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ALTERNATIVE POLLINATORS: NATIVE BEES

HORTICULTURE TECHNICAL NOTE

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Abstract: *This publication discusses using solitary or native bees as pollinators. Some of the larger groups of bees are discussed, including alkali bees, leafcutter bees, alfalfa leafcutter bees, bumblebees, sweat bees, squash bees, digger bees, orchard mason bees, shaggy fuzzyfoot bees, and hornfaced bees. Information is also presented on how to attract and conserve populations of wild bees for pollination purposes. There is also a list of suppliers of native bees and bee equipment.*

By Lane Greer
NCAT Agriculture Specialist
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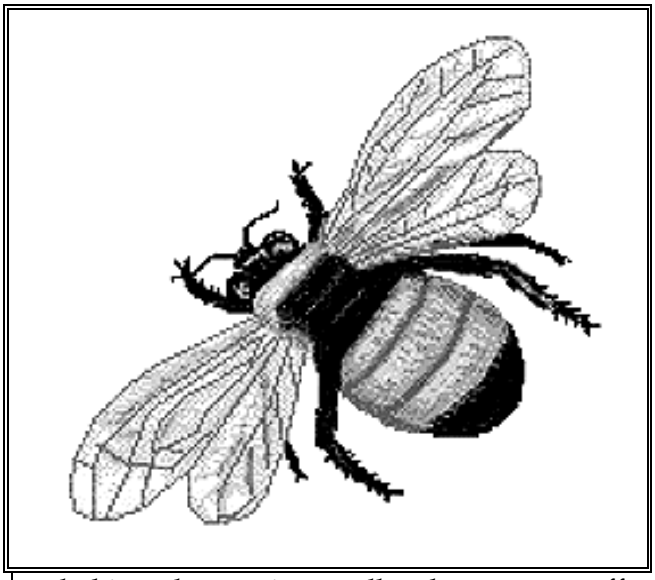

Introduction

There are more than 3500 species of solitary bees in North America. Also called pollen bees or native bees, these efficient pollinators often do the lion's share of pollinating crops. Pollen bees have a number of advantages over honeybees as pollinators (1). Many are active early in the spring, before honeybee colonies reach large size (1). Pollen bees tend to stay in a crop rather than fly between crops, providing more efficient pollination (1). Because they fly rapidly, pollen bees can pollinate more plants (1). Unlike honeybees, the males also pollinate the crop (1). Pollen bees are usually gentle, with a mild sting, and do not get disoriented in greenhouses (1).

The drastic decline in feral and domestic honeybees in the last few years, because of decimation by Varroa mites, has made it even more important to conserve and study wild bee populations. Dr. Hachiro Shimanuki, head of the USDA's Bee Research Laboratory in Beltsville, Maryland, has charted a 25 percent decline in managed honeybees in the last decade (2). Although the number of pollen bees has also declined, due to pesticide use and habitat destruction, pollen bees are unaffected by mites and Africanized bees, and many can be managed and used in commercial agriculture.

Often, growers don't realize the amount of pollination that is performed by native bees, and signs of inadequate pollination are often misinterpreted as weather problems or disease. Dr. Suzanne Batra of the USDA's Bee Research Lab in Beltsville, Maryland conducted a three-year study to discover the natural mix of bees in a West Virginia forest (3). She found that, of the 1700 bees trapped in the first year of the study, only 34 were honeybees. This means that pollen bees

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were performing almost all pollination.

Although pollen bees make small amounts of honey, it is not collectable, so the sole purpose of managing them is for pollination. According to Dr. Peter Kevan, "The economic value of pollination, seed set, and fruit formation greatly outweighs that suggested by more conventional indices, such as the value of honey and wax produced by honeybees" (4). In order for an insect to be used as a pollinator, however, it should be easily handled and readily available in large numbers (5).

Encouraging Native Bees

One of the first steps for a grower to take is to observe what kinds of native bees exist in the area. Most solitary bees are highly seasonal, timing their emergence with peak flowering in their area (6), and are more diverse and abundant in undisturbed natural habitats. Bumble, digger, and sweat bees make up the bulk of pollen bees in most parts of the country.

Dr. Batra notes that Europeans have made significant advances in the field of bee study. There, native bees have been evaluated and encouraged in much the same way that hummingbirds and butterflies are accommodated in U.S. gardens (7). In order to encourage pollen bees, we must:

- **understand their biologies,**
- **provide nesting habitats,**
- **stop using harmful pesticides,** and
- **furnish suitable crops and wild forage.**

Understand Bee Biologies

Although bees are recognized as some of the most important pollinators in almost all ecosystems where flowers occur, their precise roles in pollination are not well documented (4). At this point, only a few species have been studied. Most wild bees, unlike honeybees, are

solitary and don't form large colonies. Bumblebees form small colonies of one to five hundred workers, but most bees are independent, with the females producing and laying eggs in single cells. Many pollen bees hibernate for most of the year—up to 11 months. When they finally emerge, they pollinate with enormous energy (3).

The life cycle of most solitary bees fits into a regular pattern. Females make nests using leaves, soil, or mud, and provision them with honey and pollen. They lay single eggs in divided cells. The eggs hatch and the larvae eat, grow, and pupate inside the same cell. The adults remain in the nest until spring or summer. The males usually emerge before the females, which are mated immediately after emergence from the nest. The cycle then repeats itself.

