raising of cattle pays better than mules. The question is then a mere question of profit. And if $100 invested in bees will give a larger profit than the same amount invested in most branches of agriculture, then the first objection will be answered.

A farmer located in any average agricultural district in Michigan can purchase ten hives of bees (and if not in movable frame hives can transfer them to such), an extractor, honey knives, bee hat, and other necessary appliances at a total cost of not over $100. The time necessary to care for them each season would not exceed in the aggregate 20 days, at say $1.50 per day, being $30. Now what will he receive in return? Judging from my own experience and that of others who have practically applied the improvements in bee-culture made in the last 20 years, he will obtain not less than an average of 75 lbs. of surplus per hive, making 750 lbs., worth at least 12½c. per ℔., or $93.75; deducting the value of the labor, and he has $63.75 as a profit on the original investment of $100—an income of 63¾ per cent. Aside from this in most years there would be an increase in stocks which would offset any losses which might be suffered in wintering.

But is not the above estimate too high? Let us see. During the past year—and it was not above an average honey season in my section, linn or basswood yielding but little honey—from 29 hives, 20 of these being in box hives, I obtained 2,000 lbs. of honey and 25 new colonies. In one season previous, being desirous of ascertaining just what a number of colonies would produce if attended to carefully, and increase of colonies prevented; 17 hives averaged 125 lbs. of extracted honey each. I am satisfied the estimate is not too high, but the profits might be often larger in extra seasons. Of course my estimates are made on the supposition that the system of management is in conformity with the improved methods, and not on the old plan. I think I need not waste any time in presenting evidence that the profits above mentioned are larger than those secured in most branches of agriculture, and shall assume that the first objection is answered.

The second objection—the fear of being stung—is certainly a very *feeling* objection; and a warm reception by a score or more hybrids, without protection, would put a large majority of persons to flight, but fortunately such cases are rare, and with the use of the bee hat all danger is avoided. Occasionally there is a person who is so seriously affected by the virus of a bee that it would be imprudent for him to have anything to do with them; but we find only one such person in a thousand. Many persons care little for the sting of a bee, scarcely more than for the bite of a mosquito.

The fear of being stung is a small objection, and the pain and inconvenience is one of the unpleasant features of the business, and what business has not its disagreeable points? Crops fail, all kinds of stock are subject to disease and accident; pear trees are struck with the blight, the curculio destroys the plums, even the dog runs mad.

The third objection—a lack of knowlege of how to manage them—is the most serious one. The first two are merely used to avoid giving the true reason which would involve an acknowledgement of ignorance, which unfortunately, we oftimes hesitate to make. It is a fact not to be disguised that the successful keeping of bees requires careful study and prompt and timely care, as much perhaps as any branch of agriculture; but happily the bee-keepers of the U. S. have been a public-spirited and unselfish class, and through the medium of our bee journals, pamphlets, and books, have placed within easy reach of all people, a full and complete knowledge of the vast improvements made in the management of the apiary during the last ten years. And what more pleasant way can the farmer employ the long winter evenings than in making himself, his wife, sons and daughters, familiar with "Langstroth on the Honey Bee," "The Mysteries, by Quinby," and the equally valuable and still later information contained in the journals of to-day. In this manner the natural history of the bee and the theoretical management of the hive can be pleasantly obtained. And not only this, but the boys will be influenced to spend their earnings at home instead of at the village store or saloon; and another avenue of enjoyment and profit will be opened for our farmers and their sons and daughters.

Now, shall farmers keep bees? While the majority of them do not, and probably will not, yet I unhesitatingly reply that they should. It is a true saying that "The man who loves his bees, loves his home." And if our farmers could be induced to make themselves familiar with the wonders of the hive, I am certain that an enthusiasm would be aroused which would give us many skilled entomologists, a new interest would attach to the home circle, vice would be avoided, and a new element of profit would be introduced in agriculture.

