1967

Management of Wild Bees (in Agriculture Handbook)

George E. Bohart
Utah State University

MANAGEMENT OF WILD BEES

By GEORGE E. BOHART, *apiculturist, Entomology Research Division, Agricultural Research Service* [1]

The term "wild bees" includes all bees except the three species of honey bees *Apis mellifera* L., *indica* Fabricius, and *cerana* Fabricius [2] managed by man. Generally bees are hymenopterous insects that provide their young with a diet of pollen and honey. They are characterized by the presence of plumose body hairs and usually by somewhat expanded hindlegs. Most species construct and provision nests, but perhaps 5 percent lay their eggs in nests constructed by other bees. Most bees are solitary (no cooperation between females and no contact between mother and adult offspring), but perhaps 10 percent display various degrees of social development. Many of the solitary species are neighborly and develop nesting aggregations numbering into the thousands or even millions.

According to C. D. Michener, there are at least 20,000 species of bees in the world. These are distributed among eight recognized families and perhaps 400 genera. In the United States there are seven families, about 100 genera, and between 3,000 and 4,000 species. In favorable locations only a few square miles may be inhabited by several hundred species.

Probably the high point in wild bee populations in the United States was reached about 1915, when hedgerows and unused fields provided ideal habitats and insecticides were rarely used. Today intensive land use, elimination of weeds, and widespread and frequent broadcasting of poisons are undoubtedly taking their toll. However, seed growers in some areas are protecting wild bees and propagating a few species for pollination. Furthermore, there is increasing emphasis nationally on the development of control measures that minimize the use of insecticides.

Pollination

Crops visited freely and pollinated efficiently by sufficient numbers of honey bees have no need for wild bees. However, under some circumstances either certain "problem" crops are not visited freely by honey bees or their visits do not usually bring about the thorough pollination desired. Some of these crops are efficiently pollinated by wild bees. If these bees can be managed, they may contribute greatly to the complete pollination of our crops.

Bumble Bees

Bumble bees (*Bombus*) (fig. 1) are important pollinators of many plants. However, their small colonies do not make them well suited for large-scale pollination.

Bumble bee colonies are obtained by placing domiciles in the field to attract queens or by inducing queens to establish colonies in domiciles kept in cages or greenhouses. The queens can forage and seek out the domiciles, or they can be confined to the domiciles until they start to nest (fig. 2).

In areas where bumble bees are abundant, attracting searching queens in the spring to domiciles placed in the field is often the most successful method of obtaining colonies. A colony established in this manner can be moved just before the first workers emerge. It should be placed on a post under a shelter and the entrance tube reduced to confine the queen. Honey should be placed in the honeypot when this is done.

Colonies of *Bombus terrestris* (L.) and *B. lapidarius* (L.) have produced as many as 1,000 bees, although never more than about one-third of this number is present at one time. The queens produced in such colonies may number as many as 300, but these are not very useful for pollination until the following year. For most species, 50 to 100 workers during the peak population are exceptionally high. Some rarely have more than 10 to 15. With such small colonies it is questionable whether bumble bees could be profitably maintained for pollination in the field, although interest in doing so persists.

A more practical result of bumble bee culture may be the accumulation of knowledge about these bees on which to base recommendations for their protection and increase. We know that a continuity of suitable forage is important, but we know little about how to provide suitable nesting conditions on a large scale or how to effect practical control of such enemies as *Psithyrus*, ants, wax moths, and rodents.

[1] In cooperation with Utah Agricultural Experiment Station.

[2] Often known as *Apis indica japonica* Radoszkowski.

