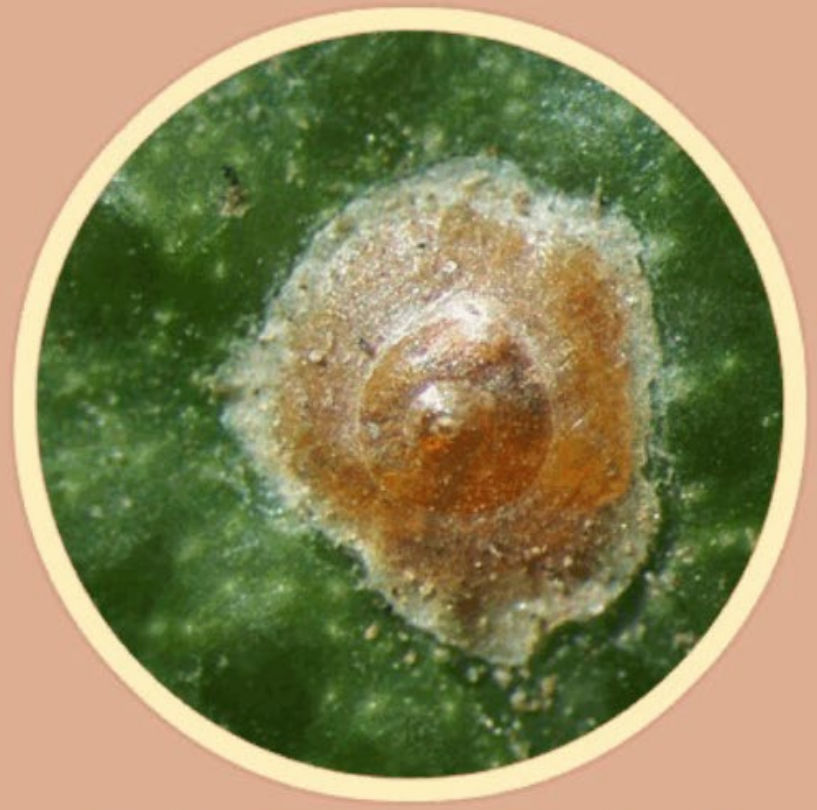
California Red Scale and its Natural Enemies

A study of the biology and management



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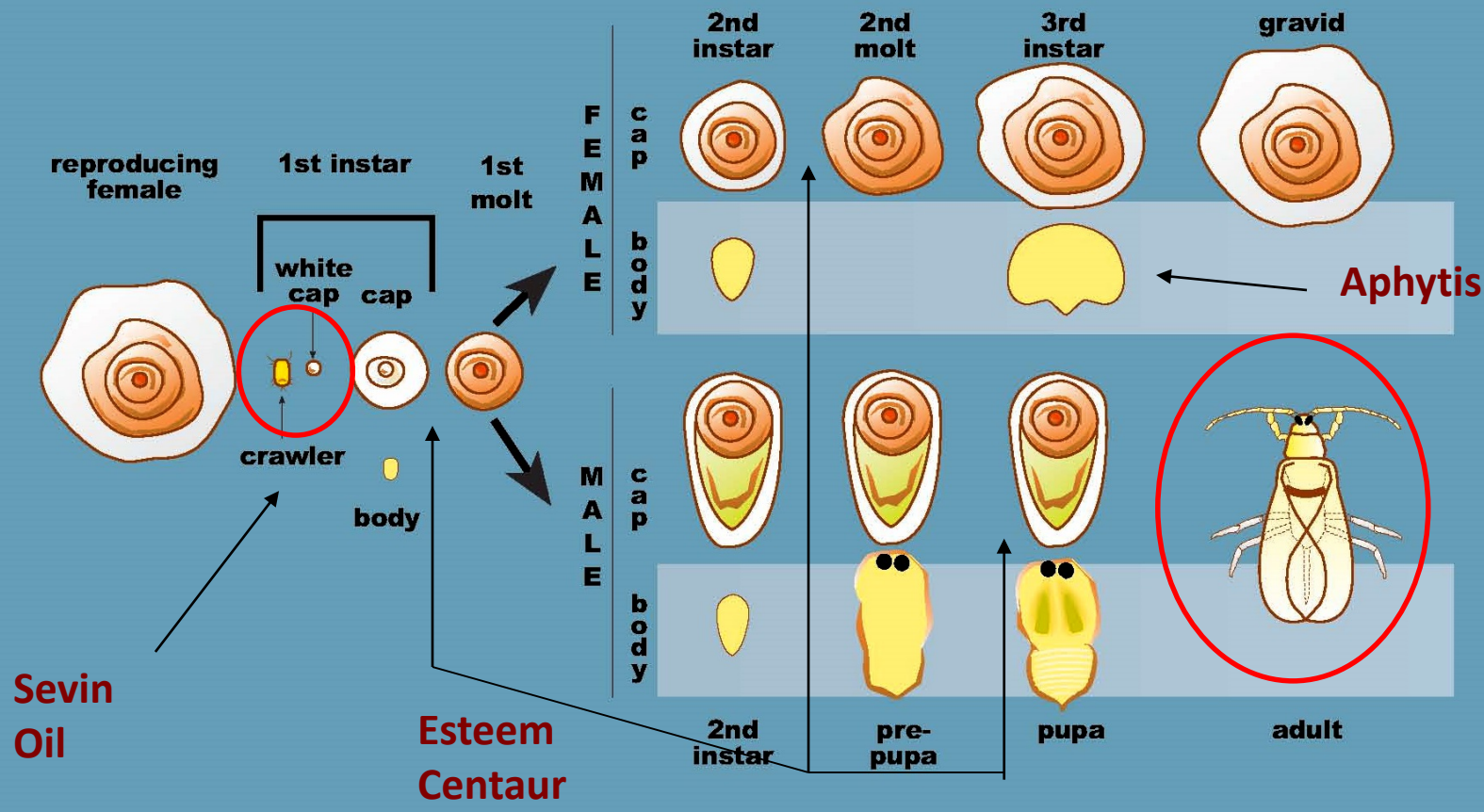
California Red Scale, *Aonidiella aurantii*