A. B. CHENEY.

Reciprocal Benefits of Bees and Plants.

READ BEFORE THE MICH. CONVENTION.

The mutial benefits of insects and plants are wonderful, varied, and manifold. With some plants, like Indian corn, pines, and spruces, the wind is the prominent agent in distributing the pollen. To atone for this imperfect method and the great waste likely to follow, nature secretes a profusion of the fertilizing dust. In the case of the trumpet-creeper and many tropical plants, the humming bird often transfers pollen from flower to flower. In some instances snails do a similar work; in others, water, as in the case of our ell-grass. In many cases flies, butterflies, moths, beetles and bugs are very efficient in the same good work. Hornets, wasps, bumble-bees, and especially honey-bees, are also frequent visitors to the flowers of plants for the purpose of collecting the pollen and nectar for themselves and for their young. Of all insects, the hive bees and their allies show the most intelligence in their behavior towards plants.

The flowers of our willows and poplars are of two kinds—male and female. The flowers are on distinct trees which are often separated by considerable distances. In some cases the pollen may be transferred by the wind, but in most cases it is undoubtedly carried by the bees which are very active while the flowers are fresh in early spring. The flowers of all our mel-

lons, pumpkins, squashes, cucumbers and gourds are of two kinds on different portions of the same plant. The flowers are each furnished with a long or rather deep corolla in many cases, and the plants often lie flat on the ground where the leaves cover the flowers from the action of the wind. Bees and other insects are the necessary agents in crossing the flowers, and to them we are indebted as one of the links in the chain which affords all our gourd-like fruits. In nature there are many other examples of plants in which the two kinds of flowers are separate, as in oak, chestnut, beech, hazel, walnut, hickory, and many more. But how is it with most of our flowers which are perfect, *i. e.*, those having both stamens and pistils? I should have mentioned that notwithstanding the stamens and pistils are near each other on trees of the chestnut, and the pistils are evidently abundantly dusted with pollen, yet no fruit sets unless two trees are somewhere near each other, that the pollen of one tree may get upon the pistils of the other. In such cases the flowers of the two trees fertilize each other. The same is said to be true with one stalk of corn in a distant field. I intend to try this more fully the coming season, and in a similar manner test many other plants singly, to see if they will produce seed, and whether the quantity and quality are good. Most of our cultivated strawberries have perfect flowers, and may be self-fertilized, at least to a great extent; but the Hovey, green prolific, and some others, have poor or abortive stamens. That they may be fruitful, it is the practice to mix the plants with the Wilson or some other plants bearing perfect flowers. The bees carry the pollen and take the honey.

But how is it with the majority of perfect flowers which have good stamens and good pistils in the same flower? In many of these the pollen is applied to the stigma by insects, and such flowers are rendered more fruitful by these insects than they would be if the flowers were left to themselves. This has been proven by experiment to be the case in many instances, though some flowers are no more likely to seed with the help of insects than without. Very many of our perfect flowers present or ripen the anthers a day or so before the stamens are ready. Such are the lobelias, campanulas—most all the compositæ which includes about one-ninth of all the flowering plants of this part of the country. The last order includes the sunflower, aster, golden-rod, dandelion, etc. Flowers of spilobrium or willow, herb, and clerodendron, thrust the stamens out straight when ripe, while the miniature stigma is curled back and unopened. On the following day, after the pollen is gone, the stigma straightens out and opens. In the case of clerodendron, the stamens curl back when the style straightens. The stigmas are the brides too late for the marriage of nearest relatives, for the pollen or bridegrooms have been carried off by the insect priests, and may be wedded to others not related or not very nearly related. All plants producing the ripe anthers before the stigmas are *protandrous*. Many others are *protogenous*. They present or ripen the stigmas before the anthers shed pollen. Of such we have the rib-grass or *plantago*, forget-me-not, scropularia.

[Full explanations are useless without illustrations. The Professor showed many of these by figures on the blackboard and on charts.—Ed.]

