

Monitoring the Adult Navel Orangeworm Moths with Pheromone and Host-Plant Volatiles

Ring Cardé, Nancy Power, Brad Higbee¹ and John Beck²

Department of Entomology, University of California, Riverside CA, 92521 USA

¹. Wonderful Orchards ². Agricultural Research Service, Albany



Objectives:

1. Develop behavioral bioassays to evaluate the attractiveness of host-plant volatiles to mated females and as synergists for the pheromone. Test identified host volatiles supplied by John Beck for attractivity.
2. Determine if these host-plant volatiles are field active and could serve as a replacement for oviposition traps.
3. Describe the daily pattern of female release of pheromone (“calling”) and determine if pheromone released by nearby females or from mating disruption formulations advances when females call and therefore might contribute to the efficacy of mating disruption.

Overview:

Our overarching goals are : 1) to improve the efficacy of mating disruption in the navel orangeworm moth, *Amyelois transitella*, referred to as “NOW.” 2) To aid in the development of lures that would be useful as a monitoring tool in pest management programs.

Based partly on our work, Suterra has developed a plastic membrane formulation of pheromone that attracts of male NOW for approximately one month (Higbee et al. 2014). This breakthrough enables pest managers to monitor populations more effectively than by using traps baited with females. Information from temporal and spatial patterns of trap capture will be useful for modeling seasonal development and for estimating density and therefore for guiding decisions on control measures.

Another strategy is to use host volatiles as a monitoring lure for females (and possibly males) or in combination with pheromone for males. This would be similar to the pear ester that has proved promising for monitoring codling moth. One great advantage of such a lure is that it would be useful in orchards under conventional control for NOW and also orchards where mating disruption is deployed. Currently there is no simple method for monitoring population density of NOW adults in orchards treated with mating disruptant because this control measure blocks male orientation to females and traps baited with pheromone.

ARS colleague John Beck has identified many volatiles released by almonds, almond mummies, and almond foliage and also by pistachios (e.g., Beck and Higbee 2013, Beck et al. 2009, 2011, 2012, 2014a,b). We are seeing if any of these alone or in combination are efficacious lures. At present, the only system in use for monitoring females relies on a bait of almond meal to induce egg laying and it is generally not considered to a sensitive detection device.

We are evaluating host volatiles in our wind tunnel for their potential as synergists for male attraction to pheromone. Volatiles are added to the pheromone plume and attraction levels are compared to pheromone alone and volatiles alone. Adding host odors to pheromone has improved codling moth monitoring and also shows promise for many other moth pests (reviewed by Deisig et al. 2014).

Methods and Findings:

Our wind-tunnel tests evaluate the most likely of these to be attractive, based on two criteria: the compounds are major constituents of the blend and they are electroantennogram active. We tested host-plant volatiles at 3 doses (10, 100 and 1000 micrograms) with and without a pheromone lure for males and 3 doses of volatiles (without pheromone) for females. Among the compounds tested so far are octanal plus nonanal, sabinene, (Z)-3-hexenal, (Z)-3-hexenal plus (Z)-3-hexenol, 3-octen-2-one, methyl salicylate, sabinene hydrate, linalool, limonene, a pistachio blend and other compounds. Typically tests are run with 20 insects per treatment for a total of 120 male moths per volatile or volatile blend with and out pheromone for males and 60 females per volatile or volatile blend. So far none of these has proved attractive alone or in combination with pheromone boosting attraction over just pheromone. One issue that we are considering is that it may not be a single active compound but rather a blend that evokes attraction. As was demonstrated with the black bean aphid (Webster et al. 2010), a blend of host volatiles is required for attraction and, surprisingly, these compounds presented individually are either inactive or even repellent. So besides testing compounds alone or paired with pheromone, we will prepare blends to see if these are attractive. John Beck will continue to provide guidance as to the best candidate compounds or blends for us to evaluate.