Provide Nesting Habitats

"It is time to protect our native beneficial bees through habitat conservation and sustainable agriculture," says Suzanne Batra (7). The best way to preserve bees and continue to gain from their pollination services is to preserve wildland. In addition, gardeners and farmers can help preserve and increase native pollinator populations by setting aside undisturbed land (1).

Most bees love sun and prefer to nest in dry places. For ground nesting bees, this means a patch of undisturbed soil in a sunny spot. For wood- and stem-nesting bees, this means piles of branches, bamboo sections, hollow reeds, or nesting blocks made out of untreated wood. Mason bees need a source of water and mud, and many kinds of bees are attracted to weedy, untended hedgerows (1).

Stop Using Harmful Pesticides

The extensive use of pesticides not only on farmlands, but also in suburbia and in managed woodlands, has contributed to the loss of many pollinators, including bees (2). Even natural herbicides and botanical insecticides can harm bees. Any kind of pesticide should be applied in the evening when bees are in their nest (7).

Furnish Suitable Crops and Wild Forage

The pollinators that are enticed to occupy habitats need alternate sources of forage when crops are not in bloom. Many solitary bees have relatively short lifespans that may not coincide exactly with the timing of a specific crop bloom. Therefore, additional forage must be encouraged or sown. This forage should last through spring, summer, and fall, but should not be in bloom at the same time as the target crop. For example, willow is an excellent source of nectar and pollen in early spring. Clover is a good source of nectar in summer, and asters provide fall forage. Plants like these could be planted along the edges of arable land, in fencerows and hedgerows. The greater the habitat diversity, the greater the insect diversity (4).

Another example: Hornfaced bees (*Osmia cornifrons)* are excellent pollinators of apples, but they are active before apple trees bloom. In Maryland, the bees use winter honeysuckle (*Lonicera fragrantissima*), which finishes blooming just as apples come into bloom. After the apples bloom, Tatarican honeysuckle (*Lonicera tatarica*) begins to bloom, and the bees then use this plant for forage (7).

Suggested Plants for Native Bees

The following plants attract pollen bees. Native bees, unlike honeybees, do not fly great distances from their nests to forage. Plantings for native bees should be within 200 yards of the target crop. Some of these plants are also good for attracting beneficial insects.

Shrubs & Trees

Blackberry (*Rubus*)
Dogwood (*Cornus*)
Fruit trees (apple, cherry, plum)
Juneberry (*Amalanchier*)
Red maple (*Acer rubrum*)
Raspberry (*Rubus*)
Sumac (*Rhus*)
Willows (*Salix*)

Flowers & Herbs

Alfalfa (*Medicago sativa*)
Alsike clover (*Trifolium hybridum*)
Asters (*Aster*)
Beard tongue (*Penstemon*)
Bee balm (*Monarda*)
Birds-foot trefoil (*Lotus corniculatus*)
Borage (*Borago officianalis*)
Buttercup (*Ranunculus*)
Calendula (*Calendula*) (single varieties)
Coneflower (*Echinacea*)
Chrysanthemum (*Dendranthema*)
Crown-beard (*Verbesina*)
Daisies
Dandelion (*Taraxacum officinale*)
Evening primrose (*Oenothera*)
Forget-me-not (*Myosotis*)
Fuchsia (*Fuchsia*)
Gilia (*Gilia*)
Globe mallow (*Sphaeralcea*)
Goldenrod (*Solidago*)
Goldfields (*Lasthenia chrysostoma*)
Hollyhock (*Alcea rosea*) (single varieties)
Impatiens (*Impatiens*)
Milkvetch (*Astragalus*)
Milkweed (*Asclepias*)
Mints (*Mentha, Salvia*)
Marjoram (*Origanum*)
Nasturtiums (*Tropaeolum*)
Oilseed rape (*Brassica napus*)
Pincushion (*Chaenactis*)
Red clover (*Trifolium pratense*)
Scorpion weed (*Phacelia*)
Sunflowers (*Helianthus*)
Tickseed (*Coreopsis*)
Wild mustard (*Brassica*)
Vervain (*Verbena*)
Wild buckwheat (*Eriogonum*)

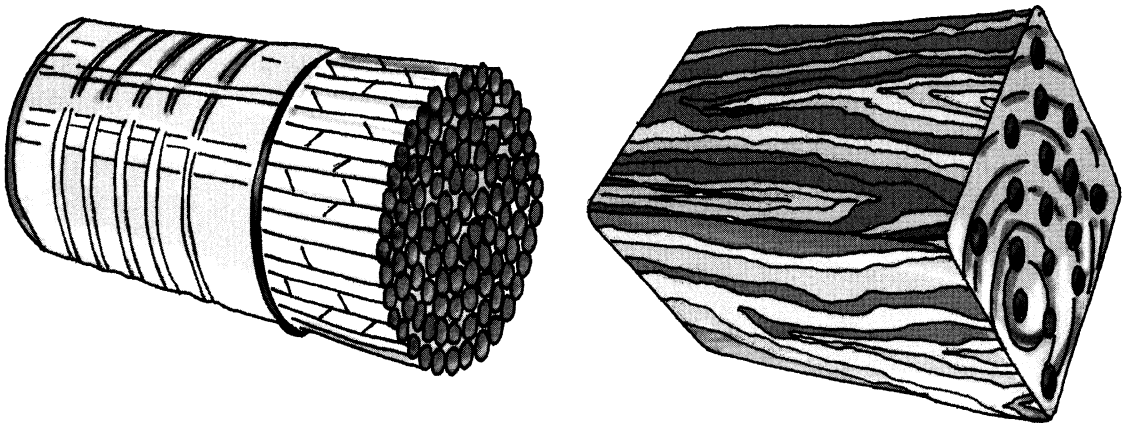

Figure 1. Two examples of artificial nests. Illustration reprinted with permission from: O'Dell, Charlie. 1997. Grow your own disease-resistant pollinators. American Fruit Grower. February. p. 24.

