



## **Certified Best Practices for Sustainably Sourcing and Managing Orchard Bees**

### **Management During Bee Development**

The purpose of these guidelines are to provide Certified Best Practices for managing blue orchard bees (*Osmia lignaria*) through summer development, pre-wintering, and wintering to minimize stress, promote rapid development, and provide the maximum number of healthy bees for the next season.

It is also important to be aware that bees of the same species will develop at different rates if they originate from different growing regions (different phenotypes). This means that if you are trying to build populations, you should not mix these different groups. If you do, the offspring will be a mix and so some will be mistimed with whatever rearing technique you are using, resulting in high mortality.

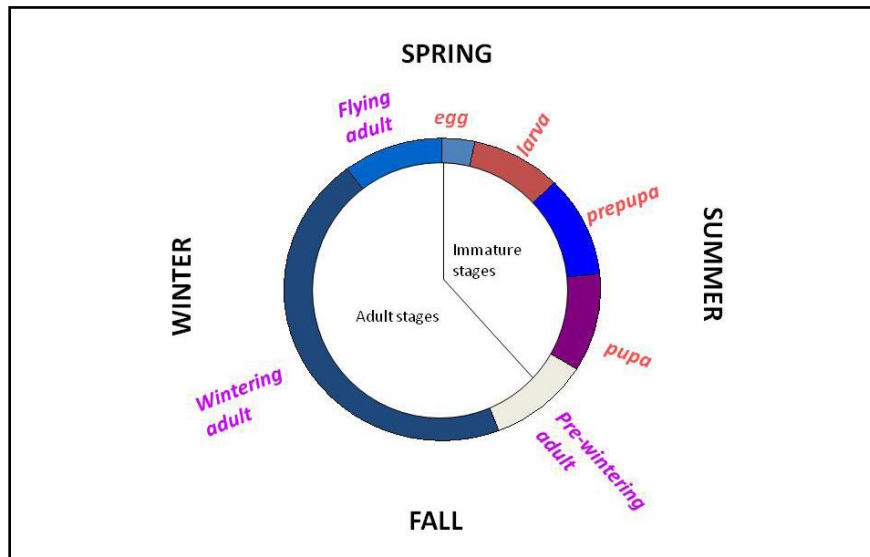
### **Summer Development**

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While it is possible to move nests throughout their summer development if handled gently, blue orchard bees are easiest to remove from the field when larvae are mature - either defecating or recently cocooned (typically 2 to 4 weeks after the nests are completed) or as adults. However, this should be weighed with removing them early if worried about animal predation/pest infestation or the presence of nesting materials interfering with orchard management. Immature bees are most susceptible to injury by movement as 1) eggs or young larvae due to being shaken off of the provision and unable to continue to eat, or 2) early pupae whose soft body tissue may get damaged.

Developing bees should be stored in either a controlled environment where temperature, humidity, airflow, and pests are managed, or stored in a protected location subject to ambient conditions in a habitat similar to that of their origin. For best results, close monitoring in controlled conditions is recommended. The mature larva will spin a cocoon, after which it undergoes a two-to-six-week period of

dormancy; the duration of this dormancy depends on local temperatures and also the geographic origin of the population. The dormant larva inside the cocoon is referred to as a prepupa. By late summer, the prepupa molts into a pupa. One month later, the pupa molts into an adult, which will remain dormant until the following spring.



**Blue orchard bee (*Osmia lignaria*) life cycle.** Jim Cane, USDA-ARS Bee Biology and Systematics Laboratory, Logan, UT

## Temperature

Fluctuating temperatures are beneficial for bee development. Bees from Utah and Idaho (high elevation), develop normally if left in the same (protected) outdoor environment, or if controlled, with a regime of 16 hours at 27°C (81°F) and 8 hours at 14°C (57°F). If fluctuating temperatures are not possible, a constant 26°C (79°F) works well. For bees from other locations, holding them at typical summer temperatures of that area will promote optimal development. Low-elevation California-origin bees have a prolonged prepupal period (summer diapause or aestivation) to survive the long summer and so will take longer to reach adulthood compared with bees from other areas with shorter summers, like Utah or Washington at the same temperature.

## Airflow

To assure cocooned bees experience temperatures and humidity evenly, air should be allowed to circulate throughout the storage chamber or outbuilding. Providing a ½” space between nesting blocks or rows of tube bundles will allow uniform temperatures to be maintained.

## Humidity

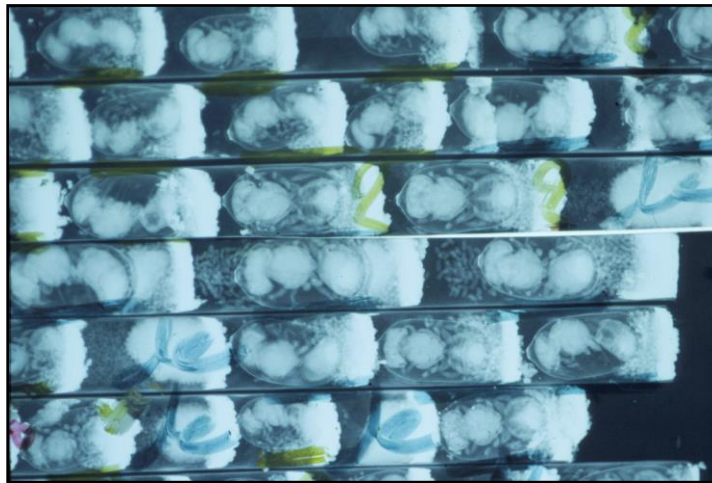
Humidity levels should not fall below 50% or rise over 90%. An exception is a period of low humidity prior to cocooning to help control mites, if necessary (see pest management page).

