Growers of bee-pollinated crops, particularly apples, may be interested in the possible use of solitary bees as pollinators.

Two species of mason bees (in the genus *Osmia*) are currently being used on a limited basis for tree fruit pollination: the blue orchard bee (*Osmia lignaria*) and the Japanese orchard bee (*Osmia cornifrons*). The latter was introduced by the USDA into the Mid-Atlantic region fruit orchards from Japan in the 1990s. In addition to their use in Pennsylvania orchards, the native blue orchard bee is also being investigated as a commercial pollinator of almonds in California. The Japanese orchard bee has been used to pollinate most of the apple crop in Japan for more than 80 years and recently in Korea. At least two other species of managed *Osmia* are used for commercial fruit pollination in parts of Europe. Several species of wild *Osmia* are important for lowbush blueberry pollination in Maine and raspberry pollination in Oregon.

Surveys of pollinators conducted by Penn State and the Pennsylvania Department of Agriculture determined that the Japanese orchard bee is now established in the wild throughout most of Pennsylvania and that it co-exists with the blue orchard bee in areas adjacent to fruit orchards. The survey also revealed that another Japanese bee, *Osmia taurus*, was also found in many areas of the state, although this species was not introduced intentionally and therefore was not quarantined for parasites and pathogens. *O. taurus* is very similar in appearance to the Japanese orchard bee.

Adults of these and most other mason bee species emerge early in the spring and begin to fly at approximately the same time as apricot bloom (usually early to mid-April). Unlike honey bees, mason bees are solitary, meaning that each female establishes and provisions their own nests (rather than cooperative living within a social colony). Although these bees are solitary, they are sometimes gregarious and will nest near other mason bees.

**Life Cycle**

Under natural conditions, mason bees nest in hollow reeds or stems of plants or in similar crevices. For example, they have been found nesting in firewood piles, slash removed from orchards, and cavities excavated by boring beetles in deadwood. In the Mid-Atlantic region, mason bees are active for roughly 6 to 8 weeks (from about mid-April through mid-June). Males tend to emerge about 1 week before pear trees bloom in the spring. Female mason bees emerge 2 to 3 days after males, or longer, depending on weather conditions. Mating occurs immediately after females emerge.

Several days after mating, females locate and provision suitable nest spaces. Though both male and female bees visit flowers to sip nectar, only females gather pollen, carrying it in stiff hairs on the underside of their abdomens (unlike honey bees, which carry pollen on their hind legs). Female bees provision cells within the nest with a mass of pollen roughly the size of a pea combined with a small amount of nectar. The female will lay a single egg onto each provision, and after the egg is laid, a mud wall is constructed around the egg to protect it. Under favorable conditions, a female mason bee can make 1 or more cells a day, often arranging cells linearly within a cavity or plant stem.

Newly laid eggs hatch in approximately a week, followed by a period of a month or more, during which the larvae will consume the pollen ball. In early summer, after the feeding period, larvae then spend a week spinning a thick silk cocoon in which complete metamorphosis (pupation) takes place. Mason bees develop into fully-formed adults in the late summer and remain dormant inside the nest throughout the winter. The bees will chew out of their cocoon and mud walls to emerge in the early spring at apricot bloom or about 1 week before peach or pear bloom. Mason bees have only one
generation per year, with adult bees dying off at the end of the nesting season.

Management of Mason Bees

Mason bees are relatively easy to manage using artificial nests constructed from wood blocks (drilled with a series of holes), cardboard tubes (with one end plugged), or sections of reed and bamboo with a stem node intact on one end (creating a dead end). Individually, such artificial nests should have internal tunnel dimensions roughly \( \frac{5}{16} \) of an inch in diameter and with a depth of 6 to 8 inches. These types of nests are bundled together and hung horizontally throughout the orchard (several feet above ground level) under some type of rainproof shelter to mimic a cluster of natural hollow cavities (such as a cluster of beetle borer holes in a stump). In addition to the nests themselves, having a steady supply of mud near the nests (such as an excavated hole in the ground with a dripping hose or a slowly leaking water bucket) is essential for nesting success.

Osima cornifrons on nest block. Photo: David Biddinger

Depending on the location and the surrounding bee population, simply hanging these types of nests out may be sufficient to attract wild bees. Where wild mason bee populations are limited, it may be easier to establish a population by acquiring dormant cocoons from another orchard that is already managing mason bees.

Parasites and Diseases of Mason Bees

Mason bees are susceptible to a number of parasites and diseases, which tend to increase over time, especially when the same nest materials are used repeatedly for multiple seasons. Small parasitic wasps, which attack the developing bees if they are left in the field during June and July, can be common parasites. Although typically very small in size, most of these wasp species can penetrate bee nests by drilling through wood or cardboard nests with their stinger-like egg-laying organ (called an ovipositor) and laying a series of eggs on the developing bee. Those eggs go on to hatch, and the larvae feed on the host bee, eventually killing it.