Direct Damage – dieback of branches

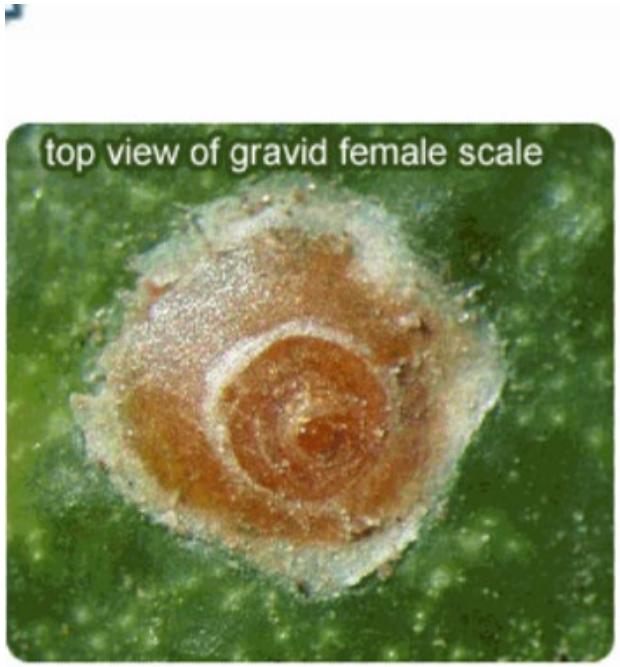
Cosmetic Damage – downgrading of fruit

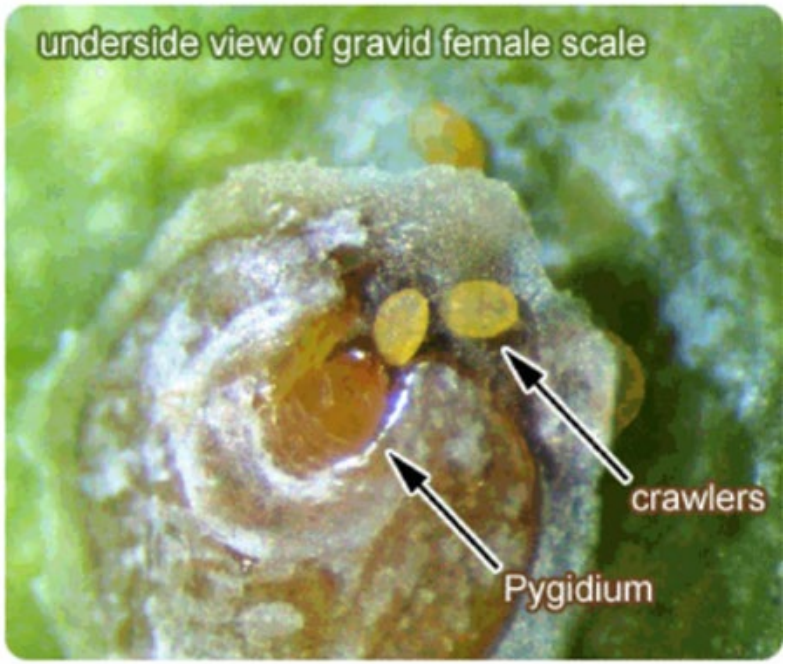
California Red Scale Life Cycle

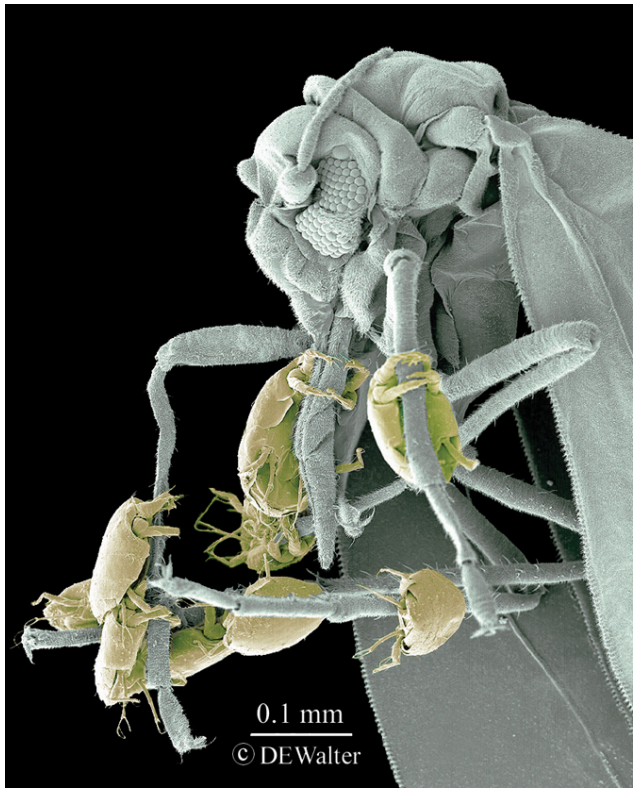


Movento – all stages, but mostly on leaves and fruit

Crawlers are the way that California red scale disperses







Broad mite riding on a whitefly

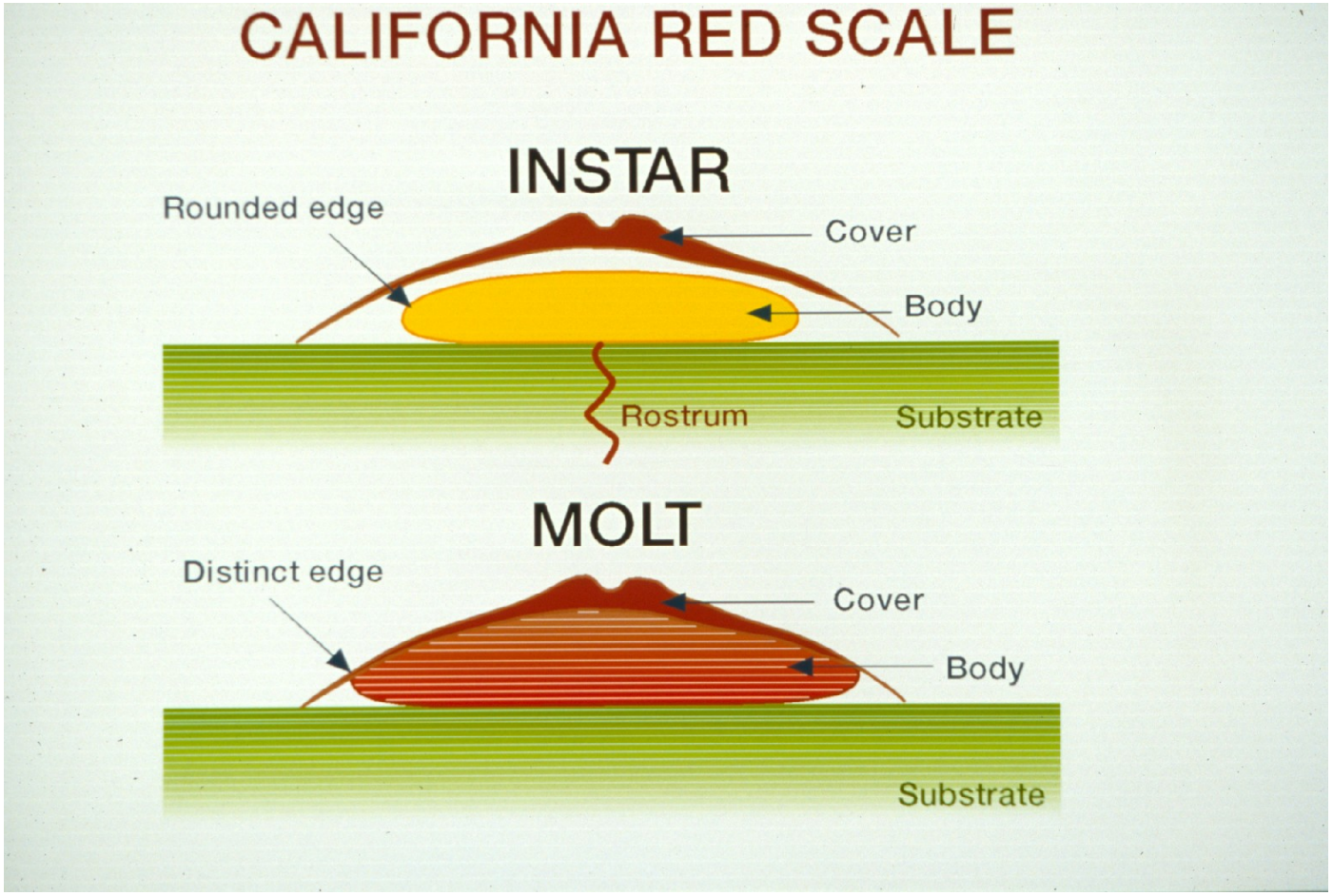
They can walk, be blown by breezes, and there is even evidence of them riding on other insects

1st Instar Scale

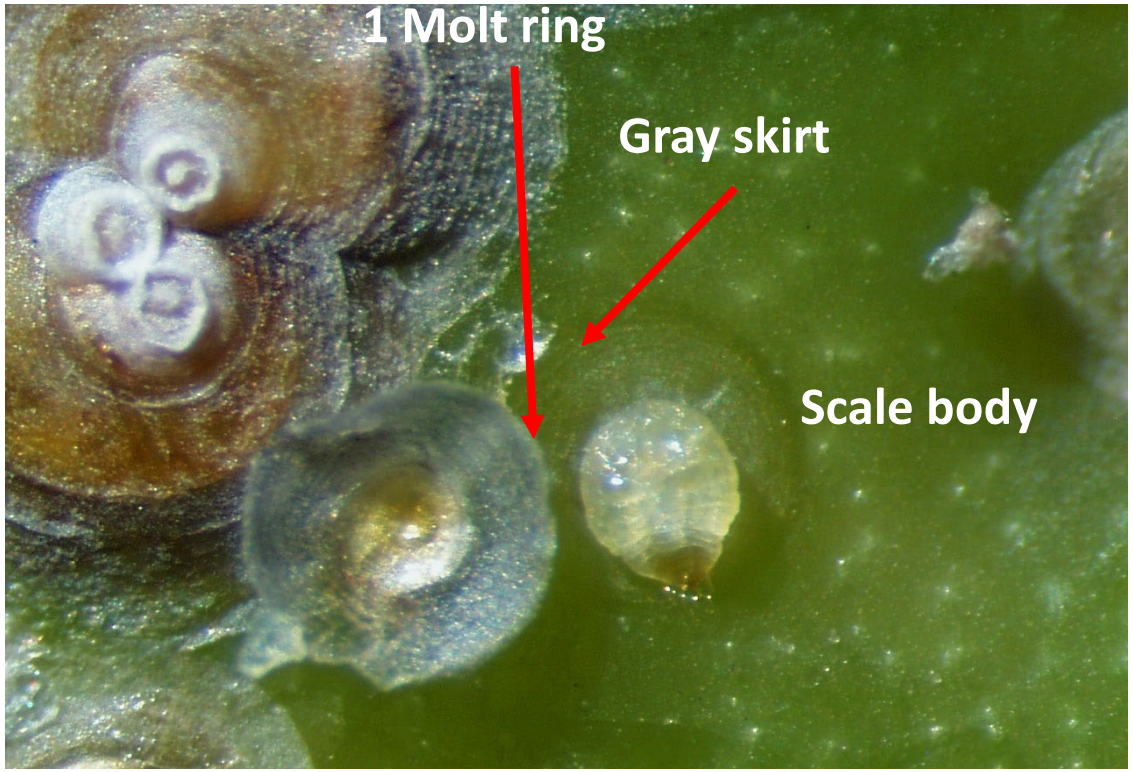
1st Molt

Why is it important to know the difference between instars and molts?

