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SYMPOSIUM ON BENEFICIAL AND HARMFUL INSECTS
IN ALFALFA SEED PRODUCTION
F. E. Todd and R. L. Parker, Chairmen

BENEFICIAL INSECTS IN RELATION TO ALFALFA-SEED PRODUCTION IN UTAH

By George E. Bohart[1/]

Parasites and Preadators of Injurious Insects

Except for pollinators, insects beneficial to alfalfa have received scant attention in Utah. However, the effect of DDT dusting for weevils on the braconid wasp Bathoplectis, a parasite of the alfalfa weevil, has been studied by F. V. Lieberman and S. J. Snow. Their findings are included in the report delivered to this group by C. M. Packard.

The following parasites and predators are commonly encountered in alfalfa-seed fields, but their significance has not been evaluated:

1. Blister beetles (Epicauta spp.): Predators as larvae on grasshopper egg masses; feeders as adults on alfalfa flowers.

2. Flesh flies (Sarcophaga spp.) and tachina flies (Larvaevoridae): Parasites of cutworms, army worms, and grasshoppers.

3. Predaceous bugs (Nabis ferus Linn): Predators on Lygus bugs and pea aphis.

4. Minute pirate bugs (Orius insidiosus Say): Predators thrips and red spiders.

5. Syrphus flies (Syrphus, Sphaerophoria, etc.): Predators on pea aphis.

6. Ladybird beetles (Coccinella, Hippodamia, etc.): Predators on pea aphis.

7. Thrips (Thysanoptera): Several genera have been observed, some of which are probably predators on red spiders and injurious thrips.

1/ Bureau of Entomology and Plant Quarantine, Agr. Res. Admin., U.S.D.A., in cooperation with the Utah Agricultural Experiment Station.

Special study would greatly expand the number of species in this list and elucidate their value as enemies of injurious insects. Studies on the effect of various insecticide applications on populations of many of the predaceous and parasitic insects in alfalfa fields should also be undertaken.

Insect Pollinators[2/]

In Utah and Southern Idaho, bees are the only effective cross-pollinators of alfalfa. Blister beetles (Meloidae) and sand wasps (Bembicidae) have been seen to trip blossoms, but in these instances cross-pollination may not have been effected. East of the Rockies in scattered localities effective pollination by the soldier beetle (Chaulignathus) has been reported, and at various localities, mostly southern, a genus of scoliid wasps (Campsomeris) has been reported as a scarce but fairly efficient pollinator.

About 50 species of bees have been found to visit alfalfa in Utah and southern Idaho. Only about 20 of them are considered either actually or potentially significant in the production of seed crops. Numerous species of very small bees, such as Hyaeus and the smaller Halictus, are not considered to be important, because they visit only flowers already tripped. When these flowers have already been cross-pollinated, no advantage is to be gained by the additional visits. The possibility remains, however, that mechanically tripped flowers may be cross-pollinated by these bees. Other bees, such as Agapostemon spp. and Melissodes spp., are of little importance, because the males, although often abundant on alfalfa, trip few flowers and the females are rarely seen on alfalfa.

Of the wild pollinators, bumble bees (Bombus spp.), leaf-cutter bees (Megachile spp.), and alkali bees (Nomia melanderi Ckll.) have been the most consistently present in significant numbers.

Honey bees (mostly from commercial hives) have been by far the most abundant pollinators in nearly all fields observed.

Pollination by Honey Bees

Honey bees generally collect nectar and pollen in separate field trips and thus may be classified as nectar collectors or pollen collectors. Nectar collectors usually take nectar by entering the flower from the side without tripping it. However, they trip a variable, but usually small, percentage (commonly from 0.5 to 2 percent) of the flowers visited. Under certain conditions this rate is radically increased. Pollen collectors enter the blossom through the throat and nearly always trip it. In

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2/ In Utah these studies are being carried on primarily by the U.S. Department of Agriculture, Legume Seed Research Laboratory, at Logan. Honey bee investigations are carried on by F. E. Todd and W. P. Nye, wild bee investigations by G. E. Bohart, and the relation of the plants to pollinators by M. W. Pedersen some fields they may visit a number of flowers in succession for nectar but confine most of their visits to pollen collecting.