261-907 O—67——8

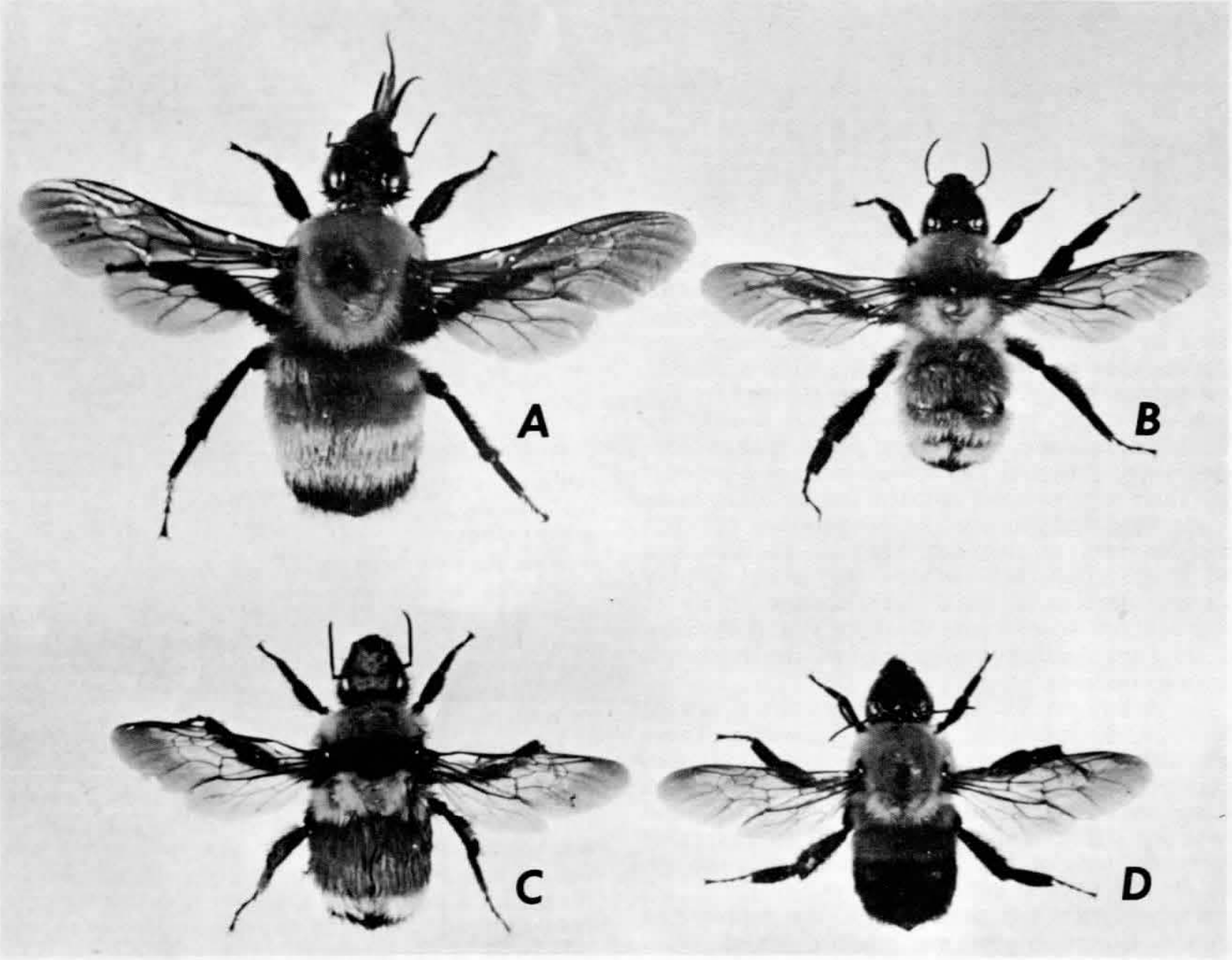


FIGURE 1.—Species of bumble bees: *A*, *Bombus nevadensis* Cresson; *B*, *fervidus* (Fabricius); *C*, *huntii* Greene; *D*, *griseocollis* (De Geer).