- Molts are not feeding and are protected from some insecticides and parasitism
- IGRs prevent scales from molting so the treatments need to be applied before the molt
- Chitin is absorbed into the cover each time a scale molts so you can tell the stage of the scale by the molt rings

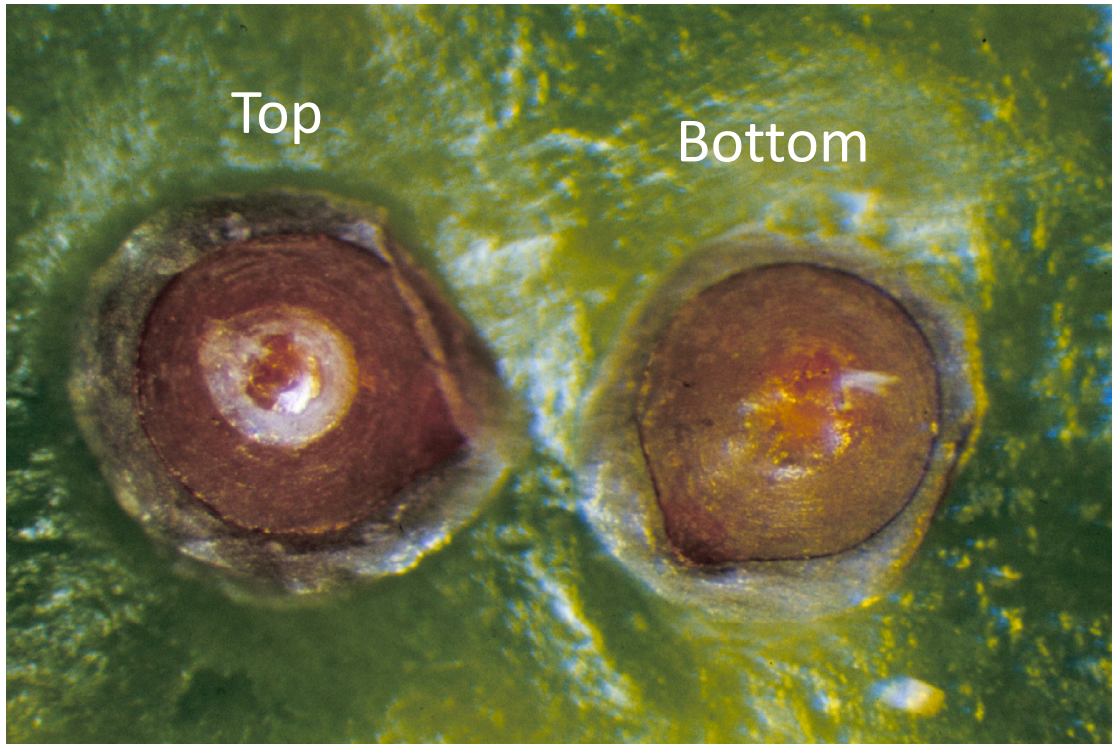


2nd Instar Scale



I know this is a second instar, because of the tear-dropped body shape and the 1 circle of chitin in the cover.

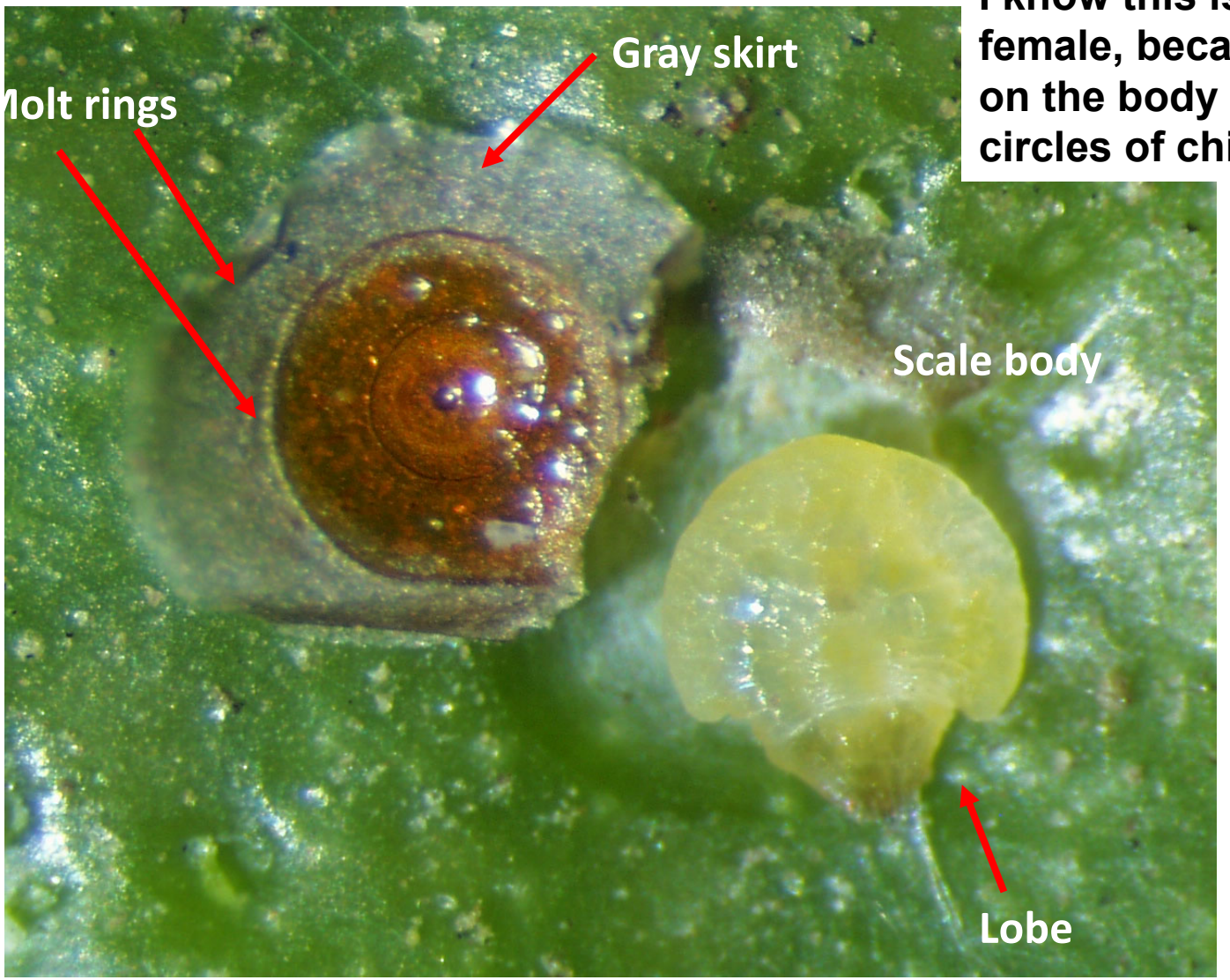
2nd Molt



I know this is a second molt, because I can't separate the top from the bottom, by the large size, and there is a circle of chitin in the middle of it.

3rd Instar Scale: the stage that the male mates with and Aphytis attacks

I know this is a third instar female, because of the lobes on the body shape and the 2 circles of chitin in the cover.

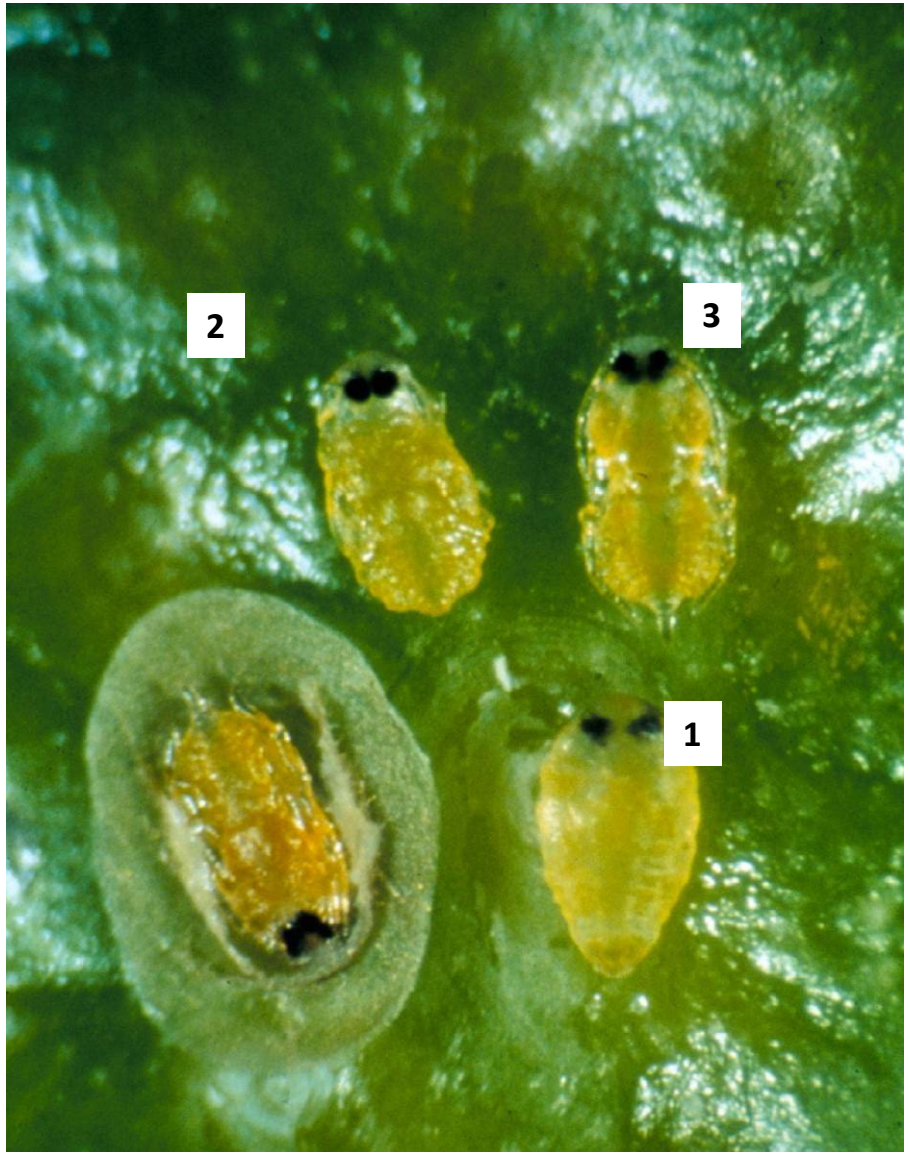


Male scale development

I know this is a male scale because it has eyes.