Raising Native Bees

The mass rearing of pollen bees is challenging because each species has its own nesting requirement (8). One reason for raising your own, however, is that locally raised bees are better adapted to local climatic conditions. Native bees can peacefully co-exist with honeybees, because the two groups have different foraging patterns.

Native bees can be roughly divided between soil dwellers and wood dwellers. Soil dwelling bees include bumble, sweat, digger, squash, alkali, and polyester bees, among others. Bees that live underground prefer south-facing, dry, sandy banks, free of vegetation (7).

Wood dwellers include orchard mason bees, hornfaced bees, leafcutters, and carpenter bees. Inexpensive artificial nests can be created out of paper or plastic straws (roughly ¼"-3/8" in diameter) packed into a milk carton, coffee can, or PVC pipe and then glued in (see Figure 1). These domiciles can be attached to tree trunks, fence posts, or the side of a shed, between three and six feet off the ground. The nests should be placed so that the holes are horizontal and the bees receive at least morning sun. Shelter from rain, snow, and wind, and from pests like woodpeckers and mice, should also be provided.

More permanent nesting blocks can be made out of untreated softwood such as pine or fir. A commonly sized block is 4"x4" or 4"x6", drilled with holes that are about ¼"-3/8" wide and 4-6" deep. Brian Griffin, who raises orchard mason bees in Washington, drills his 4x6 blocks with holes on ¾" centers, so that each block has 102 holes (9). He angles the front of the block and places a piece of cedar shingle on top, to act as a roof overhang. These blocks can be used for many years and can be cleaned with a bleach solution.

These wooden blocks can be lined with cardboard tubes, although it's not necessary to do so. The tubes can be pulled out of the blocks every year for cleaning. By holding the tubes up to light, it is possible to count the number of viable bees. (This trait might be desirable if one were selling bees.) Using tubes would also make it easier to detect cuckoo bees or other pests in the cells.

Other alternatives for nests include drilling holes in dead tree trunks and bundling pithy-stemmed plants like sumac, goldenrod, and bamboo together (2). Bees will also nest in snail shells and old mud dauber nests (6).

Native Bee Species

The information that follows describes some of the larger groups of native bees and how they can be managed for crop pollination.

Digger Bees (*Andrena*, *Colletes,* and other species)

Many ground-nesting bees are known as digger bees, mining bees, or sand bees. They excavate nests in the ground, leaving small mounds of soil aboveground. They often hide their nest entrances beneath leaf litter or in the grass (1). All digger bees are solitary, but some nest in dense aggregations. These bees pollinate a variety of plants. They are drab, solitary, and rarely noticed, yet they may be the most abundant wild pollinators in the field.

There are many species of digger bees found throughout North America. Most of these bees are known only by their Latin binomial names, although they are sometimes referred to as polyester bees. When the females build their nests, they line them with a polymeric secretion that looks shiny and synthetic. This material is waterproof, highly resistant to decay, and protects larvae while they are in the ground.

Bumblebees (*Bombus* spp.)

Bumblebees are highly social, like honeybees, but with smaller, less structured nests, consisting of one to five hundred bees. Bumblebees work harder, faster, and at cooler temperatures than honeybees (10). They prefer to nest underground, in undisturbed meadows, old barns and woodlots (7).

Artificial nests can be made out of old styrofoam coolers or wooden boxes. To make a nest, drill drainage holes in the bottom and stuff the box with upholsterer's cotton. Make a hole in one side and place the box 6-12 inches underground. Connect the box to the soil surface with a piece of old garden hose, fitted into the hole in the box (2).

In his book *Humblebee Bumblebee*, Brian Griffin discusses capturing colonies without harming either yourself or the bees (11). It is possible to purchase a bumblebee "home" from Brian. See the **Suppliers of Bees and Bee Equipment** section for more information.

Bumblebee colonies are annual; the entire colony dies out each year and leaves only inseminated queens to hibernate through winter. The queen will start a new colony in spring. After she raises the first workers, she concentrates on laying eggs. She will lay about 20 eggs a day for the rest of her life, which lasts about another 18 weeks (12). Most workers live for about a month. Larger bumblebee workers collect food and smaller ones maintain the nest and the young larvae. The size difference is largely dependent on the amount of food the bees eat while they are larvae. Colonies raise males and new queens towards the end of the growing season, usually between August and October.

Red clover is an excellent forage crop for bumblebees. By also providing forage plants that bloom eight or nine weeks ahead of red clover, growers can almost assure themselves of bumblebee colonies (13). Bumblebees pollinate tomatoes, eggplants, peppers, melons, raspberries, blackberries, strawberries, blueberries, and cranberries, just to name a few (1). Bumblebees are the only pollinators of potato flowers worldwide (3).