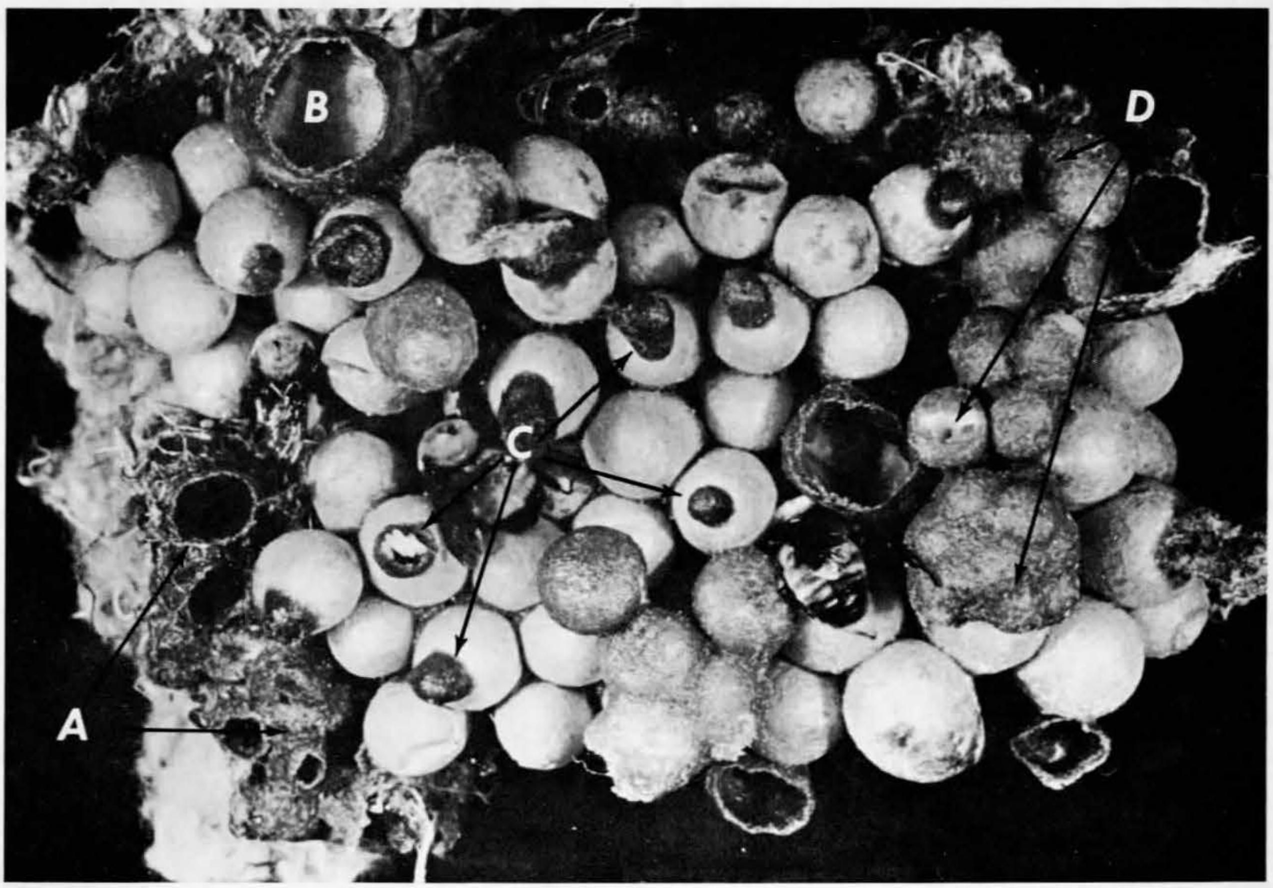
Alfalfa Leafcutting Bee

The alfalfa leafcutting bee *Megachile rotundata* (Fabricius) was accidentally introduced into the Eastern United States in the 1930's and has since spread westward across the northern two-thirds of the country, reaching Utah and California in the early 1950's.

Alfalfa seed growers have been aware of the potential value of this bee since 1950 (fig. 3). Throughout the 1960's, growers in Utah, Idaho, Oregon, Washington, Alberta, Montana, South Dakota, and California have been following recommendations of experiment stations in their areas and also developing methods of their own for culturing it. Since it nests in many kinds of manmade structures, as well as holes in banks, pores in lava, and other natural cavities, it is not limited by soil conditions and is present in most farming areas within its range, at least in small numbers.

This bee is the smallest leafcutting bee in the United States (one-fourth to three-eighths inch long). Like most other leafcutters, it is charcoal gray and carries its pollen on the underside of the abdomen. Its preferred host range is limited, consisting primarily of small-flowered forage legumes, some mints, and a few crucifers. In the West, sweetclover is the principal host plant, competing with alfalfa. Unlike other leafcutting bees, the alfalfa leafcutting bee takes its leaf pieces from herbaceous plants (fig. 4), such as alfalfa, rather than shrub and tree leaves, but it occasionally damages gardens by cutting flower petals.

Depending somewhat on their size, the female bees choose $\frac{5}{32}$- and $\frac{7}{32}$-inch-diameter holes in



BN-30063

FIGURE 2.—Nest of *Bombus morrisoni* Cresson: *A*, Honey pots; *B*, pollen tube; *C*, egg baskets on cocoons (one opened); *D*, young brood in wax cells.

which to nest. Since brood mortality is usually lower in the larger holes, many growers use only large holes. The best hole depth seems to be from 4 to 5 inches.

Nesting Materials

Of the three materials most commonly placed in the field for their use, alfalfa leafcutting bees usually prefer holes in wood to bundles of soda straws, and soda straws to stacks or rolls of corrugated cardboard. Holes cast in foam plastic (polyurethane) are also sold for leafcutter nests in the Northwest, but these are not yet well tested. These preferences are usually demonstrated when different nesting materials are combined near a natural nesting population. However, since newly emerged females tend to renest in the same kind of nest hole from which they emerged, the preferences observed may largely represent the type of nest inhabited by a natural population. It is not surprising that growers often have difficulty changing materials and hole sizes from one season to the next.

The most generally satisfactory nesting units devised so far are made of grooved boards stacked together (fig. 5). Planer blades are modified to cut a series of $\frac{3}{16}$-inch grooves in boards, which are then strapped tightly together. The principal advantages of the grooved units are clean holes, resulting from grooving with the grain, and the ease with which the units can be taken apart to clean out scavenger beetles and pollen-blocked holes.

Populations

One female per five square yards appears to be adequate for good pollination of alfalfa seed fields. If this figure is doubled to allow for the bees not actually foraging at any one time, 100,000 nesting females should be able to pollinate a 50-acre field. Since the bees tend to forage within a few hundred feet of their nests, they should be placed in shelters distributed throughout the field at about 500-foot intervals.

BN-30065

FIGURE 3.—Alfalfa leafcutting bee "tripping" alfalfa florets.

Shelter Designs

The shelter should be oriented to receive the early morning sun but protect the nests from direct rays after about 10:00 a.m. It should afford some protection from wind and rain, provide good ventilation, and be conspicuous for the bees. It should accommodate at least 10,000 nesting bees, be placed at least 2½ feet above the ground, and be built so that covers or screens can be added for protection against pesticides or birds.