Our studies of the timing of female calling (Figure 1) in a standard regime of 16 hours light: 8 hours dark at 23° C have found that female calling commences immediately after “lights on.” When we simulate a gradual increase in light intensity (as occurs naturally in the field), the proportion of females calling rises very quickly as light intensity is increased above full moonlight levels. Our immediate goal is to document the pattern of calling in light: dark regimes mimicking late summer 10L:14D and then use these two patterns 16:8 and 10:14 as a basis for determining if the presence of pheromone modulates calling as has been demonstrated in several other moths (e.g., Kuhns et al. 2012; Stelinski et al. 2014). This effect is presumed to be due female-female competition for mates. However, early calling depletes her complement of pheromone before most males are available to respond. Such contagious calling is thought to enhance the efficacy of mating disruption (Minks and Cardé 1988; Cardé and Minks 1995).

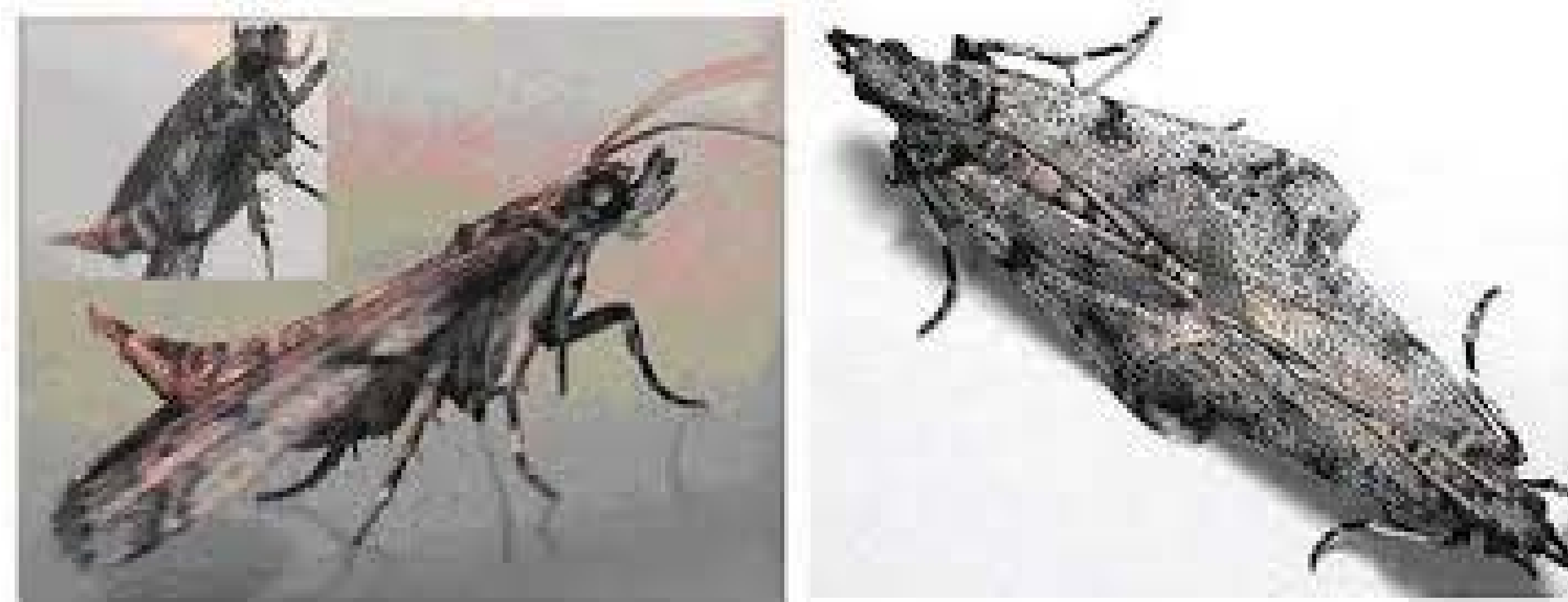


Figure 1 (left). Female calling with abdominal tip extended, exposing her pheromone gland. Figure (right) shows a mated pair. <http://www.scielo.br/img/revistas/ne/v35n6/a08fig02.jpg>

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