California Management Implications for Blue Orchard Bees (*Osmia lignaria*) Adapted to Different Climates

Project No.: **07-POLL6-Cane/Pitts-Singer**

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Objectives:

To enable successful handling of blue orchard bee populations that differ in climatic adaptations attributable to their geographic origins, our goal is to evaluate and specify what thermal management practices are needed in California for almond pollination. As almond cultivation pushes further south into ever hotter parts of CA, risks become greater for the survival of blue orchard bees (BOBs) that are not adapted to the CA summer temperatures. A particularly delicate time for the bees is during the summer transformations from larva to pupa and thence to adult. To understand thermal and seasonal adaptations of BOB populations from different geographic regions, we will experimentally investigate BOB development with regard to: 1) the impact of average CA temperatures and their duration on bee development and mortality, 2) the effects of record summer heat on bee development and mortality, and 3) the impact of pre-wintering and wintering duration on survival, emergence rate and emergence success of bees managed for CA almond pollination. We will compare three geographically distinct populations of BOBs. Two populations will be obtained from the primary regions that currently supply BOBs for CA, northern Utah and the Washington. The third population will be one that we have acquired through trap-nesting in the foothills of the southern Central Valley of CA.

Specific Objective 1: We will investigate developmental progression and mortality of three BOB populations reared at average CA temperatures. Some bees of each source instead will be left to develop in the field in California. We predict that bees of the CA population will develop slowly, undergo diapause (i.e., quiescence) during summer's

heat, and survive well to spring emergence with adequate winter chill. We predict that northerly populations will fail to undergo a lengthy summer prepupal diapause (i.e., diapause of fully-developed larvae inside cocoons), transform to adulthood too quickly, exhaust their fat reserves before autumn, and die over the winter. We will learn if and when bees enter summer and winter diapause in response to temperatures endured. These experiments will give us insights for knowing if and when to remove BOBs from the CA almond orchards to cooler conditions, and the temperatures at which they should be managed, all tailored for the BOB source of origin. Such management practices may prove necessary for sustaining or increasing commercial populations of BOBs.

Specific Objective 2: We will determine if acute heat stress imposes additional harm or mortality to developing bees from all three regions. Subsets of prepupae from UT, WA and CA populations (stored at CA temperatures) will be transferred to another incubator with a thermal cycle programmed to challenge immature BOBs record heat such as that which oocurred in late July 2006, using Modesto weather records. They will then be returned to the incubator programmed to mimic average CA temperatures. By comparing immatures from all three source regions acclimated under an approximate Central Valley thermal regime, we will duplicate field conditions and phenologies of BOBs in commercial CA production. Later, x-ray pictures of bees and dissections of cocoons will reveal individuals that died while pupating or emerging as adults. Survivors will be overwintered and emerged the following spring to check for sub-lethal effects (e.g., overheated honeybee immatures can yield adults with deformed wings (Winston 1987)).

Objective 3: We will explore the relevance of pre-wintering regimes to survival, spring emergence timing, and overall success for BOBs from each population. Once they reach adulthood, subsets bees from each population will be taken from the average CA-temperature incubator and held at 3 different durations of warm temperatures (i.e., early autumn temperatures) prior to cooling for winter diapause. We will also vary the wintering temperatures of a subpopulation of these bees. We predict that the most vigorous and synchronous emergence of BOBs will result from a brief (15-30 days) pre-wintering period, whereas metabolically active adults enduring longer periods of warmth will metabolize more of their fat reserves. We expect geographic populations to respond similarly. From this experiment, we will learn the need for thermal management protocols, and which of our experimental treatments satisfy this need.

Interpretive Summary:

Our research will document the thermal cues, timings and durations of critical periods during development, as well as summer heat tolerances, of BOB populations from the three distinct geographic regions. We expect local (CA) populations to be adapted to local climate, but we do not know the adaptablility of any of the populations currently used for almond pollination. Overlooking potentially dramatic differences could doom BOB mass-rearing programs for almond pollination. We will be able to pinpoint any differences in thermal adaptations and their limits, and be able to recommend practical management responses that tailor BOB geographic source to bee rearing conditions for

Central Valley climate. Importantly, what we learn in the laboratory will be correlated with observable responses of these populations living in the field under ambient Central Valley conditions, to assure that our interpretations are based in reality.