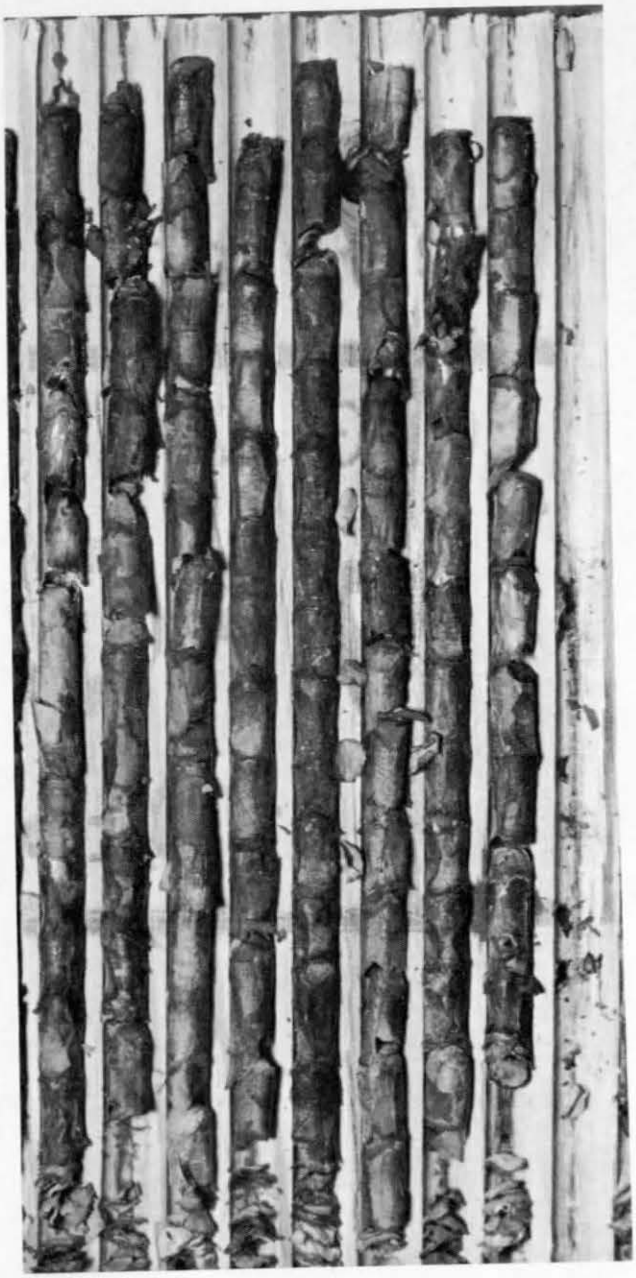
A box or cupboard supported on legs and protected by a shade board roof is generally satisfactory. It is also advisable to insulate the inner walls of the shelter and to paint the outside white or cover it on the top and the south and west sides with aluminum foil. At the back near the top, screened slots should be provided for ventilation. If birds are a problem, the open side of the shelter should be covered with rabbit wire. Cloth can be used to confine the bees for a few hours after insecticide applications, or until the temperature inside builds up to about 95° F. For longer protection, the shelter box can be placed in a cool, dark room.

Overwintering

By mid-September in most areas the nesting materials can be moved to an unheated room or cellar for overwintering and protection from mice. To prevent a buildup of scavenger beetles during storage and to guard against excessive temperature fluctuations, it is better to keep the nests (or cells taken from the nests) in cold-

BN-30067

FIGURE 4.—Cell of alfalfa leafcutting bee opened to show construction.



BN-30070

FIGURE 5.—Cells of alfalfa leafcutting bee in grooved board unit (leaf pieces at lower right).

storage facilities at 30° to 40° F. Before nests brought from the field are placed in cold storage, they should be held at room temperature for about 12 days.

Incubation

Approximately 1 month before the bees are needed for pollination, the nests can be placed in their shelters in the field. Emergence time will vary by several weeks, depending on climatic conditions. For a more predictable emergence date, it is better to incubate the nests or loose cells at a nearly constant temperature between 86° and 90° F. until the males begin to emerge (usually about 15 days) before placing them in the field. Water should be added to the incubator to provide humidity.

To prevent bees from renesting in boxes with loose cells or in unwanted nesting materials, the nests or cells should be placed in a tight box with one or more long screen cones attached to one side. Bees trying to reenter the box will usually go to the base of the cones. Before placing loose cells in a shelter, it is important that the bees be ready to emerge. Otherwise the pupae are likely to desiccate. If the bees are being used for the first crop seed and the temperatures are rather low, the shelters should be oriented to the south until shade temperatures reach the high 80's.

Moving Adult Bees in Field

If the bees are moved after they begin nesting, they will return to their original location. If nothing but alfalfa remains, most of them will return to the new location, especially if it is marked by a large shelter to which they can orient. Several seed growers have successfully used large shelters mounted on trailers, which can be moved to areas needing additional pollination.