The difference between the prepupa (#2) and the pupa (#3) is how developed the wing buds and aedeagus are.

Males (4x) molt more times than females (2x) so they are more susceptible to insect growth regulators



Prepupa

Pupa

Pupa

2nd instar

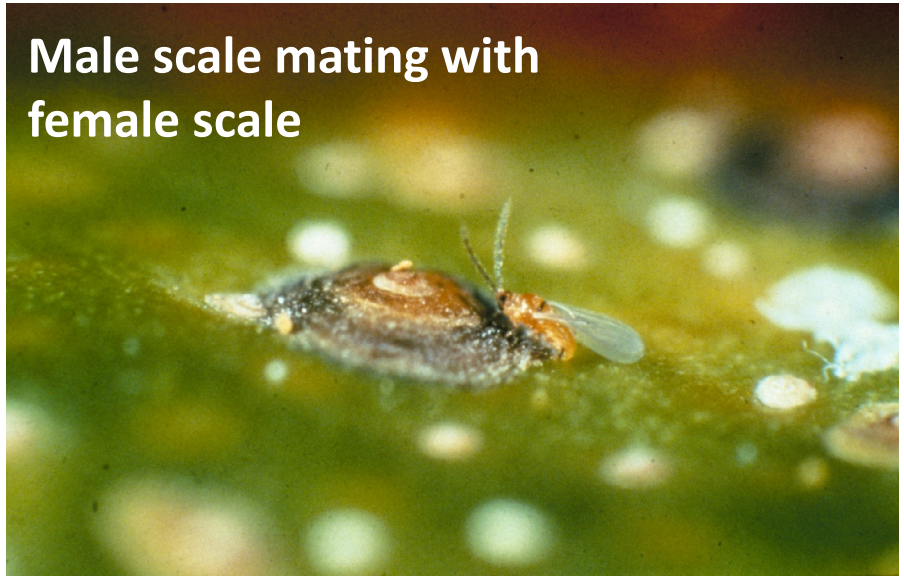
Adult male scale

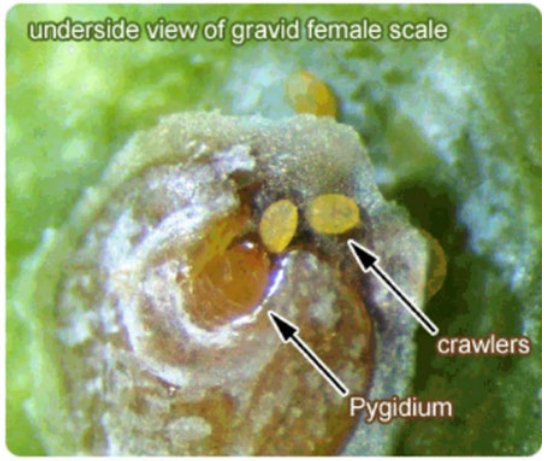
Males fly to find the 3rd instar virgin female scales to mate.

They insert their aedeagus under the scale cover.

Male scales have a brown bar on their back that makes them easy to recognize on a trap card.

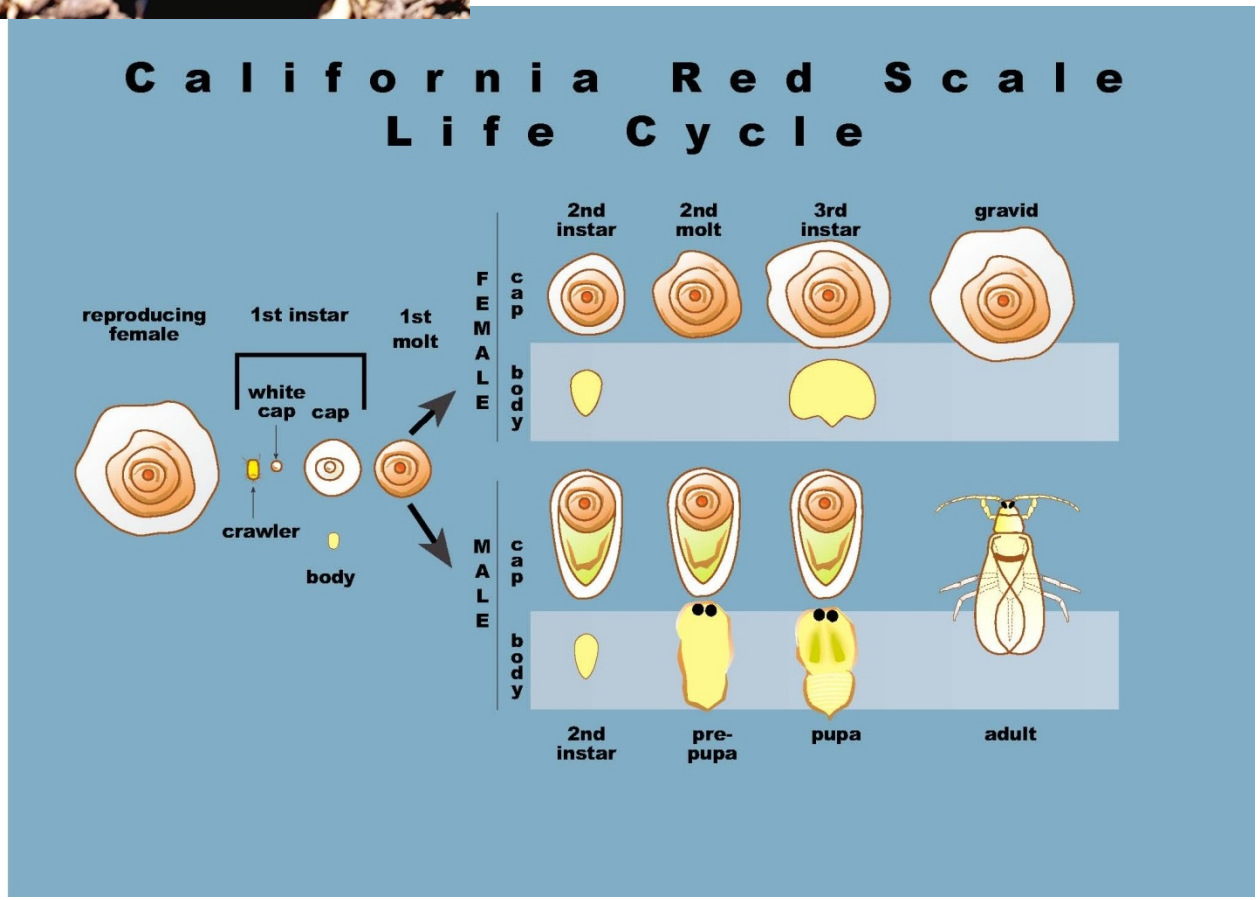
The female scale once she is mated, becomes enclosed with wax and is hard for insecticides and parasites to attack her.