In some areas, as for example certain fields in Millard County, Utah, pollen collectors may represent 20 percent of the total honey bee population in the field, but in most of the northern Utah and southern Idaho areas this percentage is much smaller, usually less than 1 percent.

Competition from flowers more attractive than alfalfa as a pollen source is generally considered to be the reason for the rarity of pollen collecting from alfalfa. In Cache Valley, Utah, and farther north, gumweed, sweetclover, mustard, corn, goldenrod, and aster are common sources of pollen. In central Utah pollens of greasewood, Iva, Dondia, salt grass, and sunflower are usually collected along with alfalfa pollen. Scattered stands of corn and gumweed also compete as a source of pollen in this area. At Delta as much alfalfa pollen is collected in small seed areas surrounded by wild competitors as in the center of large acreages of clean alfalfa.

Why do honey bees collect alfalfa pollen so readily at Delta in spite of the presence of many competing pollens? Perhaps the competitors are about on a par with alfalfa in attractiveness, or perhaps the alfalfa pollen itself is more attractive at Delta than it is farther north. Weed eradication for a 1-mile radius around an apiary in Cache Valley apparently failed to effect a significant increase in the amount of alfalfa pollen collected. Therefore, competition is apparently not the only factor involved in the difference between Delta and Cache Valley areas. That competition is the ultimate factor, however, has been demonstrated this year in Cache Valley, where 75 percent of foraging bees continuously confined to caged plots of alfalfa became pollen collectors.

The significance of the foregoing discussion may be pointed up by the following questions and answers:

1. Can nectar-collecting honey bees alone give adequate pollination?

   Answer: Yes, provided that the field is supplied with as many bees as it has nectar for, and that it is kept in good condition for the long period such pollination requires.

2. What are the principal advantages of pollination by pollen collectors?

   Answer:
   a. Fewer bees are required.
   b. The time required for protection from drouth and injurious insects is shorter.
   c. Plants mature more evenly. There is generally less lodging and regrowth.
   d. There may be less danger of frost damage to late crops. However, early pollination may not advance the date of seed maturity.
   e. With less blossom drop there is likely to be more ultimate set of pods.

3. What can be done to increase tripping by nectar collectors?

Answer: No answers have appeared. However, the following observations are suggestive:

a. Flowers which have been protected from bees increase the supply and sugar concentration of their nectar. Upon subsequent exposure they attract more bees and the tripping rate is somewhat higher than before the protection period.
b. Tripping is sometimes greatest close to the hives.
c. Tripping is often greatest at the beginning and at the end of the flowering season.
d. Some varieties of alfalfa attract more nectar collectors than others, but "easy-tripping" varieties do not seem to get increased cross-pollination.

4. What can be done to increase the proportion of pollen collectors?

Answer: No definite answer has appeared, but the following thoughts may be pertinent:

a. Elimination of competing pollen sources would have to be complete and far-reaching.
b. In some areas bloom could be timed with periods of competitor scarcity.
c. Some evidence that the alfalfa pollen itself may vary in attractiveness to bees suggests possibilities of altering its properties by agronomic practices of selective breeding.

The Relation of Beekeeping to Seed Growing

Through a gradual educative process, seed growers are coming to realize their need for bees. Beekeepers in turn depend largely upon alfalfa-seed fields for honey production in areas where alfalfa seed is a major crop. Mutual financial benefit is therefore essential, but the burden of creating such a condition rests primarily with the seed grower, since the migratory beekeeper can move elsewhere when his profits disappear.

Seed growers can conduct insecticide programs in such a way as to benefit instead of damage bee colonies and honey yields. DDT, chlordane, benzene hexachloride, parathion, arsenicals, and several other poisons have caused marked damage to bees when applied to alfalfa in bloom. Generally the three most destructive insects, i.e., weevils, *Lygus* bugs, and grasshoppers, can be controlled before the bloom stage, and with adequate pollination a good crop can be set before additional control is necessary.