To reduce wasp parasitism, it is advisable to very carefully (without jostling) remove the nests from the field in summer and move them to a dry, unheated, non-air-conditioned building (such as a barn) and store them vertically with the nest entrances facing up. If wasp damage continues to be a problem even inside barns, the nests can be stored by burying them in sand or vermiculite to prevent wasp movement around the nest tubes.

Similarly, pollen mites (Chaetodactylus) and fungal diseases (chalkbrood) may kill developing bees (in the case of pollen mites, they feed on stored pollen, causing starvation of the host bee).

Nesting—Housing of Mason Bees

One challenge of mite and fungal disease management is that mason bees will use the same nests year after year if allowed, ultimately spreading reproductive mites and disease spores through an entire cluster of nest tunnels (mites and disease spores will cling to the bodies of adult bees as they pass through contaminated nests). Because infestations can develop quickly, disease and mites can kill the majority of developing bees in contaminated nests in only a couple of seasons if not controlled.

Mites themselves are very small and hard to see without magnification, but infested cells are recognizable by the fluffy remains of shed mite skins and consumed pollen debris (rather than a compact ball of yellow pollen). Diseases like chalkbrood are recognizable in nests as either soft, gray moldy bodies or as hard, brittle, white bee cadavers, depending on the stage of fungal development.

Under favorable conditions and with an abundance of nest sites, mason bee populations can increase almost tenfold from year to year, but near sprayed orchards, two- to threefold increases are more common. Females tend to nest in the same area where they originally emerge in the spring (instead of flying off to seek a new nesting site) when there are 3 to 5 empty nest tubes for each female bee.

It should be noted: experience has shown that species of mason bees obtained from the western United States may not adjust well to conditions in the Mid-Atlantic region. In addition, bringing in bees from out of state may spread pathogens into new populations. Only acquire bees from local sources.
The most effective way to control mites and diseases is by providing mason bees with new or sanitized nesting materials each year. This is best achieved by removing the dormant cocoons from the nesting materials during the early winter months (in an unheated area). This is easily done in bamboo or reed sections by splitting them or by unraveling cardboard tubes but is impossible with wooden blocks.

Specially built wooden blocks are available, consisting of grooved boards that fit together to create a series of tunnel nests. Once removed from the nest, healthy cocoons can be physically separated from infected cells and stored in bulk containers in a refrigerator until orchard crops are about to bloom. Any nests intended for reuse should be washed with a weak bleach-water solution.

**Overwintering and Spring Release**

Refrigerated storage is optimal for the Japanese orchard and blue orchard bees during the winter months since both species require a cold period before they can emerge from their cells. Refrigerated storage will help prevent the premature emergence of bees during midwinter thaws. Optimal storage conditions are roughly 36°F and 50 to 75 percent humidity (typical ranges for most kitchen refrigerators). Long-term freezing and long-term midwinter exposure to warm temperatures should be avoided.

In the spring, the release of the bees into the orchard can be delayed if necessary due to cold weather; however, bees should be released no later than late mid-May in most cases to reduce mortality. To release bees in the field, the cocoons should be removed from the refrigerator and placed in a dark box or container with a few exit holes. This emergence box should be installed immediately next to new clean nesting materials. Male bees will typically emerge as soon as the following morning if daytime temperatures are at least 55°F. Female emergence will follow several days or weeks later, depending on temperatures.

Upon emergence, females will conduct an orientation flight to identify the location of the nest from which they emerged. If this orientation flight is prevented or if the nests and emergence box are moved more than a few inches after emergence, the bees will abandon the site for new nests. Do not move the nests during the spring when bees are active.

**Additional Information**

In addition to the mason bees described here, more than 500 species of other wild solitary bees are common throughout the Mid-Atlantic region. It may be possible to encourage these bees to form aggregations in your orchard simply by providing foraging habitat and nesting sites and restricting the use of pesticides during the short period that these bees are active. Providing supplemental wildflowers adjacent to the orchard throughout the growing season will increase the health and reproduction rate of both managed and wild pollinators.

To learn more about the management of mason bees and where to obtain these bees and/or cardboard nesting tubes:

- Contact your county extension office
- Penn State Department of Entomology
- Blue Orchard Mason Bee - USDA Forest Service
- The Pennsylvania Native Bee Survey Citizen Scientist Pollinator Monitoring Guide
- The Xerces Society for Invertebrate Conservation

Source: Penn State Tree Fruit Production Guide

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