Protection From Parasites

The most serious parasite of the alfalfa leafcutting bee is a metallic-colored chalcid wasp with a long ovipositor (*Monodontomerus*). The female parasites lay eggs in the host cocoons during the nesting season and also in the spring before the bees emerge. The best time to control them is during incubation. Since the wasps emerge earlier than the bees under constant temperature incubation, a light can be placed over a tray of water in the incubator to attract and then drown them. Unless control measures are used during incubation, a light degree of parasitism in the fall may become almost total before the bees can emerge in the spring.

Protection From Scavenger Beetles

A species of grain beetle, *Tribolium madens* (Charpentier), and several species of carpet beetles (*Trogoderma*) infest leafcutter nests. Both groups of beetles can be baited from the nests and killed with DDT-treated pollen pellets taken from pollen traps on honey bee hives. The pellets can be placed under the nesting materials where the bees cannot contact them or in boards with shallow grooves or corrugated cardboard with flutes too narrow for the bees to enter. This method of control can be used during incubation or nesting and also during cold storage if the temperature is above 40° F. Studies in Alberta, Canada, indicate that carpet beetles can also be controlled during incubation by using the method described previously for chalcid wasp control.

Megachile concinna Smith

This species is closely related to the alfalfa leafcutting bee *Megachile rotundata* (Fabricius) and apparently arrived on the east coast of the United States at about the same time. It took a southerly route across the country, or possibly was independently introduced to Arizona, from which it spread to California. *M. concinna* differs from *M. rotundata* as follows: The adults cut leaves of shrubs and trees as well as herbaceous leaves and flower petals. It presumably has greater tolerance for high temperatures. It seems to prefer bamboo stems over straws or holes in wood. In Arizona its nests are infested with a small chalcid wasp (*Tetrastichus*), which seems to be a serious limiting factor.

Alkali Bee

The alkali bee *Nomia melanderi* Cockerell is found in scattered localities west of the eastern escarpment of the Rocky Mountains. In Nevada, Wyoming, Idaho, Utah, and the intermountain areas of Washington and Oregon it ranks with the alfalfa leafcutting bee in importance as an alfalfa pollinator. In Washington, Oregon, Idaho, and Nevada, seed growers have successfully established and maintained nesting sites for several years by following recommendations of their State experiment stations.

Alkali bees are nearly as large as honey bees and can be readily recognized by the pale-green or greenish-bronze highly polished bands across the rear part of their bodies. They are found principally in the larger valleys where poorly drained, alkaline areas are prevalent. They are abundant in some areas and totally absent in others. They may appear suddenly in large numbers in one season and disappear almost as quickly several years later.

The host range of alkali bees is rather limited. In the Delta area of Utah, only sweetclover (*Melilotus* spp.) and Russian-thistle (*Salsola kali* L.) offer serious competition to alfalfa, although a few other less abundant plants such as saltcedar (*Tamarix gallica* L.), morning-glory (*Convolvulus arvensis* L.), and various clovers are attractive. Common competitors in the area for honey bees present no attraction for alkali bees. These include greasewood (*Sarcobatus vermiculatus* (Hook.) Torr.), povertyweed (*Iva axillaris* Pursh), gumweed (*Grindelia squarrosa* (Pursh) Dunal), sunflower (*Helianthus annuus* L.), and rabbitbrush (*Chrysothamnus* spp.).

In Utah, Idaho, and Wyoming, adult males usually appear in the fields near the first of July. Females often do not appear in any large numbers until the middle or even the end of July. Males in the field are restless and stop only occasionally to feed on nectar from flowers. However, they do trip a high percentage of the flowers visited, and we have observed fields in which they have been the most important pollinators. Females work much more efficiently than males. The grower, in order to take full advantage of alkali bees, must time his bloom for late July or early August. Since there is a partial second generation, some adults may be found until September.

Alkali bees construct nest burrows in the soil from 6 to 10 inches deep (figs. 6 and 7). These bees are highly gregarious, but each female builds and provisions her own nest without help from her neighbors. A successful nest contains from 15 to 20 brood cells, in each of which is placed a ball of honey-moistened pollen and a single egg (fig. 8). As soon as the egg is laid, the mother bee seals the cell and has no further contact with her offspring. Most of the nests are constructed and provisioned during July and early August. The larva matures by late August and becomes a pupa during the following June or early July.

Characteristics of Ideal Nesting Site

An ideal nesting site is composed of a fine sandy loam, a well-drained surface, a constant underground supply of moisture extending upward to the surface, a bare or only sparsely vegetated surface, and a salty crust. This crust should not be thick or hard, and no fluffy dry layer should be under the crust.

A good nesting site may contain more than a million nests and remain populous for many years. However, after a few years, the population may decline or disappear altogether. The causes, except for untimely rains, are at least partially under the grower's control. Many farming practices that are ordinarily desirable, if done without regard for alkali bees, can sharply reduce seed yields by damaging the bees' nesting sites. Growers should remember that land occupied by an alkali bee site is worth many times the same acreage devoted to crop production.

