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Supplement to
The Art of Getting Well Bee Pollen: The Perfect Food

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Sources are given in references. Authors of contributions/quotations are alphabetically arranged; major author, if any, is underlined. Gh. Baltan, Royden Brown, G. Calcaianu, Alain Callias, Ph.D., Ernesto Contreras, M.D., Leo Conway, M.D., F. Cozma, Dr. Lars-Erik Essen, M.D., William O. Grotz, L.J. Hayes, M.D., Dr. Peter Hernuss, Petrovich Ioyrish, Noel Johnson, Remi Korchemny, Dr. Gosta Leander, G. Liebold, Dr. Izet Osmanagic, L. Pokrajcic, William Robinson, Dr. A. Saenz, Gh. Salajan, James F. Scheer, H.W. Schmidt, M.D., Sigmund Schmidt, M.D., A. Soliman, F.A. Soliman/Responsible editor/writer Anthony di Fabio.

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In the search for health one's attention is constantly drawn to the evolutionary aspects of man's nutritional needs, the so-called cave-man diet. Everyone knows that man did not have sugarcane during his stone age -- and probably the only direct source for fructose, sucrose and glucose was fruit and vegetables -- with the exception of nectar from flowers and its concentrate, honey from wild bees.

What I knew of bees and their importance to our health was virtually zero until a reading of Royden Brown's book, *How To Live The Millennium*, available through C.C. Pollen Company¹. It is clear that Royden Brown loves the products of the beehive as a hobby, a profession and, like some of us, a health nut! It is furthermore clear that Royden Brown has studied bees and their products personally, and also has had translated virtually all of the important scientific papers from every country in the world. I highly recommend that you purchase a copy of the above mentioned book for a more thorough reading. This chapter, therefore, will be limited to a generalized summary of Royden Brown's book -- of what I didn't know about bees and their products, and how those products can influence our health. The content herein and all quotes are used by permission of Royden Brown who also owns the copyright.

Background on Bees and Their Products

"Renowned healers of antiquity employed [honey, bee pollen, propolis, and royal jelly] It was when the laboratories of the world community of nations confirmed that bee pollen contains all nutrients necessary in human nutrition that an efficient way to harvest bee pollen for the use of man became a necessity.

"In the course of her work, a pollen forager [the bee] will visit as many as 1,500 blossoms. A single granule of bee pollen contains from five hundred thousand to five million live pollen spores.

"Pollen is the male seed of flowers. It is required to fertilize the plant. The tiny particles consist of 50/1000ths of a millimeter corpuscles, which are formed at the free end of the stamen. Every variety flower in the universe puts forth a dusting of pollen.

"Once a honeybee arrives at a flower, she settles on the stamen and nimbly scrapes off the powdery loose pollen with her jaws and front legs. She then moistens it with a dab of the honey she brought with her from the hive.

"When her baskets are fully loaded, the microscopic golden dust has been tamped down into a single golden granule.

". . . pollen . . . cannot be duplicated in a laboratory.

". . . raw honey in the comb is rich with pollen particles and bears little resemblance to the honey you find in the supermarket.

". . . , what was needed was a device of some kind which would dislodge a measure of the pollen as the bees enter the hive, while permitting the bees to retain a sufficient portion of the life-giving golden dust for the maintenance of the colony."

Royden Brown invented such a trap. "It is equipped with a series of scientifically-designed wire grids through which the bees must pass to gain entrance to the colony. As they make their way through the grids, approximately sixty percent of the pollen is gently brushed out of their pollen baskets. It falls through a screen into the pollen drawer situated beneath the trap.

"[The pollen trap] allows sufficient pollen to pass through the grids into the colony for the care and feeding of the hive population, and insures the harvesting of the driest, cleanest pollen possible. Moisture-laden wet pollen from low-lying humid areas ferments quickly, or develops mold. This type of pollen must be heat-treated immediately to preserve it for use. But high heat processing kills the enzymes and reduces the nutrient value considerably, transforming the pollen into a dead food.

"When bee pollen is improperly stored and handled, it will lose up to 76 percent of its nutritive value within twelve months. The only satisfactory method of preserving fresh, live bee pollen is flash-freezing at zero degrees to maintain hive-freshness indefinitely and to preserve all vitamins, minerals, and other nutrients intact. Allowing pollen to remain in the trap for as little as ten days results in nutrient loss or worse. Beekeepers who harvest for the C.C. Pollen Company are required to gather bee pollen two times per week. Each maintains a large chest-type freezer right alongside their honey extractors in the bee house. The C.C. Pollen Company mandates that all freshly gathered pollen be immediately flash-frozen in small batches.