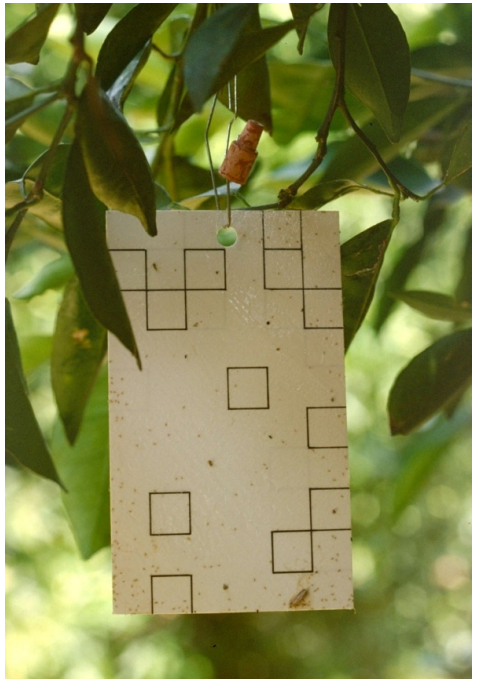


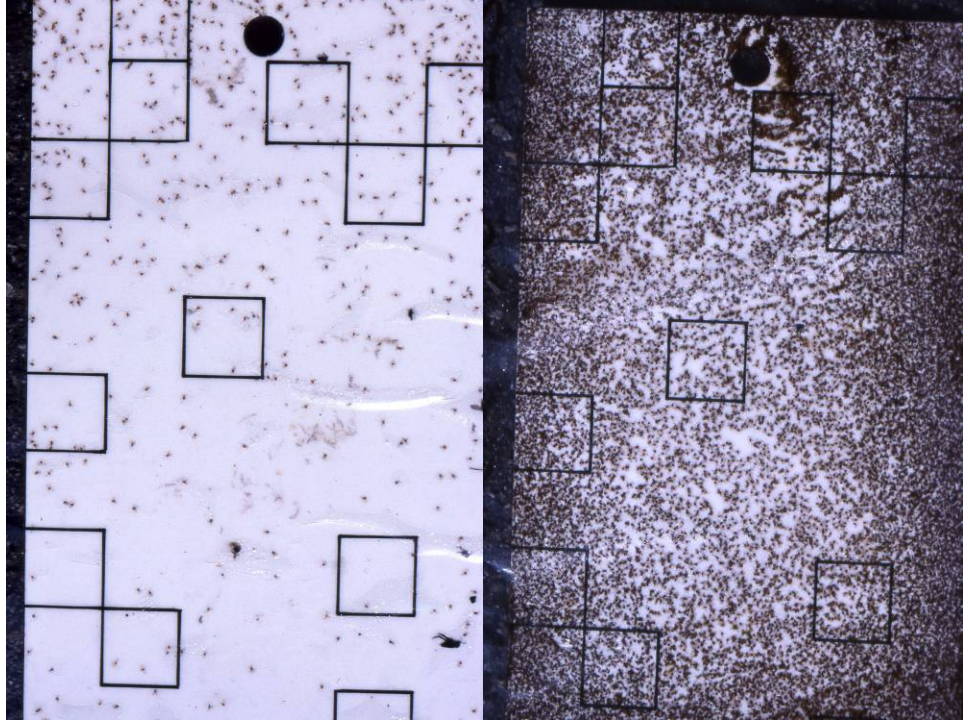


California Red Scale

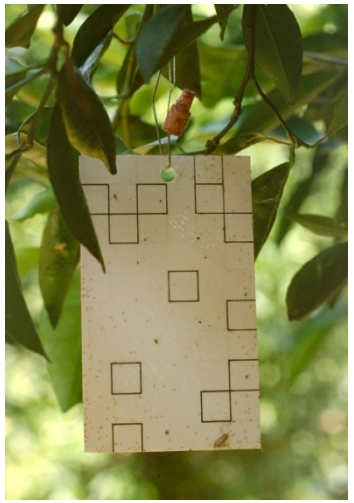
Monitoring: pheromone traps, % infested fruits, crawler tapes

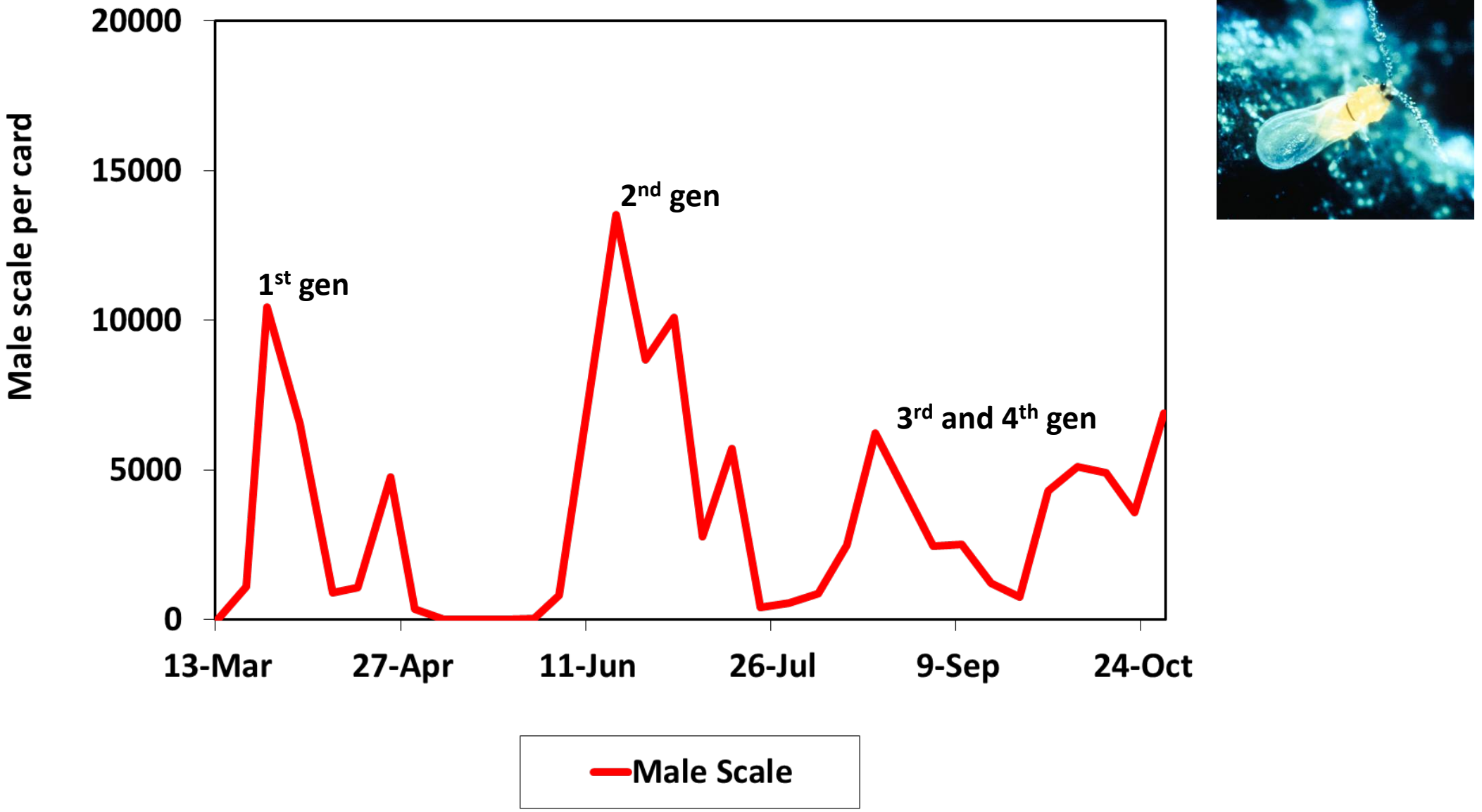




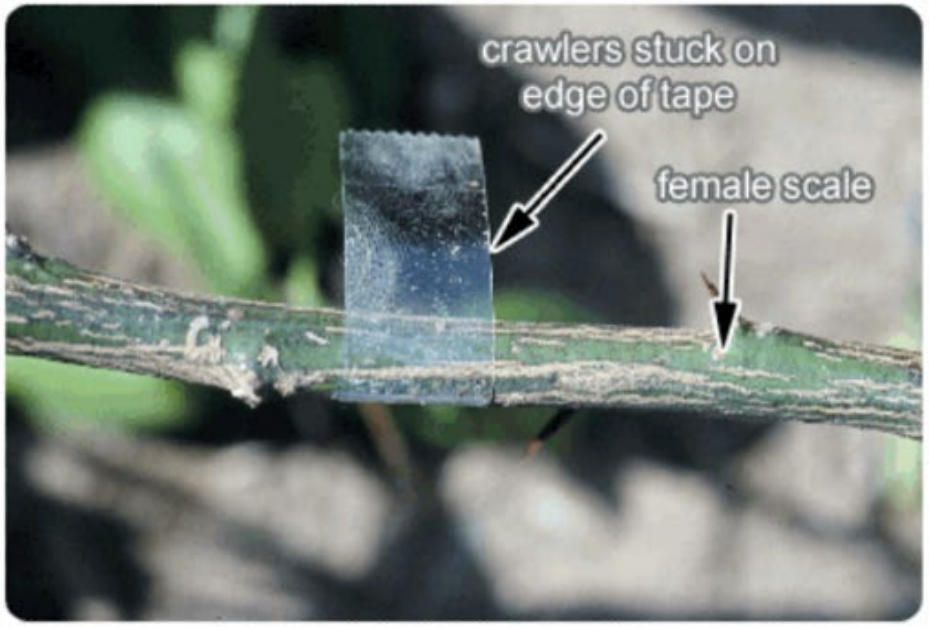


The squares represent 20% of the card and so you count both sides and multiply x 5 to estimate the total number




Male scale per card
20000
15000
10000
5000
0
1st gen
2nd gen
3rd and 4th gen
13-Mar
27-Apr
11-Jun
26-Jul
9-Sep
24-Oct
Male Scale