Bumblebees can be raised artificially, but it's probably easier to attract natural populations. Several companies are now using a patented process developed by European scientists for rearing bumblebees. The companies are charging users from $150 to $300 per colony. The high cost limits the bees' use to pollinating high-value crops in greenhouses. More than 300,000 colonies are reported to be in use in greenhouses in Europe and North America. A colony lasts for about three months in a greenhouse, after which it must be replaced (14).

Sweat Bees (Halictidae family)

Though most species of this small bee, found throughout the U.S., are black or brownish, some, such as *Agapostemon femoratus*, are bright metallic green. All species nest in the ground. Halictids have a range of nesting habits, from dispersed solitary nests to densely situated ones with individual bees sharing common entranceways to primitive social arrangements. Lateral tunnels end in a single cell. Halictid

bees are common insects and good general pollinators (15).

Sweat bees take their name from their habit of landing on people to lick the salt from their skin. Like most solitary bees, sweat bees are non-aggressive and will sting only if you swat at them.

Unlike other mining bees, halictid females mate before hibernating for the winter, so they can begin nesting earlier in the spring (1). This allows them to raise only daughters during the growing season, much like bumblebees. Males are raised in late summer or early autumn.

Alkali Bees (*Nomia melanderi*)

The alkali bee was among the first of the solitary bees to be used for pollination of alfalfa in the western U.S. (4). This native bee occurs naturally in areas west of the Rocky Mountains (16) and nests in moist alkaline soils near natural seeps and springs (15). Western scientists and farmers attract this wild bee by building nests that simulate natural in-ground nests in alkaline soil. These nests are vertical and reach down a foot or two into the soil.

Although alkali bees are solitary, individuals nest near each other (15). Adults are black with metallic-colored bluish, greenish, or yellowish bands circling the abdomen (16). The larvae overwinter in their cells, then pupate and emerge from the soil in late spring or early summer, depending on temperature and moisture of the soil (16). They rarely use their stings. The alkali bee also pollinates onions, clover, mint, and celery (15).

Squash Bees (*Peponapis pruinosa*)

Squash bees, which are related to carpenter bees, collect pollen and nectar only from the flowers of cucurbits (squash, pumpkin, and gourd). These solitary bees are found throughout the U.S., except in the Northwest (15). The bees nest in underground burrows. They become active at dawn, visiting cucurbit flowers until midday when the flowers close (4). As a result, they typically start to pollinate the crop before honeybees are abroad and have finished by the time honeybees are at their most active, from midmorning on (4). They have life spans of about 2 months, until the food source is gone (15).

Leafcutter Bees (*Megachile* spp.)

Leafcutter bees are solitary bees, usually grayish in color, native to woodland areas (1). There are more than 140 species found in North America (15). They nest in ready-made wooden cavities, in hollow plant stems, and in drilled wood nesting blocks. The females cut pieces of leaves to line their nests. They can be rather particular about the leaves they use. One species, *Megachile umatillensis*, a bee native to the western U.S., cuts leaves only from an evening primrose (*Oenethera pallida*) (6).

Leafcutter bees prefer legume blossoms (15), but they will pollinate other crops, like carrots (1). They are most active in midsummer, when the temperature rises above 70°F (17). Leafcutters are efficient; 150 leafcutters can do the work of 3000 honeybees (1). They are gentle and ideal for greenhouse work (1).

The alfalfa leafcutter bee, *Megachile rotundata*, is widely used for alfalfa pollination. Although not a native bee (it hails from Eurasia), it pollinates alfalfa better than any other insect (17). The bee is roughly half as big as a honey bee, with light-colored bands on its abdomen. Barry Wolf Farms in Carrot River, Canada, is the largest broker of leafcutter bees in Canada (17). Barry keeps his bees in styrofoam block nest trays he designed himself. Each tray is 48x12 inches, 3¾ inches thick and contains 20,000 holes where the female bees make their leaf-lined nests and lay their eggs. The cocooned larvae that develop stay in the nest block and are stored over winter in a climate-controlled on-farm warehouse (17).

"In spring, three weeks before we want them to hatch, we incubate the nest blocks," Barry explains. "It takes three weeks to go from larvae to adult bee. The incubator trays are placed in tent domiciles in the fields, 20,000 bees per acre"

(17). See the **Suppliers of Bees** section for more information on how to contact Barry.

Carpenter Bees (*Xylocopa* spp.)

Carpenter bees are some of the largest bees and have a blue-black, green or purple metallic sheen. They excavate their own nest tunnels in wood, rather than use pre-existing cavities, but they will re-use old nests. They burrow into dry wood pretty much anywhere they can find it, but they prefer softwoods like pine, and avoid wood that is painted or covered with bark (13). A nest consists of a round entrance hole (½" in diameter) and a tunnel back from it that can extend up to several feet. Carpenter bees become active when temperatures climb into the 70s in the spring. Mating occurs in April. Carpenter bees are longer-lived than most solitary bees (6).

There are several species of native carpenter bees:

- *Xylocopa orpifex*, the mountain carpenter bee is native to the western U.S. and southern California (13).
- *Xylocopa varipuncta*, the valley carpenter bee, occurs naturally in Arizona and California. Females and shiny and black, while males are more tan (13).
- *Xylocopa virginica* and *Xylocopa micans* are found in the eastern U.S.
- There are also 20 species of *Ceratina* (dwarf carpenter bees) native to North America (6).