"Honeybees have a flight range of twelve square miles and are masters at

seeking out sources of pollen and nectar.

"The population of your hive will consist of one queen, approximately 20 to 100 thousand workers, and a few hundred drones.

"There are many bee farms in the U.S. which are maintained only for their honey production. Much of this honey ends up in the supermarkets as a refined liquid sweet with all the bits of pollen and propolis strained out. Unfortunately, only a true unrefined raw honey can be classified as a nutritive food. This type of honey is getting harder and harder to find. A few unrefined honeys still find their way into supermarkets, but health food stores are the place to be certain of finding this unrefined liquid gold, cloudy and rich with suspended bee pollen.

"The C.C. Pollen Company offers multiblended bee pollen harvested in environmentally-clean areas where man has not intruded with harmful chemicals, or polluted the surrounding countryside with the by-products of civilization, such as car exhaust and worse.

"Because it would be a disaster of huge proportions if the population of their hives were exposed to some of the dangerous agribusiness chemicals, migrating beekeepers are extremely careful to place their hives with farmers who use only harmless chemicals which pose no danger to the bees. The experts say the difference in yields in fields pollinated by the bees can amount to hundreds of millions of dollars per year across the U.S.

"This bit of amber [in the American Museum of Natural History] has been dated at 80 million years, but the bee preserved inside it may be much older than that. Chemical analysis indicates that the resin components which produced this amber actually came from a family of early conifers which proliferated in the Cretaceous period, from 135 million to 65 million years ago. The grand sequoia of today is a relative of those early pines."

Bee pollen will survive in a hard encasement that surrounds it for millions of years, and is often used to date archeological sites. This husk must be cracked for human usage. The C.C. Pollen Company developed

a means for doing this without use of heat, chemicals, radiation or alcohol.

"Propolis is often called 'bee-glue.' Bees, then as now, collect propolis, take it back to the hive, mix it with flakes they secrete, and use it to chink up stray holes. Because propolis is the strongest natural antibiotic and disinfectant known, the bees also use it to insure that the interior of the hive remains hospital-clean. If a foreign object too large for the housekeeping bees to move contaminates the hive, it is coated with propolis and sealed off. This little bee [in the American Museum of Natural History] was undoubtedly on a propolis-gathering mission when she was caught and held fast in the sticky resinous sap of some ancient leafbud.

". . . experts have long theorized that bees came into being at least 125 million years ago when flowering plants began blossoming in profusion. Bees and flowers are so dependent on one another for their very existence that the experts say they must have 'invented' one another. . . . Bees must have the carbohydrates they glean from the nectar present in the hearts of blossoms, as well as the proteins they require from the pollen they collect. Fossilized remains of pollen, leaves, and even flowers have been dated back to when dinosaurs ruled the land, more than 125 million years ago.

". . . bees have changed very little in the past 80 million years.

". . . we do know that primitive man not only fought the bees for their honey, but also feasted royally on the bee pollen stored in the comb and even ate the eggs and larvae. Aboriginal tribes still feast on bee grubs and still regard bee pollen and honey as well worth the price of a few stings.

". . . every age has regarded the bee as benefactor of mankind and accords this little creature almost holy status.

"The Bible, the Talmud, the Torah, the Koran (the Code of Islam), along with the scrolls of the Orient, the writings of the ancient Greece and Rome, the legends of the Russian and Slavic people, even the relatively recent Book of Mormon (1830), all praise the industrious honeybee and

her highly nutritious and healing products of the beehive.

"Hebrew scholars of the Torah, the Old Testament of the Christian Bible, say that early translators mistakenly used 'honey' in many scriptures in place of the more accurate phrase 'products of the beehive'."

Royden Brown replaces the proper word in various biblical sentences, clearly making the meanings different when the words "pollen," "honeycomb," and so on are used, rather than the generalized inaccurate term, "honey."

The ecologists of today reckon that over 100,000 species of plants would die out and become extinct without the pollinating work of the bee. Without these plants, life as we know it, perhaps all life, would become impossible.

Health Benefits of Products of the Hive

"Writings over 2000 years old reveal that Egyptian physicians called honey the 'universal healer'. In ancient China, honey was used to treat the victims of smallpox. The sticky stuff was smoothed over the entire body of the infected person. According to old records, this very contagious and disfiguring disease was stopped in its tracks and no pitting or scarring ensued.