We may almost say that flowers which are *protandrous* or *protogenous* are the rule and not the exception. Honey bees are the most prominent, but not generally the only insects which transfer the pollen. In the primrose of our greenhouses, Houstonia and partridge-berry and others, all the styles of the flowers on one plant, and those propagated from this by cuttings are of a certain length. They are long on some plants and short on others. On plants with long styles showing the stigma at the throat of the corolla, the stamens are inserted on the corolla below, near, or towards the base of the flower, while flowers with short styles have stamens at the throat of the corolla. Some experiments show that the plants are most productive of good seeds when stigmas of the long styles are fertilized by anthers occupying a similar position on flowers of other plants. And so of the short stigmas. The above plants are often called *dimorphous lytherum solicaria*, loose strips, and others perhaps are *timorphous*, *i. e.*, there are stamens of three different lengths, and styles—of three different lengths, long, medium and short. If a flower has a medium style it has long and short stamens; if it has a short style, it has medium and long stamens. What does this mean? Why, that bees (I have seen them at work thus) carry the pollen to the styles of different lengths by different parts of their bodies which have touched the anthers on stamens of a corresponding length which were on other flowers of other plants.

There is an endless number of special contrivances differing in plan and details in each flower or genus of flowers. Those interested are referred to Gray's "How Plants Behave," for details and illustrations of kalmia, milkweeds, orchids, iris, etc. Prof. Riley observed a small moth especially adapted to fertilizing a yucca. She laid an egg and then sipped honey, and so repeated the operation. The plant reared her young insects. She took the honey and transferred the pollen enabling the plant to set seeds. Insect and plant were useless each without the other. This is sometimes true of the striped cucumber-beetle. She eats the young plants, and, later, the pollen and honey, but she helps the plants to seed.

The flowers of *martynia*, trumpet creeper, *mimulus catalpa*, bladderwort, and others have broad flat stigmas which curl apart. When touched by a bee's head in passing in, the stigmas close in a few seconds, and cover the surface which is sensitive to pollen. While taking the honey, the bees are dusted with pollen which is just in the right place to be left on the stigma when entering the next flower. In these flowers, self-fertilization is impossible unless in rare and exceptional cases. For particulars see *American Journal of Science* for Oct., 1876, in article on the subject by the author of this lecture. Flowers of Dutchman's-pipe, some arums, and lady's-slippers, entrap and hold as prisoners different kinds of small insects which enter them. They are not prisons like Libby or Andersonville in miniature, for they treat their prisoners well, with good shelter and an abundance of food and drink of the best that nature affords. The flowers of our common flax are absolutely sterile when

close fertilized by the pollen which is ready in abundance, and often falls upon the stigma of the same flower. Bees cause the flowers to get seeds by crossing with the proper pollen. Our crop of flax seed, then, is benefitted in yield, and in some cases entirely dependent on the aid of the little busy bee. Our common garden beans are self-fertilizing to a certain extent, but the crop is more than doubled by the aid of bees.

Most or all plants are better for a cross. This is not always so apparent at first, as it is after several generations of plants raised from self-fertilized flowers. In such cases, a cross adds increased vigor and fruitfulness. Many, very many flowers you see are as plainly intended for cross fertilization as the beak and talons of the eagle are intended for catching, holding and tearing prey. Not honey bees, but little insects nearly akin, produce the galls on oak. The oak kindly receives the egg, swells up a soft succulent house and gives the young worm an abundance of food. An insect lays an egg in the stem of a golden-rod, or in the tip of a young stem of willow. A brush in one case, a cone in the other is produced to nourish the young worm and feed and shelter it to maturity. Whether these insects repay these plants for their kind reception I have not been able to find out. Paid or not paid, they have food enough and to spare for these interesting little creatures. With small bladders, the bladderwort is busy catching microscopic amimals, and retaining them till dead, and then slowly transferring the nourishing juices to the rest of the plant. Here is cruelty even among humble plants. The queer common pitcher plant of our swamps is supplied on the inside with spines pointing downwards. This is the case with numerous others on the continent. Some of them prepare a honeyed secretion which grows more abundant until the lid or open mouth of the pitcher is reached. Insects are enticed, lured on, like a tippler in the dram shop, to the open mouth of destruction. Curiously-constructed lids make the mouth dark, and help to keep the insect from escaping. Most of them cannot walk up the inside of the pitcher. They are drowned by the liquid and devoured by the carnivorous plant.