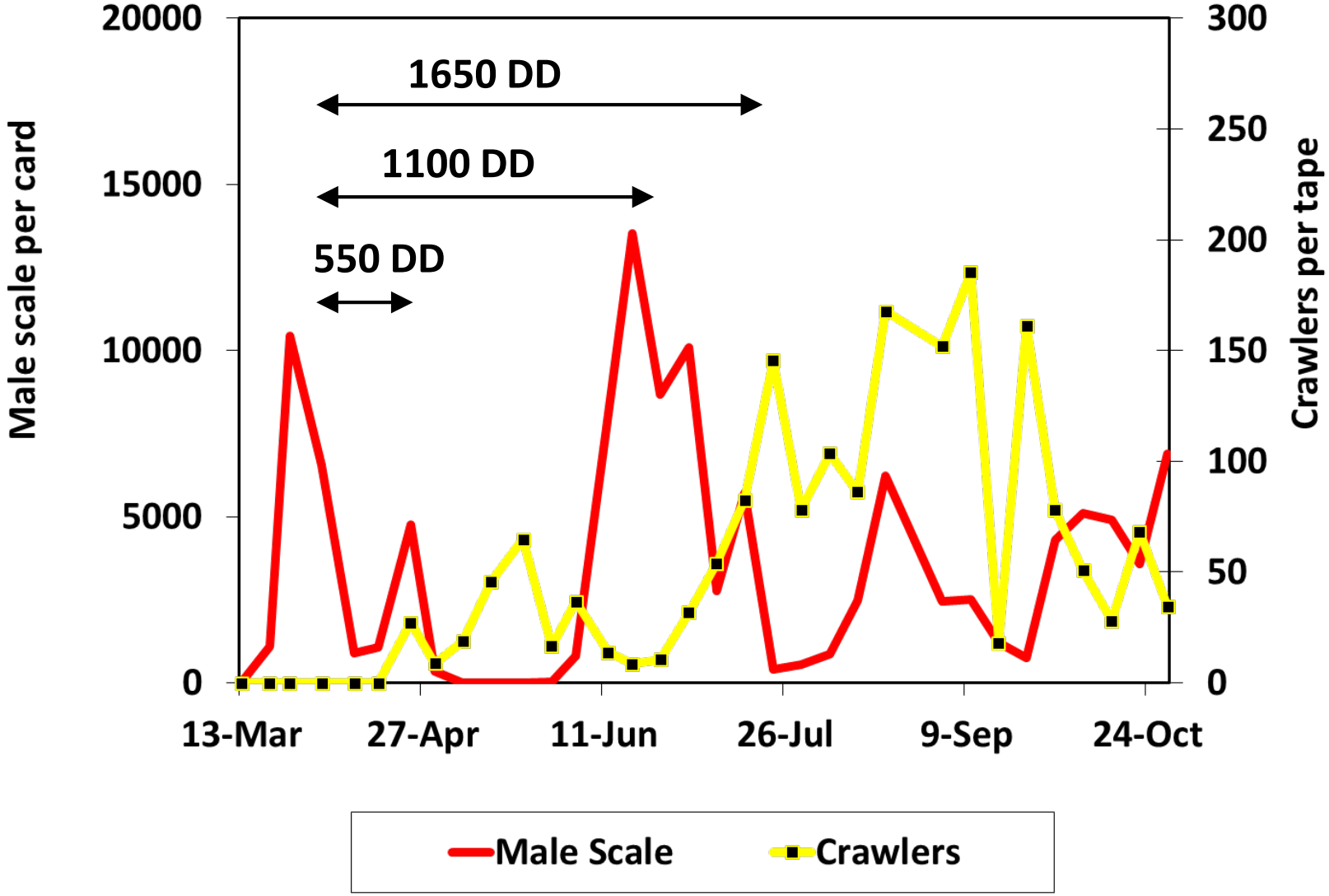
Catching crawlers



The crawler stage can be trapped using double sticky tape wrapped around a branch that has one or more live females on it. The tapes can be replaced weekly to find out when crawler emergence is occurring.

The tapes can be replaced once a week and examined for crawlers with a hand lens or microscope.

Degree days = accumulation of the average daily temperature above the lower developmental threshold (53°F)



Degree day units

Spring

California red scale
lower developmental threshold
LDT=53°F

High: 74

Low: 50

Average daily temperature = (74+50)/2 then subtract the LDT 53

= 62-53

= 9 degree days/day

(spring: 61 days from males to crawlers to accumulate 550 DD)

Summer

High: 103

Low: 81

Average daily temperature = (103+81)/2 then subtract the LDT 53

= 92-53

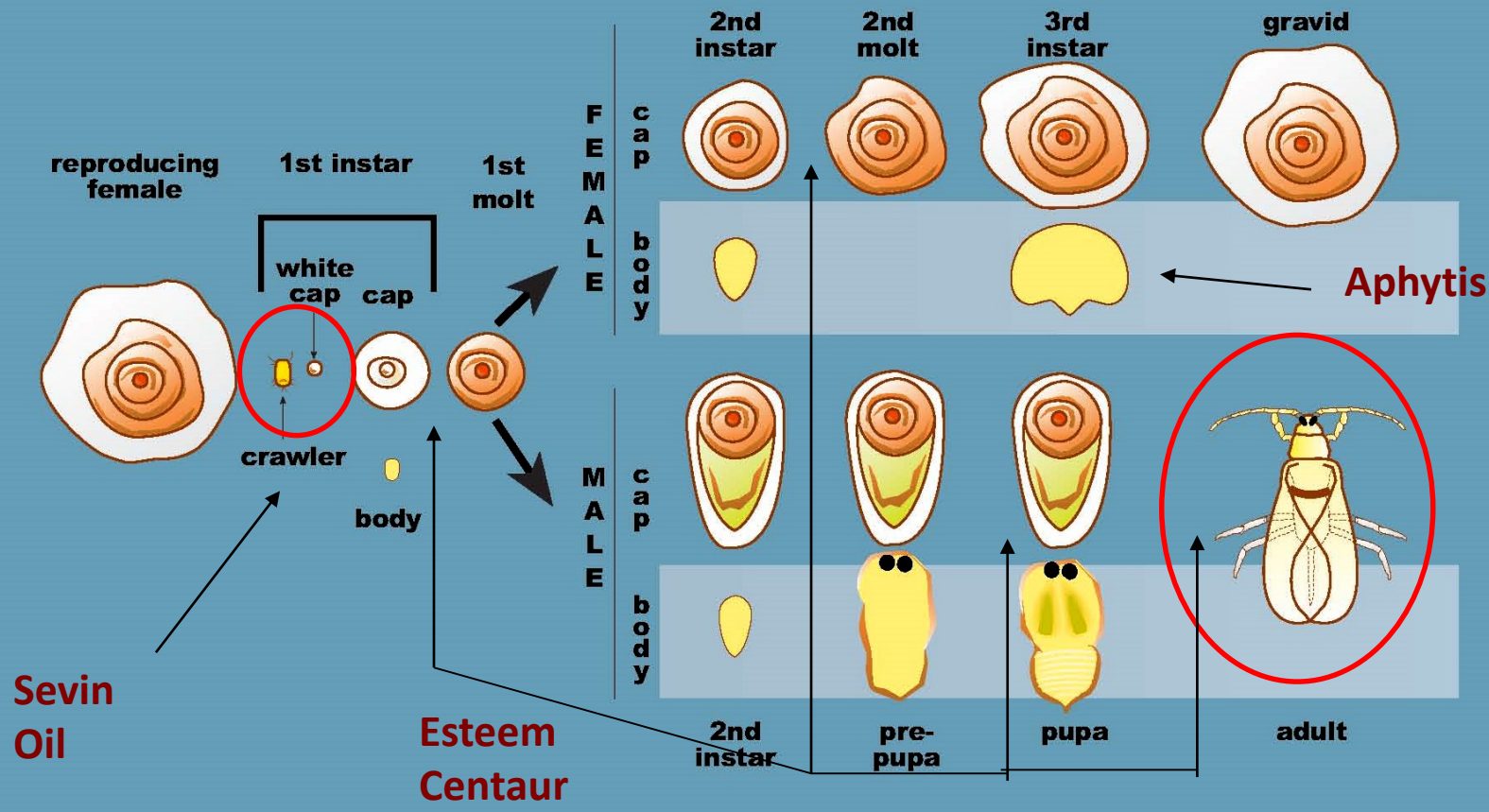
= 39 degree days/day

(summer: 15 days from males to crawlers to accumulate 550 DD)

California Red Scale Management Choices

	Efficacy	Selectivity	Spectrum
Sevin	Moderate: *Resistance issues*	Toxic to most natural enemies	Broad: CRS, citricola scale, FRB
Esteem	Moderate: *Resistance issues*	Toxic to beetles	Narrow: CRS
Centaur	Moderate	Toxic to beetles	Interm: CRS, citricola
Movento	Moderate: *Does not control scale on wood*	Toxic to predatory mites	Narrow: CRS
Oils	Moderate: *Short residual*	Short term effect on all insects	Broad: most pests
Aphytis parasites	Moderate: *effectiveness varies*	Nontoxic	Narrow CRS

California Red Scale Life Cycle



Movento – all stages, but mostly on leaves and fruit

Aphytis releases

Release 5,000 wasps/acre every two weeks, every six tree in every sixth row from March 1 to October 31 = 100,000/acre for the entire season

Special considerations to maximize the efficacy of *Aphytis*:

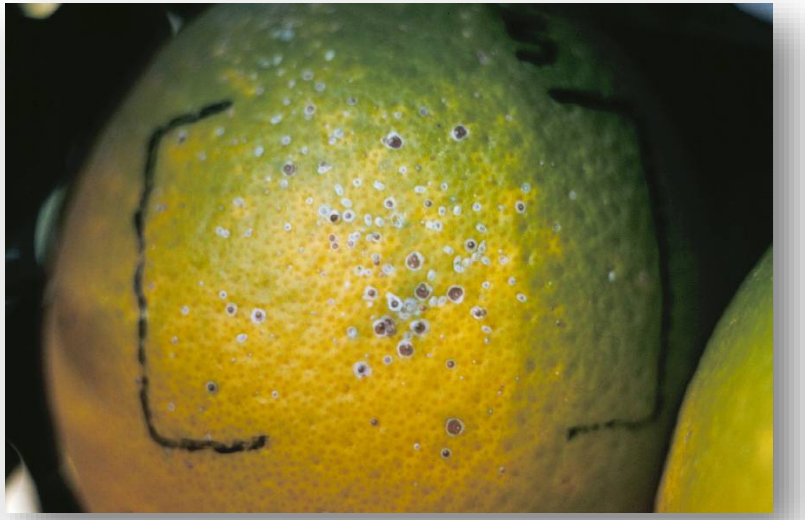
- prune the interior and skirts of the tree so that Aphytis can get to the scales
- minimize broad spectrum insecticides (rates and timing)
- avoid dust, lime sulfur, Surround and other coatings that prevent parasites from reaching the scales
- avoid water stress of trees that can promote scales
- larger orchards are easier to control biologically because the sprays of neighboring blocks have less influence
- reduce ants that protect scales from natural enemies

How do I know if Aphytis is working?