There may be an inverse ratio between honey yield and seed yield. In other words, a rapid seed set tends to restrict blooming and should thus tend to limit the honey crop. If this proves to be a valid and generally applicable ratio, some form of subsidization or profit sharing may have to be devised.

Pollination by Wild Bees

Most of the work on pollination by wild bees has concerned the abundance, distribution, and tripping efficiency of the various species. These studies have clearly shown that, although many species are efficient alfalfa pollinators, they cannot be depended upon to appear in effective numbers where and when they are needed. Some of the better pollinators--*Megachile*, for example--always collect pollen and may trip as many as 40 flowers per minute. On this basis, bee for bee, the wild bees may be 100 to 200 times as effective as nectar-collecting honey bees and 2 or 3 times as effective pollen-collecting honey bees. It speaks eloquently for wild bee scarcity that, in most areas we have observed, honey bee pollination predominates.

In Utah and southern Idaho about 20 species of wild bees have been found to be sufficiently abundant and efficient as pollinators, at least in certain fields, to increase pollination materially (table 1). Members of the genera *Bombus* (bumble bees), *Megachile* (leafcutter bees), and *Nomia* (alkali bees) are generally the most important. *Osmia seclusa* Sandhouse and *Halictus rubicundus* Christ. rank next. It can be seen that each of these bees has its areas and seasons of greatest abundance. Most of them have also fluctuated in abundance from year to year. Consequently, wild bee pollination in a particular field is usually accomplished primarily by one or two species. In a few fields as many as half a dozen species were involved.

How May Alfalfa Seed Fields Be Better Supplied with Wild Bees?

The following are some of the obvious lines of approach. Details have not been worked out for accomplishing any of the methods with our species of bees and some of them will be likely to prove impractical with certain species.

1. Grow seed in areas where wild bee species exist in effective numbers. Acreage might need limitation to avoid "spreading the bee population too thin." Avoid destroying natural nesting sites by cultivation and irrigation practices.

2. Time the alfalfa bloom to coincide with maximum wild bee populations.

3. Increase the numbers of wild bees in existing seed-growing areas by the following methods:
   a. Prepare and maintain ideal nesting sites; stock these sites, if necessary.
   b. Increase bees for stocking purposes by off-season breeding in the absence of natural enemies.
   c. Increase the range of valuable species by introducing them to new areas.

Table 1. Principal wild bee pollinators of alfalfa in Utah and southern Idaho.

Species of Bee	Areas where most abundant on alfalfa	Seasons of greatest abundance on alfalfa
Apidae:		
Bombus mormonorum Franklin	Cache Valley, northward	Late July, August
morrisoni Cresson	All areas	Late July, August
huntii Greene	All areas	Late July, August
occidentalis Green	Cache Valley, northward	Late July, August
Anthophoridae:		
Anthophora urbana Cresson	Millard County	July
Tetralonia edwardsii Cresson	Cache Valley	June
Melissodes spp.	Scattered areas near virgin country	Early, late July
Megachilidae:		
Megachile perihirta Ckll.	Cache Valley, northward	July, August (esp. Aug.)
dentitarsis Sladen	Millard County	July, August
onobrychidis Ckll.	All areas	July, August
texana cleomis Ckll.	Cache Valley, near Downey, Idaho	July
coquilletti Ckll.	Cache Valley	July, August (esp. Aug.)
Osmia seclusa Sandhouse	Cache Valley, near Downey, Idaho	June, July
Halictidae:		
Halictus rubicundus Christ	Cache Valley	June, early July
sisymbrii Ckll.	Scattered areas near virgin country	June, early July
Agapostemon cockerelli Crawford	Millard County	June, early July
virescens Fabr.	Cache Valley, southern Idaho	July
Nomia melanderi Ckll.	Flat lands of all major areas	Late July, August (Sometimes early July)
Andrenidae:		
Andrena prunorum Ckll.	Cache Valley, near Downey, Idaho	June, early July