Protection of Nesting Sites

Seed growers should find all the nesting sites within several miles of their fields and take whatever steps are needed to protect them. Usually nesting sites can be protected most effectively on a community basis, since the value of the bees

BN-30069

FIGURE 6.—Female alkali bee at nest entrance.

extends beyond property lines, as does the effect of many farming practices, such as spraying and drainage. Most of the measures involve simple control over farming practices. Simply fencing off a nesting site does not necessarily protect it. This may permit excessive growth of vegetation, which removes soil moisture and shades the surface. Weeds can be eliminated by mowing or by spraying with herbicides. Skunks are readily controlled by baiting or trapping. Seed growers can organize and offer a bounty for skunks on an areawide basis.

A decline in nest density often results from a year-to-year buildup of fungus (*Aspergillus*) in the soil. By systematically removing about 20 percent of the nesting bed to a depth of about 10 inches each year and backfilling with fresh soil, it should be possible to maintain relatively "clean" beds. The removed soil can often be taken out as "plugs" with overwintering larvae and used or sold for stocking newly prepared beds.

Controlling the bee fly parasite *Heterostylum robustum* (Osten Sacken) is difficult (fig. 9). On newly established nesting sites the adult parasites are simply swatted by teams of "vigilantes." Some growers have found that "a penny a fly" is expensive but worthwhile. Blackbirds and other birds are also a serious problem in some areas. Scarecrows and firecracker devices soon lose their effectiveness.

Building and Maintaining Nesting Sites

Where a hardpan layer exists a foot or more under the soil surface, a natural nesting site can often be built by gently crowning the area and providing it with water in a series of blind, parallel irrigation ditches close enough for moisture to seep to the surface from one ditch to the next. If the water is run through draintiles laid above the hardpan and the tile has open joints covered by gravel, a better site is likely to result.

Where a natural hardpan is not present or is insufficiently impervious, plastic film can be substituted. To construct sites with plastic film, a 3½-foot-deep excavation should be prepared with a level bottom and 1-to-1 or 2-to-1 slope on the walls. The entire excavation should be lined with 0.008-inch polyethylene or 0.006-inch vinyl film overlaid with 4 to 6 inches of soil

BN-30064

FIGURE 7.—Nest mounds (tumuli) of alkali bees.

for protection. If the excavation is larger than the sheets of film, adjacent pieces can be overlapped on berms about 1 foot high placed where needed. This procedure creates two or more water-holding compartments. A 6- to 8-inch layer of clean gravel should be spread over the protecting soil. Some site builders lay a grid of draintile in the gravel layer to insure rapid and uniform distribution of water. At 3- or 4-foot intervals, footwide holes should be dug into the gravel and filled with soil to serve as wicks. The gravel layer should then be covered with an inch or two of straw or with plastic screen to keep dirt from plugging the gravel. One-foot-wide strips of plastic film a foot apart can also be used. The excavation should then be filled with fine sandy loam until the surface is strongly crowned. At each end of the site or of its compartments a large diameter pipe or tile should extend from above the soil surface to several inches deep in the gravel layer. The gravel should be mounded around the base of the tile. If a grid of draintile has been laid in the gravel, the standpipe should connect with it.

Water should be run into the pipes until moisture appears uniformly across the surface of the site. Where the soil is low in salt (sodium chloride), it is necessary to add stock salt at the rate of a pound per square foot to help draw moisture to the surface. The salt can be raked into the top few inches as crystals or dissolved in water and sprinkled on the surface. More salt may be required, but it is easier to add it than to remove an excess. The soil should be moist when added to the site. The moisture should be kept up to the surface in the site during the entire nesting season. Sometimes only one watering is required before the bees are active.

The size of the site depends on the acreage of alfalfa to be pollinated and the resources of the grower. Since it is unlikely that a surplus of wild pollinators will ever be developed in artificial sites, the best recommendation is to continue building and expanding them as time and resources permit. It would be advantageous for groups of farmers to pool their equipment and labor to build sites on an areawide basis.

Newly created sites can be colonized by installing blocks of undisturbed soil removed from existing sites in the spring. Steel cylinders about 1 foot long made from 12- to 18-inch well casing can be sharpened on one end and welded to a protective rim on the other. The cylinder should be cut down one side and provided with clamps to hold it together. It can be driven into a densely populated part of the site with a mallet or preferably with the hydraulic drawbar of a tractor. It can then be pried loose against an existing trench and the soil plug released from it by opening the clamps. The plug can be protected from breakage by wrapping it in bottle-wrap cardboard held in place with bands made from truck or tractor inner tubes. Another way to obtain good soil blocks is to saw them out with a chain saw or a disk saw attached to a tractor. The sawed blocks can be pried loose with cardboard cartons slipped over them.