1. Count the number of fruit (out of 100) that have scale: calculate the percentage of infested fruit
2. Examine 2nd and 3rd instar scales on 20 scale infested fruit and determine the percentage that are parasitized.
3. Parasitism should be increasing during Aug-Oct
4. Its not so much the number of scale on the fruit that is important, it's how many are parasitized because those will flake off

August

September



2001-2002 Tulare County – California red scale and parasitism
% Fruit Infested with CRS (% parasitism of 3rd instar scales)

Orchard	July 2001	Aug	Sep	Oct 2001	July 2002	Aug	Sep	Oct
1 *Aphytis*	0 Oil	0	2%	3% (62%)	1%	0	0	2%
2 *Aphytis*	0 Oil	11% (27%)	11% (39%)	18% (86%)	8%	8% (35%)	6% (40%)	7% (50%)
3 *Aphytis*	0	0	15% (36%)	5%	1%	0	2%	2%
4	0 Lorsban	0	1%	2%	0 Esteem	0	0	0
5	0 Supracide	0	0	0	1% Esteem	0	0	2%
6	0	0 Lorsban	0	0	1%	0 Esteem	1%	0

Pesticide screening

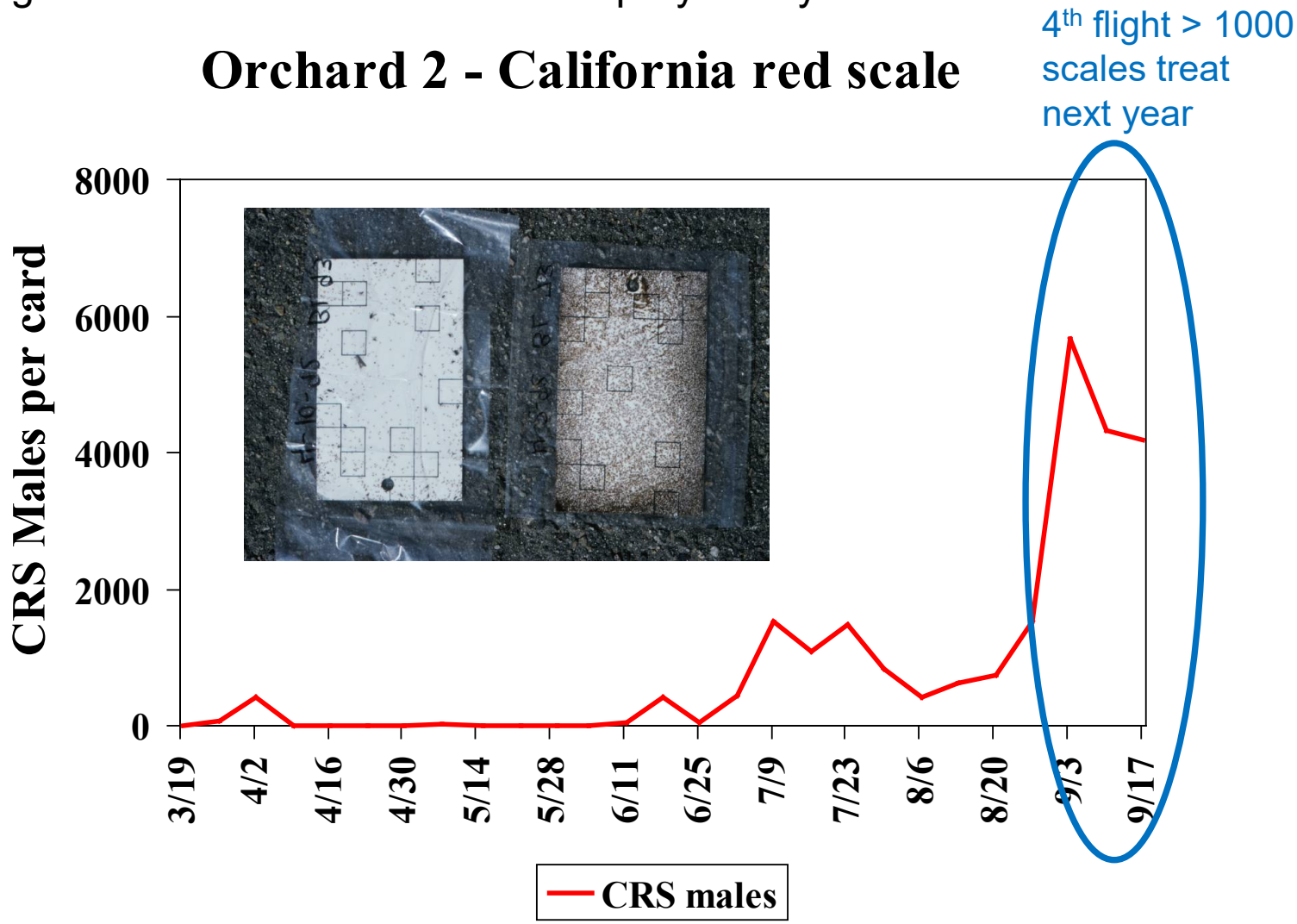
	MOA	Parasites	Predatory mites	Predatory beetles
OPS and Carb	1a,b	Rate dependent	Resistant	resistant
Pyrethroids	3	Toxic	Toxic	Toxic
Neonicotinoids Admire Pro, Assail, Actara	4a	Toxic	Toxic	Toxic
Sivanto	4d	Toxic	Soft	Egg production
Esteem	7c	Soft	Soft	Toxic
Entrust/Success	5	Soft	Soft	Soft
Delegate	5	Toxic	Soft	Egg production
Agri-Mek	6	Soft	Toxic	Soft
Micromite	15	Soft	Soft	?
Centaur/Applaud	16	Soft	Soft	Toxic
Fujimite, Nexter	21a	Toxic	Toxic	Egg production
Movento	23	Soft	Toxic	Soft
Exirel	28	Soft	Soft	Egg production

What about Neonicotinoids like Admire, Actara, Platinum and Assail?

- Can suppress red scale
- Very toxic to all natural enemy groups
- Foliars are harsher than the systemics
- Tend to kill scales on leaves and fruit (not wood)
- Overuse leads to build up of scale on the wood, which eventually spills out onto the fruit

When to spray: decision making

Pest Control Advisors have traditionally used pheromone cards to watch populations on a weekly basis – or put them out during the 4th flight to decide which orchards to spray next year.



Male scale pheromone lures and cards were developed for Lorsban, Supracide and Sevin so they don't predict the scale population accurately with the newer scale control methods:

Few male scales on the pheromone cards, but there is still a noticeable scale population in the block?

- **IGRs** (Applaud and Esteem) are more toxic to males than females
- **Pheromone Disruption** – males can't find the trap cards

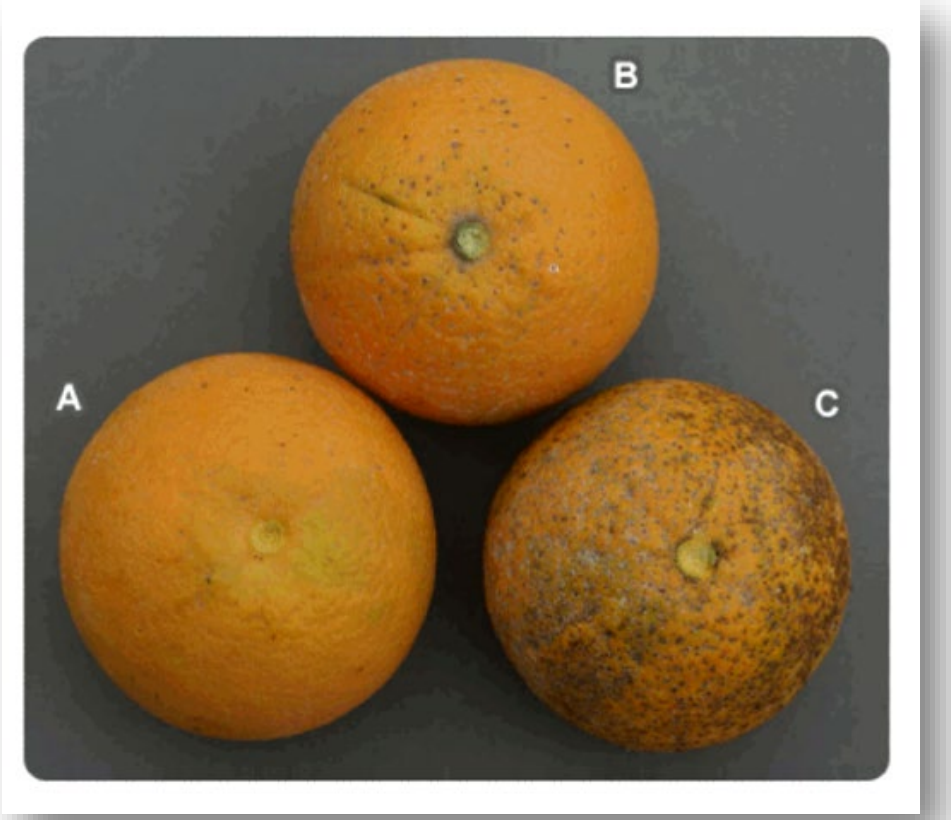
High levels of male scales on pheromone cards after treatments even though the fruit is pretty free of scale?