## Fall / Pre-wintering

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### Development Monitoring

Two months after nests are completed, start frequent checks of the developmental stage of the bees. X-rays can give a good indication of when the bees become adults, but also, you can open samples of cocoons to verify their stage. Adults will have wings that are fully developed and hardened and an exoskeleton that is dark, hard and shiny. With experience and checking by opening, you can also use a strong backlight to distinguish between pupae and full adults within the cocoon, as well as detect the wasp pest *Monodontomerus* (see Pest Management guidelines).



X-ray of cocooned adults in natal nest showing extended legs and body segment differentiation (head, thorax, and abdomen)

It is critical to know when your bees become adults in order to cool them at the appropriate time. Keeping them in warm conditions too long or starting wintering too early will likely kill your bees.

To ensure all bees are fully developed and ready for wintering, wait another two to three weeks from when most (>90%) have become adults to begin wintering. Be sure to sample from various locations in your storage area to accommodate for differences in temperature.

### Synchronize development

If your bees have a 6-week or more spread in nest completion date, then they will become adults at different times as well. A gradual cool down can help synchronize the bees\*. When the first bees reach adulthood, bring down the temperature to 10°C (50°F) for 24 hours. Then, raise the temperature up to 22°C (72°F) for 2 days.

Repeat this 2 to 3 times. This cold cycling slows down mature bees, while the immature bees catch up.

\*Gorden Wardell pers. Comm.

## **Wintering**

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### **Environmental controls**

#### **Temperature**

If possible, bring the temperature down to the wintering conditions gradually over a couple of weeks. One week at 15°C (59°F) and one week at 10°C (50°F) works well. The wintering temperature can be from 2 to 5°C (36 to 41°F). Use 5°C if a short wintering period (i.e., <150 days) is expected.

During stripping operations, warming the bees to room temperature for a few hours will not harm the bees. Stripping operations are best done in fall and on cool, cloudy days and under canopy cover, and avoid setting cocoons in direct sunlight. Nests should be stripped, and cocoons cleaned after bees have fully developed to the adult stage inside of their cocoons and after the cooling process has been initiated. If washed, cocoons should be dried completely before putting them in cold storage.

#### **Humidity**

The humidity should be between 50 and 70%. If humidity is over 70%, mold may grow on the surface of the cocoons. If this happens after the larva completes cocooning, the cocoon protects it, but if the mold grows too dense, the adults will have problems emerging. Moldy cocoons can be washed off, if necessary.

#### **Air flow**

Ensure uniform temperature and humidity is maintained. It is advisable to double check different areas with a thermometer. If your bees are in loose cocoons at this stage, they should be in containers that are not airtight, are not more than 1" deep with cocoons and have space for air flow around them for even temperatures throughout.

## **Emergence**

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Bees that have had more wintering days will emerge faster than bees with fewer wintering days. Bees of Utah or Idaho origin ideally should remain for at least 180 days at or below 45°F (7°C) through the winter in order to emerge 1-7 days after warming (72-78°F – 22-26°C). If fewer than 175 days are necessary, it is beneficial to raise the temperature to 7°C (45°F) one month before release. Some males may begin to emerge in the chamber after a few weeks at 7°C, but this is all right, and a good indication that the bees are ready to be released.

If timing with bloom is important, three weeks before bloom, a sample of 20 to 30 male cocoons can be brought to room temperature to check how quickly they will emerge. When half have emerged, you can use the number of days that took to then estimate how long before females emerge at those temperatures. If you use the rough formula of 2 X as long, plus one day, that gives a good approximation of how long it will take for half of the females to emerge if temperatures are at least in the mid 60's F.

It is important to make sure the environment you are releasing them into is a healthy one for the bees if you want successful pollination/nesting. Avoid areas where pesticides are applied during bloom without concern for the bees. If you are using the bees in an area with pesticides, expect reduced nesting, and try to work with the landowner to apply softer pesticides, only applying after bees have established, at night and only when necessary. Also make sure mud is available near nesting sites for partition material. It may help to protect with a screen so bees are not eaten by predators as they collect mud.

## Summary

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It is important to protect bee nests from excessive moisture, parasites, predators, and pesticides while mimicking outside temperatures. Bees need to be warm in the summer and cool in the winter.<sup>1</sup>



<sup>1</sup>Cory Stanley, Utah State University, Logan, UT

For a more detailed description of pests and mechanism of control as well as more on management, see "[How to Manage the Blue Orchard Bee as an Orchard Pollinator](#)" by Jordi Bosch and William Kemp.

<https://www.ars.usda.gov/ARSUserFiles/20800500/Bosch2001.pdf>

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Pollinating Orchards Successfully

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