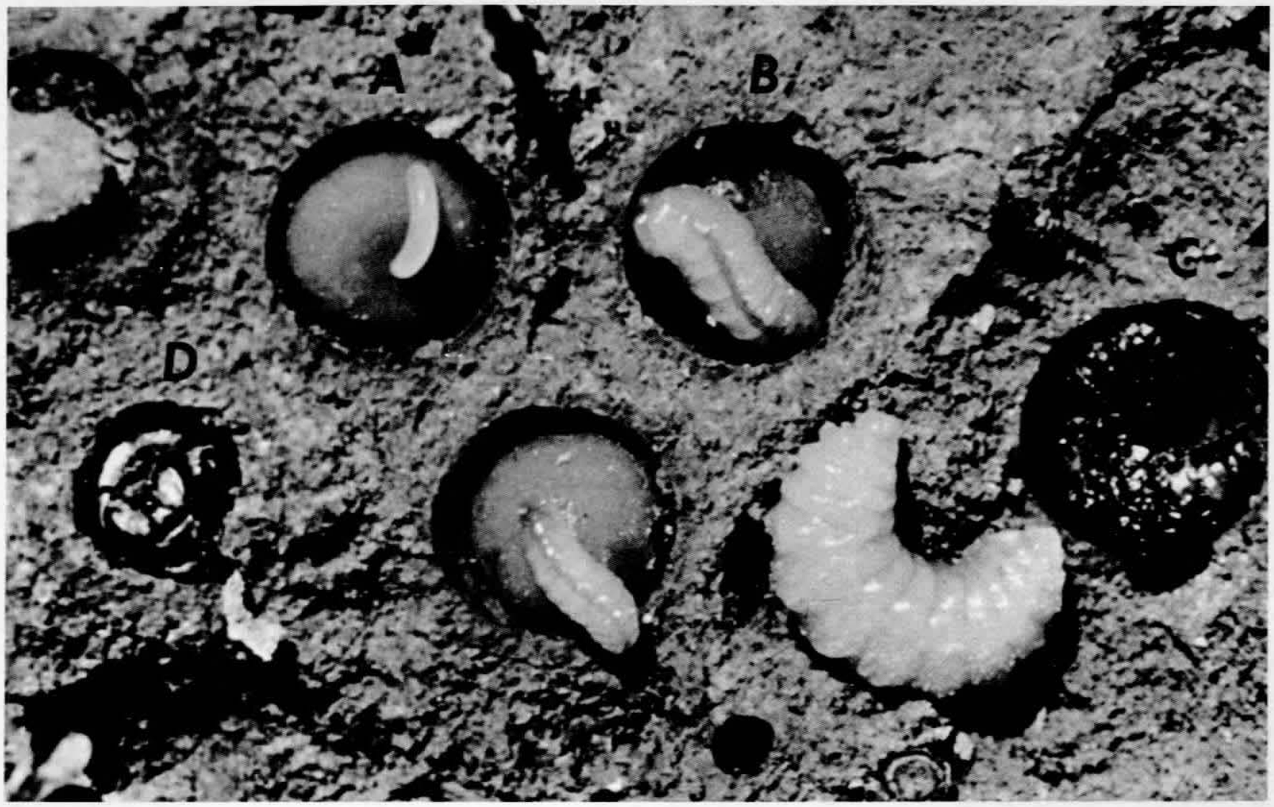
References

(1) BOHART, G. E.
1952. POLLINATION BY NATIVE INSECTS. *In* Insects. U.S. Dept. Agr. Ybk. 1952: 107–121.

(2) ———
1962. INTRODUCTION OF FOREIGN POLLINATORS, PROSPECTS AND PROBLEMS. 1st Internatl. Symposium Pollination, Aug. 1960, Copenhagen, Proc., Pub. Commun. 7, Swedish Seed Assoc., pp. 181–188.

(3) ———
1963. HOW TO MANAGE THE LEAF-CUTTING BEE FOR ALFALFA POLLINATION. Utah Agr. Expt. Sta. Cir. 144, 7 pp.

(4) ——— and KNOWLTON, G. F.
1962. MANAGING ALKALI BEES FOR ALFALFA POLLINATION. Utah State Univ. Ext. Serv. Leaflet 78, 2 pp.



BN-30054

FIGURE 8.—Alkali bee nest (horizontal section at cell level): *A*, Egg on pollen ball; *B*, growing larva; *C*, diseased larva; *D*, adult in main burrow.

(5) ——— and NYE, W. P.
1956. BEES. FORAGING FOR NECTAR AND POLLEN. Gleanings Bee Cult. 84: 602–606.

(6) ——— and NYE, W. P.
1956. BEES. NESTS AND NESTING SITES. Gleanings Bee Cult. 84: 468–472.

(7) ——— and NYE, W. P.
1956. BEES. THEIR PLACE IN THE WORLD OF INSECTS. Gleanings Bee Cult. 84: 265–268.

(8) ——— and NYE, W. P.
1956. BEES. THE TOOLS OF THEIR TRADE. Gleanings Bee Cult. 84: 400–405.

(9) ——— and NYE, W. P.
1956. KINDS OF BEES. Gleanings Bee Cult. 84: 331–333.