When one considers that each species of bee has its own habits and living requirements, and that these have not been carefully studied for any species, it is apparent that any solution to the problem of increasing pollination by wild bees must have many aspects and require considerable time. Consider, for example, Osmia seclusa. This small greenish-black bee is an efficient pollinator of first-crop alfalfa bloom in most parts of Cache Valley. At first it was thought to nest in dense aggregations in certain road cuts, but in 1947 the road-cut bees were found to belong to three other species. Osmia seclusa was identified in the winter of 1947-48, but no literature concerning its habits could be found. Late in June 1948 it was seen to cut small leaf pieces from a genus of mallow (Sphaeralcea) which grew adjacent to an alfalfa field. Careful search in the area revealed one bee entering the nest of a turret-making bee (Diadasia), a pollinator of Sphaeralcea. Of 30 Diadasia burrows examined, 6 contained nests of Osmia seclusa. Suggestions for means of increasing this Osmia are at once evident, but following them up with trials would require several seasons of intensive work. Such trials, even if attended with some success, would shed little, if any, light on problems concerning other wild bee pollinators.

The following brief resumes indicate the present status of our studies and some of the lines of attack we have employed:

1. Nomia melanderi: A gregarious species, which nests in moist, flat lowlands.

   Blocks of soil containing overwintering larvae were successfully moved from Idaho to Cache Valley, and emergence in the new locality was satisfactory. Individual larvae were also transported in small holes drilled into wood blocks. Good emergence was obtained from a set of holes that were lined and sealed with beeswax.

   Attempts to establish new aggregations of the bees in soil of various types in Utah were generally unsuccessful. Addition of various amounts of calcium chloride and sodium chloride to the soil raised the moisture content slightly, but did not attract the bees for nesting purposes. Most of the bees that emerged in the experimental area either disappeared or nested in the small soil blocks from which they emerged.

2. Bumble bees: Colonial species, the colonies of which die out in the autumn and are built up each spring by fertilized overwintered queens.

   Fifty-four domiciles of various constructions and containing various nesting materials were placed in the field in the spring to attract queens for colony establishment. Eighteen of the domiciles were accepted by the following species:

Bombus huntii Greene - 9	Bombus fervidus Fabricius - 2
Bombus morrisoni Cresson - 3	Bombus occidentalis Greene - 1
Bombus nevadensis Cresson - 2	Bombus rufocinctus Cresson - 1

   About half of the colonies reached maturity and produced males and new queens at the end of the season. The others fell victim to flooding, parasites, vandalism, and death to the queens from unknown causes.

One vigorous colony of Bombus morrisoni was utilized in a large cage to test the attractiveness of various clones of alfalfa. This colony performed perfectly in the cage, responded well to feeding with diluted honey, and produced about 35 queens which were promptly fertilized by males.

3. Megachile (leaf-cutter bees): Solitary bees which line their brood cells with leaf pieces. Some species nest in beetle burrows and other holes in timber.

   Slabs of wood drilled with holes of various diameters and depths were set in likely locations in the field to attract these bees for nesting. Although several species known to nest in wood were seen in some of the locations chosen, none of the slabs were utilized by them. Several species of bees of the genus Osmia (but not alfalfa-pollinating species) nested in them readily.

Effect of Insecticides on Wild Bees

Only a few specific tests with insecticides have been made on wild bees. Results from field tests are generally inconclusive because a sufficient number of nests of bees visiting the treated fields cannot be put under observation. Counts of bees in the fields before and after treatment may measure nothing more than repellency of the material.

More complete measurements were made on the toxicity of DDT to Nomia melanderi Ckll. near Delta, Utah, in 1947 and 1948. Although results of this year's test have not yet been analyzed, it can be stated that definite kill was caused by an early morning application of 3-percent DDT dust at the rate of 20 pounds per acre, as indicated by the appearance of dead bees at the nest entrances and by a sudden dropping off of about 15 percent in the number of active nests. Field counts in the tests showed that the DDT, as applied, was less repellent to Nomia than to honey bees.

Bumble bees and leaf-cutter bees are apparently not repelled by DDT, according to the field counts made before and after dustings. However, after a sufficient contact period they show the same uncoordinated behavior as honey bees. Consequently, it appears likely that they are even more endangered by dusting operations. In solitary genera such as Megachile, it is also significant that death of a female field bee stops progress on her nest and generally leaves it unprotected.