Male carpenter bees can be annoying, since they tend to buzz around your head. They have no sting, however, so they are completely harmless. The females possess a sting but they very rarely use it. Although carpenter bees can pollinate several crops, including passionfruit, black-berry, canola, corn, pepper, pole bean, and rhododendron, these bees often "rob" flowers by cutting into the side of flowers instead of pollinating them (18).

Mason Bees (*Osmia* spp.)

Bees in the genus *Osmia* are found throughout the U.S. All the bees in this family have similar nesting requirements. They don't excavate their own nests, but use existing holes instead. They can nest in straws or in wood blocks drilled with 5/16" holes. They are gregarious bees, so the nests should be close together. Placing the nests close to streams is advantageous, since mud for nest building can be collected there (19).

Mason bees are so called because they construct their nests out of materials like mud and small pebbles. Eggs are laid in tubular cells, with up to 11 cells per nest. The female determines the sex of the egg and lays male eggs closer to the entrance hole. This assists in perpetuating the species in two ways. First, the males are more accessible to predators than females, and second, males emerge several days before females. If the female "at the back of the line" emerges first, she opens the cell of the next female and nips at her to urge her out of the nest. This continues down the line until all females have emerged from a single nest tube (6).

The nests of *Osmias* should be positioned so that they receive morning sunlight. Put the nests up in late winter or very early spring, before the bees begin nesting and remove them after nesting is completed. If the blocks are stored outdoors over winter, the bees will emerge after temperatures have reached 55°F. Wherever the boards are stored, they must be kept out of rain and snow (19).

If nests are left outside, low winter temperatures may kill bees. Warm spells in late winter may draw bees out of the nest prematurely, killing even more when cold temperatures return. By storing bees under refrigeration, they can remain dormant until spring arrives (20). To build up large populations of mason bees, store the nests under refrigeration at 35-40°F. Greg Dickman, a grower in Auburn, Indiana, stores his inventory of 700,000 bees in a 12x12 shed over winter. One wall of the shed holds all the bees (14). Brian Griffin also recommends placing the nests in a paper bag along with a moist paper towel, to reduce dehydration (9). Indoor storage reduces the likelihood of predation and also allows the grower to control the time of emergence. In this case, the nests should not be placed in storage until September or October (19). Then, allow about 3 days of at least 50°F weather, and the bees will begin to emerge.

Osmia lignaria (commonly called the orchard mason bee, blue orchard bee, mason bee, or orchard bee) is a pollinator of many fruit crops, including almond, apple, cherry, pear, and plum (16). The orchard mason bee (OMB) is a native, solitary bee, slightly smaller than a honeybee and is shiny dark blue. They are non-aggressive and rarely sting. One only needs 250-750 orchard mason bees to pollinate an acre of apples. It would take 60,000-120,000 honeybees to cover the same area.

Osmia cornifrons (the horned-faced or hornfaced bee) is a commercial pollinator of apples in Japan and is a pollinator of orchard crops grown in areas of higher humidities in the U.S. (16). The hornfaced bee is 80 times more effective than honeybees for pollinating apples (14). A single hornfaced bee can visit 15 flowers a minute, setting 2,450 apples in a day, compared to the 50 flowers set in a honeybee's day. In Japan, where hornfaced bees pollinate up to 30 percent of the country's apple crop (14), apple growers need only about 500 to 600 hornfaced bees per hectare (2.47 acres) (3).

Osmia ribifloris (sometimes called the blueberry bee) has been used successfully as a highly effective and manageable pollinator of highbush blueberry (16). This bee, native to the western U.S., pollinates blueberries three times faster than a honeybee (15). Only 300 *Osmia ribifloris* are needed to pollinate an acre of blueberries (3).

Shaggy Fuzzyfoot Bees *(Anthophora pilipes)*

The shaggy fuzzyfoot bee is a fat, shaggy, fast-flying bee that buzz-pollinates blueberries. In this type of pollination, the bee creates a vibration that releases the pollen from inside tiny, tubelike anthers. Shaggy fuzzyfoots pollinate in the rain. They pollinate blueberries, apples, and other crops for about 6 weeks in the spring. During this time, females lay eggs in mud cells. Bee larvae grow inside them during the summer, pupate in the fall, become adults, and hibernate in the cells over winter. They're best adapted to a moist, warm climate and can survive mild winters (3).

Other Pollinators

The bees listed above are by no means inclusive of all available pollinators. Other candidates among the native bees include sunflower bees (*Eumegachile pugnata*) and blueberry bees (*Habropoda laboriosa*) (4). Beetles, butterflies, moths, and flies can also be good pollinators.

Enemies and Pests of Native Bees

Native bees have numerous enemies: birds, rodents, skunks, lizards, toads, hornets, wax moths, robberflies, assassin bugs, spiders, beetles, and mites all prey on bees. Wasps and flies lay eggs in bee cells. These pests eat either the honey/pollen store or the bee larva itself (6).

Cuckoo bees (so called because they get other species to raise their offspring, like cuckoo birds) also lay eggs in the nests of solitary bees. Roughly 20% of all bee species are cuckoos, so these bees can be problematic. Cuckoo larvae have large jaws, which they use to kill the host larvae. Some cuckoo bee females invade the host nest of social bees and kill the queen. The workers then feed and protect her and her offspring.

There has been no evidence to suggest that the Varroa and tracheal mites that are so detrimental to honeybees also infest solitary bees. There are mites present in nests, but they are largely symbiotic and assist in nest cleanup. Greg Dickman controls mites on his orchard mason bees by removing the bee cocoons from the nesting holes and immersing them in a solution of water and 5% bleach for 5-10 minutes. The cocoons can then be replaced into a nesting hole or straw, "nipple" end towards the entrance hole, which is plugged with cotton (9).