(10) ——— and NYE, W. P.
1957. BEES. THE NURSERY. Gleanings Bee Cult. 85: 82–87.

(11) ——— and PEDERSEN, M.
1963. THE ALFALFA LEAF-CUTTING BEE, MEGACHILE ROTUNDATA (F.), FOR POLLINATION OF ALFALFA IN CAGES. Crop Sci. 3: 183–184.

(12) ——— and TODD, F. E.
1961. POLLINATION OF SEED CROPS BY INSECTS. *In* Seeds. U.S. Dept. Agr. Ybk. 1961: 240–246.

(13) HOBBS, G. A.
1965. IMPORTING AND MANAGING THE ALFALFA LEAF-CUTTER BEE. Canad. Dept. Agr. Pub. 1209, 11 pp.

(14) ——— NUMMI, W. O., and VIROSTEK, J. F.
1962. MANAGING COLONIES OF BUMBLE BEES (HYMENOPTERA-APOIDEA) FOR POLLINATION PURPOSES. Canad. Ent. 94: 1121–1132.

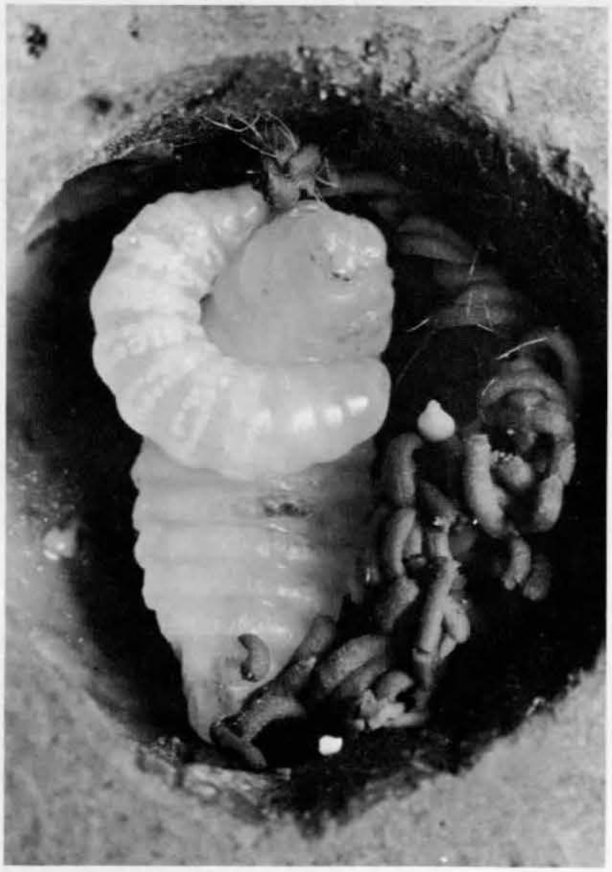
(15) HOLM, S. N.
1960. EXPERIMENTS ON THE DOMESTICATION OF BUMBLEBEES (BOMBUS LATR.) IN PARTICULAR B. LAPIDARNIS L. AND B. TERRESTRIS L. Roy. Vet. and Agr. Col., Copenhagen, Ybk. 1960: 1–19.

(16) KNUTH, P.
1906. HANDBOOK OF FLOWER POLLINATION. (Transl. by J. R. Davis.) 2 v. Clarendon Press, Oxford.

(17) MEEUSE, J. D.
1961. THE STORY OF POLLINATION. 243 pp. Ronald Press, New York.

(18) MICHENER, C. D.
1944. COMPARATIVE EXTERNAL MORPHOLOGY, PHYLOGENY, AND CLASSIFICATION OF THE BEES (HYMENOPTERA). Amer. Mus. Nat. Hist. Bul. 82, pp. 151–326.

(19) MUESEBECK, C. F. W., KROMBEIN, K. V., TOWNES, H. K., and others.
1951. HYMENOPTERA OF AMERICA NORTH OF MEXICO SYNOPTIC CATALOG. U.S. Dept. Agr. Agr. Monog. 2, 1420 pp.



BN-30057

FIGURE 9.—Third-instar larva of bee fly parasite feeding on alkali bee prepupa. (Artificial cell—fecal pellets not in natural position.)

(20) NOGUEIRA-NETO, P.
1953. A CRIAÇÃO DE ABELHAS INDÍGENAS SEM FERRAO (MELIPONINAE). 280 pp. Chacaras e Quintais, Sao Paulo, Brazil.

(21) PLATH, O. E.
1934. BUMBLEBEES AND THEIR WAYS. 210 pp. Macmillan Co., New York.

(22) SLADEN, F. W. L.
1912. THE BUMBLE-BEE. 283 pp. Macmillan Co., London.

(23) STEPHEN, W. P., and EVANS, D. D.
1960. STUDIES ON THE ALKALI BEE (NOMIA MELANDERI CKLL.). Oreg. Agr. Expt. Sta. Tech. Bul. 52, 39 pp.