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MARRIAGE BY MICROSCOPE

(Dr. Watson's Bee Study)

A paper prepared by

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Marriage by Microscope

The honeybee is a farm animal like the cow, the horse, the sheep and the fowl; and is feminine in gender. The average layman regards her as an irascible little insect whose unwelcome presence upsets outdoor picnics and garden parties. Yet history reveals that she has been associated with great minds throughout the ages. Pliny and Aristotle kept bees, and Virgil's fourth book of the Georgics is a dissertation on bees. More books have been written about her than about any other farm animal. She has enjoyed an undisputed popularity with the agriculturalist for over three thousand years, and is an adjunct to every country estate, suburban cottage and farm. Recently, scientific interest in the bee has been greatly augmented by the important discovery made by Dr. Lloyd R. Watson, recipient of a Guggenheim fellowship, who announced a few years ago a technique for the positive control of mating in honeybees; thus opening the door to scientific bee-breeding.

The importance of Dr. Watson's discovery may best be explained by a brief sketch of what has been accomplished in the development of certain other farm animals by means of controlled mating for many generations. The little, wild jungle fowl of India bears slight resemblance to the Leghorn, Orpington or Plymouth Rock seen in poultry yards today. The Rhode Island Red is a man-made fowl synthesized from Malay, Cochin and Wyandotte ancestors. These changes have been accomplished through years of systematic propagation, during which time man has succeeded in emphasizing certain desirable qualities of poultry and eliminating the undesirable ones. Our modern, meat-producing hog bears but slight likeness to his ancestor, the wild boar; nor does the present-day dairy cow resemble closely the little, wild cow that grazed on the plains of northern Asia. But the honeybee has not been changed in any essential point since bible

times. Those preserved in amber, which have come down to us from the Miocene Age, are almost identical to the honeybee of today. This important insect, smallest of all farm animals, has been last to come under the complete domination of man. True, she fertilized his fruit trees and rendered to him great stores of golden honey; but her private life was not to be interfered with. No eugenic offspring for her! She mated indiscriminately, with whom she chose. The queenbees have differed in this respect from queens of the human race, whose alliances have been dictated for centuries. Since Dr. Watson has perfected a plan by which the mating of the queenbee is positively controlled, the bee has begun a long period of evolution, from which we may expect her to emerge as greatly changed in form and habit as were other farm animals.

Until Dr. Watson made his discovery, scientists had been searching for over 150 years for some way by which the mating of bees could be controlled. Tents had been placed over the hives in an effort to segregate the virgin queens with selected drones. One scientist tried attaching a queen to the end of a pole, by means of a gossamer thread about her leg, and allowing her to fly before the desired mate. But upon the slightest interference with their normal life, the drones became suspicious, and all desire for romance vanished. Because of the bee's diminutive size, her unyielding disposition, and her inherent proclivity for conducting her nuptials in her own way, it became obvious that if this perplexing problem were to be solved, some very unusual method must be devised. Dr. Watson conceived and carried out a plan so fantastic, that those who have seen it in operation, continue to wonder that it works.

When the time arrives for the mating of a pair of royal lovers, these bluebloods of beedom, are placed beneath the lens of a microscope, both in their appointed places. Here the brief ceremony takes place. It

cannot be said that this little romance of the laboratory ends like the fairy tales of old, "and so they were married and lived happily ever after." For the selected drone, choicest of his breed, becomes a martyr to science. With the aid of minute instruments, the queen is inoculated with his life fluid, containing perhaps a million sperms. He learns too late, however, that loving queens is dangerous business. Like many royal lovers throughout history, he loses his head in the process. To continue the analogy of a royal romance, the queen enters a cloister for the remainder of her life. One of her four wings is clipped so that she may never fly again. She is placed in a hive, and the entrance is covered in a way which allows the smaller workerbees to come and go unimpeded, but she remains a prisoner. This is to forestall the possible desire of the queen for further nuptials. After their execution, the bodies of the drones, or royal lovers, lie in state in the laboratory so that Dr. Watson may observe what progress he is making from generation to generation. During the late spring and summer, this little domestic tragedy is performed many times in his laboratory, always with the same number of characters, the same stage properties and the same plot--the brief period of passionate love, the royal lover condemned to the guillotine, and the queen entering a veritable convent to end her days. All of this sounds like the resume of a grand opera, but lest Dr. Watson be considered the villain of the piece, the Dr. Faustus of the apiary, the relation of his work to some of the vital needs of man should be explained.