Quick Guide to Pollen Bees

Blueberry Bee – *Osmia ribifloris*
Native to the coastal mountains of southern California, this solitary bee normally gathers pollen from manzanita, but will pollinate blueberries.

Bumblebee – *Bombus* spp.
Many native species across the country. Form small colonies, usually underground. Begins working around 7 in the morning.

Carpenter Bee – *Xylocopa* spp.
Create so much sonic energy with their buzzing that pollen shoots out of tomato flowers' hollow anthers in a cloud. These native solitary bees nest in bamboo and wood.

Hornfaced Bee – *Osmia cornifrons*
Used commercially for several decades in Japan to pollinate apples, it's now in the U.S. A single hornfaced bee can visit 15 flowers in a minute. This solitary bee nests in reeds, tubes and holes in wood.

Oxaeid Bee – *Ptiloglossa arizonensis*
Prefer to pollinate between 5 and 6 in the morning. This solitary bee nests underground.

Polyester Bee – *Colletes* spp.
Native solitary bees, they build plastic-lined cells in underground nests.

Shaggy Fuzzyfoot Bee – *Anthophora pilipes villosula*
Fat, shaggy, and fast-flying; it can pollinate in rainy, cool weather. This Japanese solitary bee nests in dry adobe. It was imported to the U.S. in the 1990's.

Sweat Bee – family Halictidae
Nesting underground, some kinds form social units with queens and workers.

References:

1) Smith-Heavenrich, Sue. 1998. Going native with pollinators. Maine Organic Farmer & Gardener. March-May. p. 16-17.

2) Woodier, Olwen. 1998. How to protect our imperiled pollinators. National Wildlife. February-March. p. 36-41.

3) Rieckenberg, Regina. 1994. The busiest of bees. Buzz Words. Cornell Cooperative Extension. Feb. 25. p. 1-4.

4) Kevan, Peter G., E. Ann Clark, and Vernon G. Thomas. 1990. Insect pollinators and sustainable agriculture. American Journal of Alternative Agriculture. Vol. 5, No. 1. p. 13-22.

5) Free, J.B. 1970. Insect Pollination of Crops. Academic Press, New York.

6) O'Toole, Christopher and Anthony Raw. 1991. Bees of the World. Facts on File, New York. 192 p.

7) Byczynski, Lynn. 1998. Encourage native bees; increase your yields. Growing for Market. May. p. 1, 4-5.

8) Batra, Suzanne. 1994. Diversify with pollen bees. American Bee Journal. September. p. 591-594.

9) Griffin, Brian L. 1993. The Orchard Mason Bee. Knox Cellars, Bellingham, WA. 69 p.

10) Light, Nina. 1994. Abuzz about bumblebees. Fruit Grower. March. p. 20-21.

11) Griffin, Brian L. 1997. Humblebee Bumblebee. Knox Cellars, Bellingham, WA. 112 p.

12) Gunstone, Giles W. 1994. Biological systems for glasshouse horticulture. The Growing Edge. Summer. p. 443-45, 47, 50.

13) http://wwww.netside.net/~jb/images/research2.html

14) Henkes, Rollie. 1997. Calling all pollinators. The Furrow. November. p. 10-13.

15) Wright, Amy Bartlett. 1997. Not just honeybees do it: The other pollinators. National Gardening. May-June. p. 32-37, 74.

16) Torchio, P.F. 1990. Diversification of pollination strategies for U.S. crops. Environmental Entomology. Vol. 19, No. 6. p. 1649-1656.

17) Polachic, Darlene. 1996. Bee business. Small Farm Today. December. p. 43.

18) Delaplane, Keith S. 1994. Honey bees and other pollinators. American Bee Journal. January. p. 21-22.

19) Bekey, Ron and E.C. Klostermeyer. 1981. Orchard mason bee. Extension Bulletin 922, Washington State University, Pullman, WA. 4 p.

20) O'Dell, Charlie. 1997. Grow your own disease-resistant pollinators. American Fruit Grower. February. p. 24-26.

Suppliers of Bees and Bee Equipment

Barry Wolf Farms
Box 6
Carrot River
Saskatchewan, CANADA S0E 0L0
306-768-3518
Source of leafcutter bees.

Bee Busters
George Bristol
PO Box 600
Pescadero, CA
415-879-0233
Raises and sells Osmia lignaria.

Bees West, Inc.
PO Box 1378
Freedom, CA 95019
408-728-3325
*Provide bumblebees (*Bombus occidentalis, B. impatiens*) and other commercial pollination services.*

Benecia Garden & Nursery
Carol de Maintenon, Owner
126 East E Street
Benicia, CA 94510
Email: benicia@beniciagarden.com
Supplier of Osmia*, condos, and straws.*

Custom Paper Tubes, Inc.
PO Box 44187
Cleveland, OH 44144-0187
800-766-2527
Web: http://www.custompapertubes.com
Provides fabricated-to-order paper tubes as solitary bee nesting materials.

