 trees surveyed in 1930 were infested according to Mackie 1931). Presently, latania scale is not present at high levels in CA avocado groves (but we believe it is present at low levels in many groves) and we believe the reason is that natural enemies introduced for control of California red scale on citrus (in the 1950's or earlier) moved onto avocados and controlled latania scale. We do not know to what degree parasitoids and predators already present in California would control some or all of the 7 species of exotic scales found on Mexican avocados.

Our project has 3 objectives:

OBJECTIVE 1. Survey California avocados for armored scale species present on the crop.

It is important to know what the more common species of armored scales are on avocados in California and to develop data that suggests whether or not one or more of the 7 exotic species found on Mexican fruit have already established in the state.

OBJECTIVE 2. Survey for natural enemies associated with armored scales on California avocados.

This objective is important for two reasons. First, we need to know what parasitoids and predators are present on armored scales on California avocados so we can test these species to see if they will attack the exotic Mexican scales. Second, we need to compare key parasitoids and predators present in California versus those that appear to be effective in attacking armored scales in Mexico. For exotic scales that might establish in California, this would help us prioritize Mexican species for possible importation and release (once permits for this have been obtained).

OBJECTIVE 3. Initiate cultures of the more important natural enemies that are found and test their ability to attack various exotic armored scales that are reared in UCR's Quarantine facility.

Our first step is to develop colonies of key armored scales so that we have the infrastructure to evaluate armored scale parasitoids and predators. We will then test the more common natural enemies against Mexican armored scales inside UCR's Quarantine facility (we have a permit allowing us to rear these scales as part of the Millar & Morse project dealing with the development of scale pheromones – See the report for Project 65105).

PROGRESS TO DATE:

Surveys of California Avocado Groves for Scales and Parasitoids. To date, we have surveyed 91 California avocado groves and found 4 armored scale species, although genetic examination of a number of scale samples remains to be done. The 4 scale species identified so far are latania scale (*Hemiberlesia lataniae*), greedy scale (*Hemiberlesia rapax*), California red scale (*Aonidiella aurantii*), and oleander scale (*Aspidiotus nerii*). All reports from growers and PCAs of their having armored scales in their groves were investigated and data recorded. We believe the general impression is that armored scales are rare. However, when we search groves we are working in for other purposes (avocado thrips, perseia mite), we often find low levels of armored scales. This is actually very good news – scales are present and appear to support low but persistent natural enemy populations, i.e. biological control is currently very good for the scale species we already have in California. The key question is whether the parasitoids we have would control the exotic Mexican scales or not. The average numbers of armored scales present on Mexican fruit was 0.71 live scales and an additional 0.34 live eggs or crawlers per fruit (Morse et al. 2009). We don't know if this level of scales was

present because biological control of armored scales in Mexico is poor or because pesticide use had excluded biological control agents.

We have not found any of the 7 species of exotic Mexican armored scales in California to date. We have identified 5 species of parasitoids to date (many more samples remain to be run), all found associated with Iatania scale (*Aphytis* nr *diaspidis*, *Plagiomerus diaspidus*, *Signiphora* sp. 1 nr *flavopalliat*a, *Signiphora* sp. 2 nr *flavopalliat*a, and an unidentified species). For the unidentified species, we have a genetic signature (DNA sequence) that does not match a known species identity. When we do not have a species identity, we will recollect from these field sites (perhaps best with out-plants, see below) and rear out the parasitoid to the adult stage so that we can identify the species or determine if it is a new, undescribed species. A real advantage of the methodology we are using is that genetic signatures are unambiguous – it is not necessary to know the species identity right now; we can continue to make progress and in time, will be able to match a species name with a signature.

Research with Scale Infested Squash Out-plants. One problem with our survey for parasitoids of armored scales in California is that biological control of scales is quite strong (this is very good news for the industry). Most fruit contain relatively few live scales and only a fraction of those contain parasitoids. We expected this would be the case and our plan is to more accurately survey for parasitoids using “out-plants”. The concept of out-plants is that we rear scale on butternut squash to the ideal stage for parasitism in the laboratory and place it in the field for perhaps a week to allow parasitoids to parasitize the scale. We then return the squash to the lab and rear out parasitoids to the adult stage. Based on research on both soft and armored scales on citrus, out-plants can be a highly effective means of surveying for natural enemies of scale insects.

Our initial out-plants were placed in an avocado grove in Grand Terrace (San Bernardino Co.) on 21 July 2010 for 2 weeks but they failed to produce parasitoids, perhaps because the levels of scales and parasitoids in this block were too low. However, the device that was constructed to hang the scale infested squash in avocado groves worked quite nicely and we did not have problem with animals damaging the squash (they were protected by a wire cage that parasitoids can access freely), something we had been concerned about.

We next selected 3 avocado groves (2 in San Diego Co., 1 in Orange Co.) for additional out-plant research and to date, scale infested squash have been placed in each grove for a week on two occasions. We are presently in the process of rearing the scales (and hopefully parasitoids) in the lab. We plan to continue this work to see what species of parasitoids are present and when during the year the highest numbers can be captured.

SELECTED REFERENCES

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ACKNOWLEDGMENTS

We owe a real debt of gratitude to Reuben Hofshi and the Del Rey Packinghouse for their assistance in providing us with scale infested fruit when they detect such fruit passing across their pack-line. This has very much increased the number of different grove sites we have been able to sample for armored scales and their parasitoids. In addition, Reuben and the F.A.R. Insectary in Corona have been very helpful in assisting with field out-plants as described above.