For a number of years, scientific agriculture has been seeking for some little insect or organism to perform certain services for him. This little body or animal must be numerous, easily controlled by man, and obtained without difficulty, when needed. It is probable that, when scientists have completed their remodeling of the bee, she will be ideally equipped

to fulfill these duties. The development of the new bee is definite economic value to the farmer, for the cooperation of the honeybee is essential to scientific agriculture. Professional fruit growers rent thousands of hives to place in their orchards during blossom time. Statistics show that in localities where disease has greatly decreased the number of bees, some crops are poor the next season and for several succeeding years, until the bee population is again normal.

It is a popular supposition that the bee's greatest gift to man is honey. To be sure, there are 800,000 people in the United States engaged in raising honey, and the annual crop is over 200,000,000 pounds, ranging in value from \$50,000,000 to \$75, 000,000. However, the most important service of the honeybee to man consists, not in the honey she produces, but in the fertilization of bloom by transporting pollen which adheres to her legs and body as she passes from flower to flower. Practically every orchard blossom which comes to fruit, must have been fertilized by pollen from another tree. By far the most active and reliable agent for carrying on this work is the honeybee. Man can and does find possible substitutes for honey, but no substitute has ever been found for the honeybee as a pollinizing agent.

This fact has inspired Dr. Watson to breed a bee which shall surpass the ordinary bee's in ability to perform this service. For the past few years, he has been engaged in the development of what he terms a "downy bee." These bees are covered with a soft, fuzzy coat to which the pollen of the blossoms adheres, and is more efficiently carried from flower to flower. It is obvious that bees possessing this characteristic, would be superior to the common variety as pollinizing agents.

About seventy-five years ago, a mutation occurred in a hive belonging to a beekeeper in Maryland. A mutation is a sudden departure from

the normal type, which at once begins to breed true. These sport bees were covered with a coat of down extending over their entire bodies, even between their eyes. For want of a better name, their owner called them "albino bees," because the downiness was white. As no controlled mating was possible at that time, the strain rapidly became diluted with surrounding bees. Recently, Dr. Watson made a trip to that locality and spent some time examining and collecting bees. He succeeded in obtaining several specimens which still retained some of the downiness of their ancestors. These he brought back to his laboratory at Alfred, New York, and started a program of microscopic marriages, breeding the downiest sons with the downiest virgin queens. By repeating this process through several generations, he has been able not only to perpetuate, but to intensify this characteristic. The bees are again becoming quite downy, and these beautiful "platinum blondes" of the laboratory may be identified on flowers any distance from their hives.

Scientists hope to improve the bee in other ways. Something ought to be done about her disposition. Charitably speaking, she is extremely temperamental; and on occasions when aroused, she may become incorrigible. There are certain strains of bees which are comparatively mild in disposition, and it is reasonable to expect that by a systematic program of breeding, made possible by the Watson method, more docile insects will result.