Entomo-Logic
Evan Sugden & Kristina Williams
9807 NE 140th St.
Bothell, WA 98011-5132
425-820-8037
Email: easugden@msn.com
Services: pollination, consultation on rearing and pollination, presentations on bees, beekeeping, and pollination. Products: Osmia lignaria*, bee blocks, paper nest inserts, pollination kits for beginners.*

Tom Farner
16021 Marsing Rd.
Caldwell, ID 83605
208-459-8251
Raises and sells Osmia lignaria.

Brad Gill
PO Box 761
Rainier, WA 98576
360-894-3672 or 206-894-3672
Raises and sells Osmia lignaria*, nest blocks.*

The Green Spot Ltd.
93 Priest Rd.
Nottingham, NH 03290-6204
603-942-8925/8932
Email: GrnSpt@internetMCI.com
Source of bumblebees.

Hydro-Gardens, Inc.
PO Box 25845
Colorado Springs, CO 80936
800-634-6362
Web: http://www.hydro-gardens.com
Source of bumblebees.

International Pollination Systems USA
16645 Plum Rd.
Caldwell, ID 83605
800-990-1390
Web: http://www.pollination.com
*Provides consultant services, supplies, and breeding stock of various bees (*Megachile rotundata, Osmia lignaria, Bombus occidentalis, B. impatiens*) for commercial orchards and field crop growers.*

International Pollination Systems Canada
Box 241
Fisher Branch, Manitoba
CANADA ROC OZO
204-372-6920
IPS' primary objective is to provide pollinating bees and assistance to growers who want to initiate their own pollination program or improve an existing one. They are providers of alkali bees (Nomia melanderi), *blue orchard bees* (Osmia lignaria), *bumblebees* (Bombus spp.), *honeybees* (Apis mellifera) *and leafcutter bees* (Megachile rotundata).

Jonesville Paper Tube Corporation
540 Beck St.
PO Box 39
Jonesville, MI 49250
517-849-9963
Email: info@papertube.com
Web: http://www.papertube.com/
Manufacturer of paper tubes for bees.

Knox Cellars
25724 NE 10th St.
Redmond, WA 98053
425-898-8802
425-898-8070 fax
Email: Brian@knoxcellars.com
Web: http://www.Knoxcellars.com
*Sells blue orchard bees (*Osmia lignaria*) along with nesting materials and education products about them. Provides starter kits called pollinators with three filled nests containing six to seven overwintering bees each. Also sells cardboard nesting tubes or assorted drilled pine boards as bee real estate ready to be hung on a wall and occupied by nesting females. Also sells bumblebee houses and education material about them.*

Koppert Biological Systems, Inc.
28465 Beverly Rd.
Romulus, MI 48174
734-641-3763
734-641-3793 fax
Source of bumblebees.

Maxtek
Ray Elder
2539 NE 108th Pl.
Seattle, WA 98125-6712
206-367-6042 fax
Email: opie2539@aol.com
Sells nest blocks, raises & sells live bees.

Dale C. Nielson
530 East 600 South
Logan, UT 84321
435-753-2004
Email: wildbee@uswest.net
Nesting tubes for Osmia lignaria *&* O. cornifrons

Orchard Bees
Greg Dickman
4391 County Rd. 35
Auburn, IN 46706-9794
219-925-5076
Web: http://user.dekalbnet.org/gdi2364
*Sell the blue orchard bee (*Osmia lignaria*), along with paper straws, cardboard nesting tubes, and a video on their life history and propagation. Bees are supplied during the fall, winter, and early spring as overwintering adults in their nesting tubes.*

Pawood Bee Blocks
Box 415
Ambrose, ND 58833
701-982-3237
Provides nesting blocks for hornfaced and orchard bees.

Plant Sciences, Inc.
342 Green Valley Rd.
Watsonville, CA 95076
831-728-7771
Source of bumblebees.

Mark Porath
2451 E. 3900 So.
Salt Lake City, UT 84124
801-278-3141
Raises & sells Osmia lignaria *and equipment.*

Raintree Nursery
391 Butts Rd.
Morton, WA 98356
360-496-6400
Web: http://www.raintreenursery.com/
Bee blocks and bees.

Territorial Seed Company
20 Palmer Ave.
PO Box 157
Cottage Grove, OR 97424-0064
541-942-9547
888-657-3131 fax
Web: http://www.territorial-seed.com
Bee blocks and bees.

Torchio Enterprises
Dr. Philip Torchio
PO Box 6054
North Logan, UT 84341
435-752-9339
Email: torchio@xmission.com
Web:
http://www.xmission.com/~torchio/mason_bee.htm
Provides parasite- and disease-free Osmia lignaria *in natal test tubes using a unique system. Also sells "Bee Condominium" designed to reduce diseases and eradicate parasites.*

Ustick Bee Board Co.
11133 Ustick Rd.
Boise, ID 83704
208-322-7778
*Supplies wooden drilled bee nesting boards in addition to modern styrofoam nesting materials for the management of alfalfa leafcutter bees (*Megachile rotundata*).*

Raymond D. Williams
PO Box 1943
Binghamton, NY 13902-1943
607-775-3369
Supplies Osmia *spp.*

Sources of Information

Publications:

O'Toole, Christopher and Anthony Raw. 1991. Bees of the World. Facts on File, New York. 192 p.
An excellent book for more in-depth information on solitary bees. Although the authors are English, they identify and discuss bees around the world. Also contains numerous photographs to help identify bees. Available for $29.95 from:
Facts on File
11 Penn Plaza
New York, NY 10001
800-322-8755

McGregor, S.E. 1976. Insect Pollination of Cultivated Crop Plants. USDA Handbook No. 496. Agricultural Research Service, USDA. 411 p.
Although this book is out of print, it can be found in most large libraries. It can also be accessed at the website maintained by the Carl Hayden Bee Research Lab, located at http://gears.tucson.ars.ag.gov/.