- **Aphytis release blocks** – the Aphytis prefers to attack the female scales and that lets a lot of the males go
- **Neonicotinoids and Movento** keep the fruit pretty free of scale, but allow populations to build on the wood that produces lots of males
- **Poor applications** – sometimes the spray doesn't reach the tops of trees

During the season: check leaves and twigs and the wood for live scale

- Is the scale just on the dusty roads or throughout the orchard? (edge effect)
- Look at the interior and tops of the tree to see if scale is building there (improve coverage)
- Rub your thumb lightly over the scales and see if they easily rub off (get to know live vs dead scale)
- One month after treatment, take samples back to the office and look closely at 2nds and 3rds to see if they are healthy or parasitized (is biocontrol helping?)

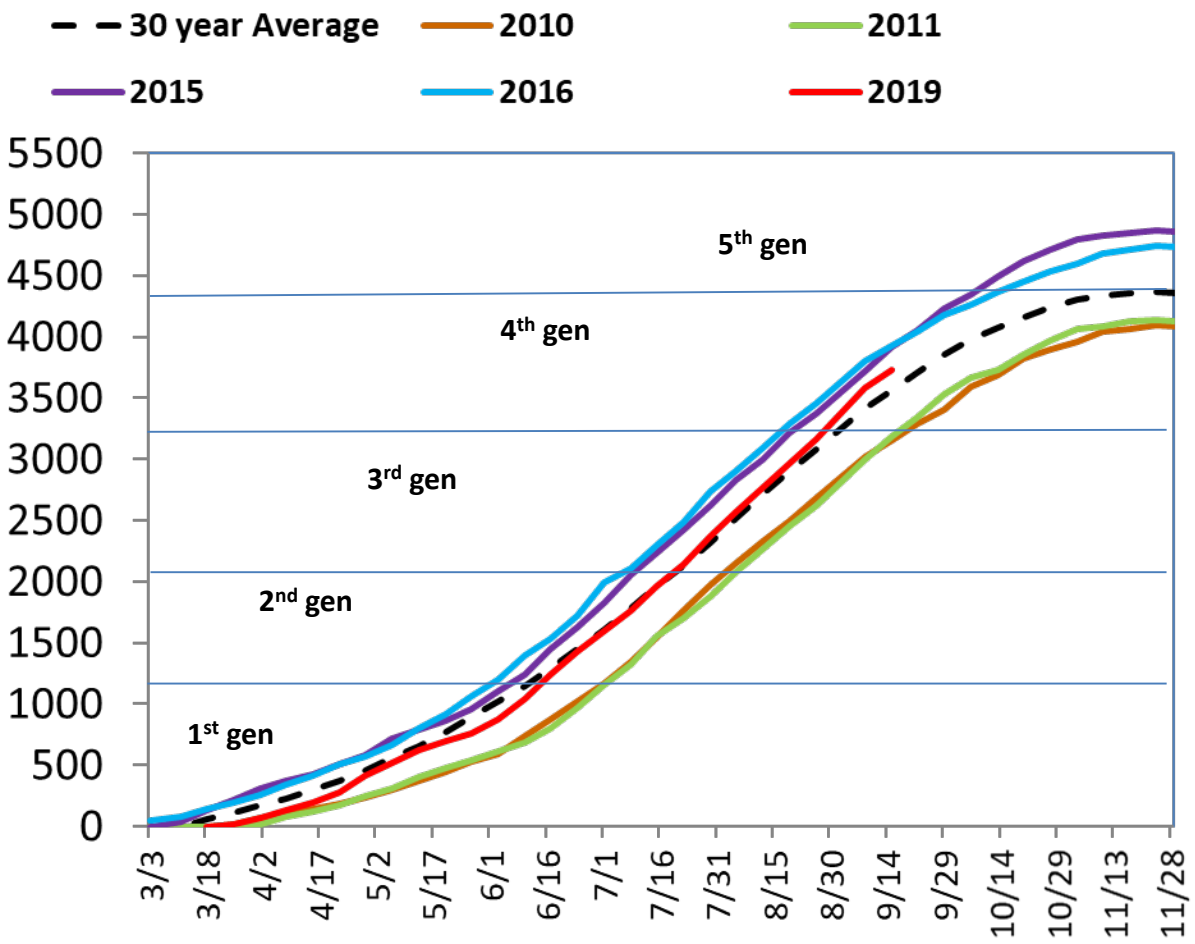
Walk the block and check fruit for live scale
At harvest check bins of fruit



Estimate the % of fruit with >10 scales

If you find more than 5% of fruit infested, the block likely needs a treatment next year

California Red Scale Degree Days
Lindcove Research and Extension Center

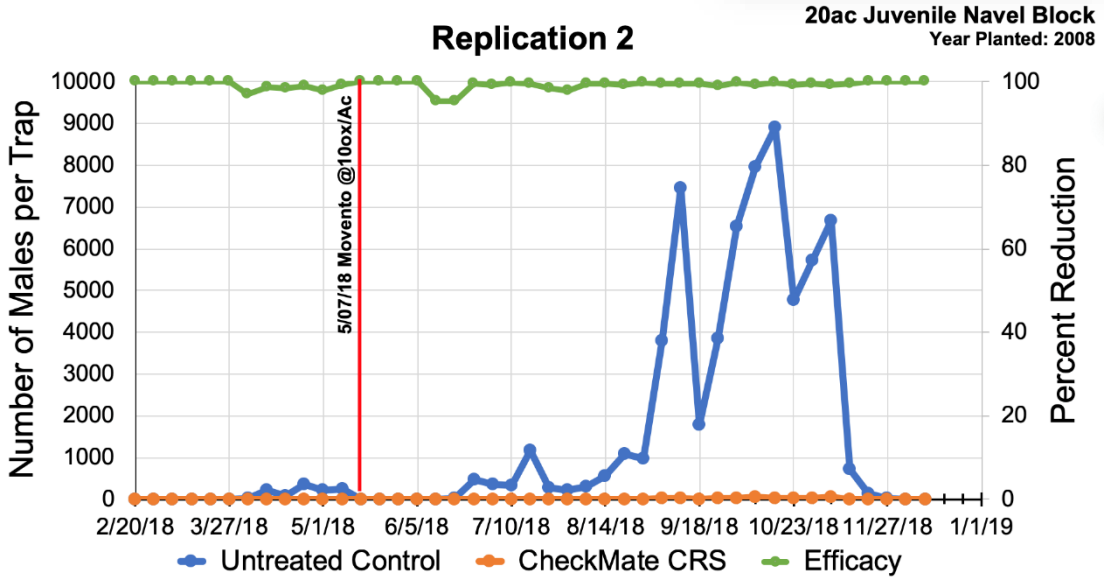


Factors that caused California red scale to explode in 2012-2018?

1. Warm winter = scales of all stages developing at all times, less overwintering mortality
2. Drought – dusty, stressed trees have more scale, parasites don't work as well
3. Heat = fast development of scale, more generations and the parasites don't keep up
4. Insecticide treatments only last about 1 generation – forcing growers to treat more often
5. Some insecticides don't control scales on wood (imidacloprid, spirotetramat)

Product: Suterra CheckMate CRS®

- Mating disruption
- 5 orchards, 10-20 acre plots
- Split control/pheromone
- 180 dispenser/acre
- Deployed February 16th 2018



% Fruit with > 10 scale					
Treatment Rep	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Untreated Control	6.62	11.63	5.03	2.09	0.63
Suterra pheromone	7.23	0.18	0.28	0.19	0.01
% reduction	0	98.4	94.5	91.2	98.7
Movento Application (In both control & treatment)	May Movento @ 10oz/ac	May Movento @ 10oz/ac	May Movento @ 10oz/ac	May Movento @ 10oz/ac	None

Recommendations for control of California red scale:

- **Timing: hit the stage that is most sensitive**
- **Attack generations 1 or 2 when the scale population is uniform in stage**
- **Use the selective insecticides that allow natural enemies to survive when you can**
- **Rotate products to avoid resistance**
- **Good coverage: 750-1500 gpa (Movento 250-500 gpa)**
- **Drive slowly! < 1.5 mph**
- **Use pheromone disruption in groves with chronic problems in combination with insecticides or *Aphytis***