The ideal bee should have a longer tongue. If this organ were 9.0 millimeters long instead of but 6.5, then millions of dollars would, in time, be added to the income of the agriculturalist. This idea may seem too extravagant to be true, but the problem of developing such a bee has been assigned to a Russian student, who is devoting his life to the work and is making excellent progress. The importance of the length of

of the honeybee's tongue is easily explained. Red clover is one of our most important forage crops, second only to alfalfa. In many localities, where the plant thrives, two crops are raised each year. The first crop grows during the moist season, and the whole plant is so luxuriant that the honeybee's tongue can not span the corolla tube and reach the nectar at its base. This crop, therefore, must depend upon a small force of moths, bumble bees and humming birds to effect the pollenization. The result is that the "set" of seed is exceedingly small and the price correspondingly high. However, the second crop of clover matures during the dry season. The plants are drawfed to such an extent that the honeybees, even with their short tongues, are able to reach to the bases of the corolla tubes and fill their hives with an excellent crop of elite honey; but, incidentally and of much more importance, the flowers are pollinated and the farmer reaps a harvest of fine seed. When crop potatoes or grain are removed from the land, the nourishment of the soil soon becomes exhausted, and must be replaced by fertilizers. On the other hand, the harvesting of a fine crop of honey takes no measurable fertility from the soil.

A study of the tongues of bees in different localities is being made, and has progressed far enough to show that their length is a variable quality, as well as a heritable one. A program of microscopic marriages between bees with longer tongues is under way, and it is probable that in time a bee will be developed with a tongue of sufficient length to pollinate red clover and other blossoms with long corollas.

Nearly all of the characteristics that the new bee will have, are already possessed in varying degrees by different races and strains of bees. In various parts of the world, where geographic conditions have compelled long inbreeding, distinct types of bees have resulted. Bees on the Island of Cypress, for example, have been unable to mingle with other bees for

centuries, and a pure Cyprian strain is found there. They are beautiful, yellow bees, and energetic honey-gatherers, but are incorrigibly cross, and cannot be readily controlled, even with smoke. The bees of Yugoslavia, the so-called Carniolans, are a pure, unmixed strain, because they are isolated from other bees by mountains on three sides and the Adriatic Sea on the other. It is claimed that they are the gentlest bees in the world. They are very industrious, but swarm excessively, depopulating the hives. The Caucasian bees of Russia are another pure strain. They are energetic workers, gentle, and hardy in cold weather; but their excessive use of propolis, or beeglue, is objectionable. One honeybee of India is small and lazy; another is large and energetic, but too ferocious to be of use to man. The Melipone bee of Central America does not sting, but has a disagreeable bite, and is not a good honey-gatherer.

The best breeding queens sell for a price ranging from \$10 to \$15. It may be truthfully said of them that "they are worth their weight in gold." A laying queen is the only mother in a hive and, during the rush season of early summer, she may lay as many as 2000 eggs in one day. Queens have been known to live six or seven years. The average life of one of Dr. Watson's queens is two or three years. In the early days of experimentation, he killed many bees, but now the marriage a la microscope seldom ends fatally for the queen, and scientists throughout the world who are using his method, are equally successful.

Bees are good travelers. Bee-breeders in all parts of the world are continually exchanging them, in an effort to develop different strains. Bees and queens are imported into the United States from China, South America, Tahiti; and even from Russia, for in spite of their present aversion to royalty, it seems that they must put up with the queenbee. When bees enter this country, they must first go to a bee "Ellis Island" situated

in Washington, D. C., and like other immigrants, remain in isolation until they are pronounced healthy. This is to prevent the introduction of dreaded bee diseases from foreign lands. When a queen travels, she is never sent alone, but is accompanied by several workerbees or "ladies-in-waiting." She rarely helps herself, and they care for her throughout the journey, grooming and feeding her. The little royal retinue travels in a tiny private car, with a dining compartment at one end, in which is stored sufficient food for the trip.

When one has some knowledge of the bee, she becomes a real personality. Dr. Watson describes her as "that independent, industrious, waspish, little aviator." Her disposition varies from mildness to irascibility, as does the human temperament. She suffers from illnesses and ailments as does man. Her short span of life is spent in her own well-ordered community, under laws which benefit the commonwealth rather than the individual. She has a positive genius for social organization. Up to the present time, at least, she seems to have no problem of unemployment. She has been "air-minded" for generations, using flying as a means of travel, when man's ambition to fly seemed but a vague dream, never to be realized.