Free, J.B. 1993. Insect Pollination of Crops. Academic Press, San Diego. 684 p.
Widely available.

Andrewes, Sir Christopher. 1971. The Lives of Wasps and Bees. American Elsevier Publishing, New York, NY. 204 p.
Out of print. If unavailable at your local library, request a copy through inter-library loan (ILL).

Buchmann, Stephen L. and Gary Paul Nabhan. 1996. The Forgotten Pollinators. Island Press/Shearwater Books, Washington, DC. 292 p.
Widely available for $16.95.

Griffin, Brian L. 1993. The Orchard Mason Bee. Knox Cellars, Bellingham, WA. 69 p.
Full of practical information from someone who's been raising native bees for a number of years. Available for $9.95 from:
Knox Cellars
25724 NE 10th St.
Redmond, WA 98053
425-898-8802
425-898-8070 fax
Email: Brian@knoxcellars.com
Web: http://www.Knoxcellars.com

Griffin, Brian L. 1997. Humblebee Bumblebee. Knox Cellars, Bellingham, WA. 112 p.

Includes information on finding and relocating wild colonies. Also contains a field guide to all the bumblebees in North America. Available for $12 from Knox Cellars (see address above).

Selected articles:

Delaplane, Keith S. 1998. Bee Conservation in the Southeast. Extension Bulletin 1164. University of Georgia Cooperative Extension Service, Athens, GA. 16 p.

Contains photographs of bees, descriptions, advice on how to conserve native bees, and an extensive list of plants for "bee pasture". Free from:

University of Georgia
Entomology Dept.
463 Biological Sciences Bldg.
Athens, GA 30602
706-542-1765

Torchio, P.F. 1990. *Osmia ribifloris*, a native bee species developed as a commercially managed pollinator of highbush blueberry (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society. Vol. 63, No. 3. p. 427-436.

Specific information on raising O. ribifloris.

Torchio, Philip F. 1987. Use of non-honey bee species as pollinators of crops. Proceedings of the Entomological Society of Ontario. Vol. 118. p. 111-124.

Specific information on several native bees.

Bekey, Ron and E.C. Klostermeyer. 1981. Orchard mason bee. Extension Bulletin 922, Washington State University, Pullman, WA. 4 p.

Available through your local land-grant university.

List server:

Bumblebee list server – BOMBUS-L@LIST-SERV.UOTTAWA.CA

Web Sites:

http://www.uidaho.edu/pses/Strickler/SolitaryBees/solitary.htm

Excellent web site from University of Idaho that contains information on raising several species of native bees, particularly orchard mason bees and hornfaced bees. Numerous links are provided.

http://users.aol.com/pollinator/polpage4.htm

This web site, hosted by Dave and Janice Green in South Carolina, has lots of links to information about solitary bees.

http://www.insect-world.com/main/solbees.html

An Introduction to the Solitary Bees

http://www.netside.net/~jb/images/research2.html

Links to pictures of carpenter bees, mason bees, and bumblebees.

People:

Raymond Williams
PO Box 1943
Binghamton, NY 13902-1943
607-775-3369

He has lots of practical know-how and advice for anyone who wants to begin raising native bees for pollination.

Dr. Suzanne Batra
USDA Bee Research Lab
Bldg. 476, BARC-East
Beltsville, MD 20705
301-504-8384
301-504-8736 fax

She can offer literature, advice, and may have some bees (in small quantities) available for folks who want to try raising them. She also has a list of people who raise pollen bees for sale.

Dr. Vince Tepedino
Dr. James Cane
Dr. Philip Torchio
USDA Bee Biology Lab
Utah State University
5310 Old Main Hill
Logan, Utah 84322-5310
435-797-2524
http://www.loganbeelab.usu.edu/

They have information on all kinds of solitary bees.

Dr. Bill Stephen
Dept. of Entomology
2046 Cordley Hall
Oregon State University
Corvallis, OR 97331
541-737-5512

He has information on alfalfa leafcutter bees.

Dr. Dan Mayer
Washington State University
24106 N. Bunn Rd.
Prosser, WA 99350-9687
509-786-2226
He has information on bumblebees and alkali bees.

Dr. Stephen Buchmann
USDA Carl Hayden Bee Research Center
2000 E. Allen Rd.
Tucson, AZ 85719
520-670-6481
http://gears.tucson.ars.ag.gov/

Dr. Blair Sampson
USDA-ARS Small Fruit Research Station
PO Box 287
306 South High St.
Poplarville, MS 39470
601-795-8751
bsampson@ars.usda.gov
Researches pollination using Osmia *spp.*

Dr. Richard L. Wilson
Craig Abel
G-204 Agronomy Hall
Iowa State University
Ames, IA 50011
http://www.arsgrin.gov/ars/MidWest/Ames/
Use Osmia cornifrons *to pollinate several crops.*

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The electronic version of **Alternative Pollinators: Native Bees** is located at:
HTML:
http://www.attra.org/attra-pub/nativebee.html
PDF
http://www.attra.org/attra-pub/pdf/nativebee.pdf

By Lane Greer
NCAT Agriculture Specialist

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