A few insects, among them a moth, is provided with sharp stiff spines on her legs which act like stilts to enable her to walk up and down among the stiff spines in the pitcher. When a boy, we used to make a box trap for squirrels and rats. To deceive them and make them waste their strength, in busily gnawing where it would not injure the trap, we bored small holes through the sides, and nailed over a piece of tin with a hole through it to let in the light. In the pitcher plant of the Southern swamps are thin translucent spots towards which the insects are attracted instead of the open mouth above which is shaded by the overshowing lid. This is one of nature's cunning traps. The *martynia* plant and others catch and suck to death with their sticky glands innumerable small insects. The venus fly trap of Carolina, everyone knows about, and very likely they have heard of the several kinds of sun-dews which catch little flies with their glands.

Honey is secreted in different parts, or by different organs of the flower. Sepals, petals, stamens, pistils, and disk, each in different flowers is found to secrete nectar. By this I mean that one kind of flower secretes honey with its petals, another kind by sepals and so on. Petals attract bees. Saunders, of Canada, cut off the petals of raspberries and by so doing made it difficult or impossible for the bees to find the honey. Individual bees have been observed to behave differently about flowers, in some respects, from a majority of bees. Some are excentric. They have their own peculiarities. Nageli put artificial flowers to branches, and used essential oil on some, and on others he used no oil. The odor attracted them to the flowers containing it. Aristotle, 2,000 years ago saw that hive bees worked continously on flowers of the same species. They even do so when the flowers are not all colored alike, as in some plants in our flower gardens. By this means they economize time. They get the hang of it. They learn how better to make more rapid motions, and to make every motion count. The same as is true of people who become expert in certain parts of any trade after much practice in often repeating the same operation. In some cases, large numbers of honey bees soon learn to glean after bumble bees, where the latter have made holes into the nectar. I have seen orioles pinching the tube of the Missouri currant or yellow currant, to get the little honey from each flower. This left a small hole which the bees were not slow to find, and frequently use as long as the flower remained fresh.

We have thus seen some of the diverse contrivances by which plants are made to secure cross fertilization. The list might be almost indefinitely extended, and yet find something different in nearly all of them. Flowers shut up, go to sleep, bend over in all manner of ways to prevent themselves from wind and weather, to retain the essential parts in a fresh condition until the time when the proper insects are likely to be about. If they are intended for the visits of moths, they open when the moths are likely to fly, and do not waste their sweetness in daylight. If, like the dandelion, they are dependent to any degree upon bees and other day insects, there is no need of their remaining wide awake all night. They had better close up as they do, and keep for the best part of several days. So you see, the honey is placed in the flowers as wages to pay the bees for serving the plants. The colors and odors are advertisements to call the attention of insects to the rich supplies of food in store for them. It may be said that the honey is there for the bees, but *primarily* it is there for the good of the plant, *secondarily* for the good of the insect. As has been said: "The flowers surpass in an incomparable degree, the contrivances and adaptations which the most fertile imagination of the most imaginative man could suggest with unlimited time at his disposal." You who like the honey bee and are so familiar with its habits and worth, will think no less of it on account of my showing its value to plants.

Had good old Dr. Watts lived in our day, and become familiar with those parts of science, he would very likely have written the familiar stanza in this way:

How doth the little busy bee,
Improve each shining hour,
By carrying pollen day by day
To fertilize each flower.

W. J. BEAL.

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