Many of the weaknesses of the human race are possessed by bees. When a queen or a drone is to be killed, they manifest an example of mob rage as terrible as any that appear in history. There are robber bees, who would rather steal the work of industrious, law-abiding citizens than labor for honest profit. At times, bees are most intemperate. In the autumn they hang about fermenting fruit and cider barrels, where they become disgustingly tight. But their virtues far outweigh their faults. Nearly every peach, pear or apple that we consume is a gift from some industrious little bee, toiling busily throughout the late spring days, never loitering

at her task. It is lucky for man that bees are not susceptible to "spring fever."

Dr. Watson is quite as interesting as his bees. He is a member of the faculty of Alfred University, where he graduated in 1905; and though other duties have claimed much of his attention, the passion of his life has been his bees. His career is an unusual one. Always deeply interested in biology and kindred sciences, he first practiced instrumental insemination of poultry. As early as 1916; he began a diligent and systematic study, the purpose of which was to find a way to control the mating of bees. This was the subject of his thesis while studying at Cornell University, and the successful termination of his experiments earned for him a doctor's degree from that institution. The fundamental accuracy of his work is attested, not only by the fact that the Watson method, in practically its original form, is in use in many widely separated countries of the globe; but now after ten years, it remains the only practical method for controlling the male parentage of these important insects.

His home is situated at the edge of the little college town of Alfred in Western New York. It is surrounded by orchards and gardens, where on sunny days in summer, his eugenic bees drone pleasantly as they hover over the flowers. His chief relaxation, when not engaged in research, is playing the flute. He has a voluminous correspondence with apiophiles in all parts of the world. His articles on bees are translated into many languages, and reveal something of the poet, as well as the man of science. He is a quiet, kindly man and an indefatigable worker, for he says, "Nature reveals her secrets only after long, patient and intelligent wooing."

He visualizes the new bee as one of greater beauty, possessing a larger body, stronger wings, gentler disposition, superior physical strength, longer tongue, more capacious carrying stomach, and downier coat. It is to be hoped for the comfort of mankind, that while designing his new bee, Dr. Watson will not fail to eliminate the sting. Many of these changes will not occur so far in the future as might be imagined. It is an interesting fact that 150 years would be required to produce the same number of generations in the human race, that are produced in but five months of bee-breeding.

The story of marriage by microscope may be told briefly. But many skills were mastered to make this little miracle possible. First, there was acquired a wide knowledge of the bee and her mysterious ways; then, the ingenious arrangements for the ceremony; next, the tiny instruments so cunningly fashioned; finally, a perfect technique for handling the fragile organism involved, with gauzy wings so easily broken, little velvet body so easily crushed. I, who have seen it many times, am always breathless during its accomplishment. Yet when it is completed, the little queen is safe and sound. Not a hair of her silky coat is rumpled when she emerges, fully equipped to perform the service for which she was ordained, the giving of life to millions. But I have witnessed something of deeper significance than the wedding of the honeybee. The same unseen, creative forces which cause the mountains to rise and the rivers to flow, are at work in the body of this tiny creature. As they surge onward toward eternity, prevailing all life, I have watched them stayed for a moment by the hand of a man; guided by him into new, untrodden paths. I have glimpsed for a second, the strange things which will some day ensue, when man and nature work together in perfect understanding.

by Helen Cottrell

Alfred, New York

This is also the reason for the honey candy sold here. Mrs. Watson had to find a way to use the enormous amount of honey her husband's bees produced. She is the only person known to have overcome the natural stickiness of honey so it could be used as the sweetening in candy.

Mr. Watson was the first to have the idea of a carillon for Alfred and helped raise funds for the first group purchased which were the smaller bells.

When Lloyd Watson went to Cornell for his doctorate he told them he wished to work on the controlled mating of bees. They tried to discourage him and told him it had been tried for years without success and unless he succeeded in it he would never receive his doctorate. Then he answered "I will go without it." He did succeed and when the person who introduced him to receive his doctorate he said, "He is one of the best, but the most stubborn scientist we have ever had."