"In light of present day scientific studies by the U.S. Bureau of Entomology showing that typhoid germs are destroyed in 48 hours and dysentery bacteria killed in less than 10 hours, when these bacteria strains are placed in a lab dish with a bit of raw honey, those oldtime healers were onto something big. Raw honey is rich with the bee pollen particles we now know are the true source of honey's remarkable healing powers. . . . British researchers at England's Norfolk & Norwich Hospital tried raw honey to treat infected wounds with notable success. In days of old, raw honey was often the treatment of choice for dressing battle wounds." [Raw honey also contains hydrogen peroxide which explains some of its anti-microorganism status, and may also contribute to some of the health effects, according to Walter O. Grotz.: Ed.]

Bee Pollen

Contents of Fresh Bee Pollen

(Percentage follows the ingredient in parenthesis.)

Amino Acids by dry weight: Arginine (4.4-5.7), Histidine (2.0-3.5), Isoleucine (4.5-5.8), Leucine (6.7-7.5), Lysine (5.9-7.0), Methionine (1.7-2.4), Phenylalanine (3.7-4.4), Threonine (2.3-4.0), Tryptophan (1.2-1.6), Valine (5.5-6.0).

Minerals by percentage of ash: Potassium (20-45), Magnesium (1-12), Calcium (1-15), Copper (0.05-0.08), Iron (0.01-0.3), Silicon (2-10), Phosphorus (1-20), Sulfur (1), Chlorine (0.8), Manganese (1.4).

Vitamins and Hormones in micrograms/gram: Thiamine (5.75-10.8), Riboflavin (16.3-19.2), Nicotinic acid (98-210), Pyridoxine (0-9), Pantothenic acid (3-51), Biotin (0.1-0.25), Folic acid (3.4-6.8), Lactoflavine (0.2-1.7), Alpha/Beta Carotene (A) (avg. 1.53), B2 (16.3-19.2), C (152-640), D (0.2-0.6), E (0.1-0.32), Inositol (30-40), B12 (avg. .0002).

Pigments: Flavoxanthine, Xanthophyll epoxide, Carotene, epiphasic Carotenoids, Flavonols, Ethylic Ether, Quercitin, Zeaxanthine, Lycopene, Crocetin, others.

Other Components: Water (3-4%), Reducing sugars (7.5-40%), Non-reducing sugars (0.1-19%), Starches and other carbohydrates (0-22%), Etheric extract (volatile fatty acids falsify the quantitative analysis of humidity beyond 700C.) (0.9-14%), Proteins (7-35%), Free amino-acids (10%), Human Growth Hormone Factor (not measured), Hormones (gonadatropic estrogenic) (not measured), Rutin (not measured), Ash (1-7%).

Bee Pollen Miracles -- Testimonials

1. A young man had acne -- pimples and pustules -- for over five years. Tried everything without success until at last observed his brother who used 3000 mg per day. In just three days, brother's redness was almost gone. Tried it himself, and quit worrying about his complexion thereafter.

2. Middle aged man cleared up long-standing (7 years) San Joaquin Valley fever. Had tried everything. After three months of bee pollen condition cleared up at least 50 percent.
3. Forty year old woman suffered for years with serious depression. She could hardly function. After a week or so of fresh bee pollen granules, slept less. After two months, found depression gone and took long walks and did housework cheerfully. After one year on the granules, lost twenty-five pounds.
4. Twenty-eight year old, overweight by 67 pounds, easily tired, took granules for four months and started losing two to three pounds per week. No longer too tired to exercise, noticed personality changes becoming more outgoing and having more self-confidence; increased mental alertness, too.
5. Young woman of twenty-four suffered from hypoglycemia. Switched to an all-vegetarian diet and eliminated all types of sugars, including honey. Began taking bee pollen with breakfast. After two weeks noticed drastic improvement in symptoms. Another woman of thirty-eight, 20 pounds overweight, also with hypoglycemia changed from constant fear and depression to calm cheerfulness with energy.
6. Forty-seven year old diabetic at 257 pounds was diabetic. After taking insulin for five years, has not taken any now for five months. Also has not taken ulcer or arthritis medicine for one year.
7. Health-food store owner and her husband took two capsules of Pollenenergy per day at breakfast for two months. Stopped both of their snoring.
8. One person's colon infection cleared up on taking six caps per day for four weeks. Six months of doctoring could not kill the colon's bacterial strain.
9. One doctor says, "I give this honeybee pollen to all my patients. It is an excellent product. I certainly recommend it to my fellow physicians as the best of its kind."
10. Fifty-two year old man with atherosclerosis and blockage of heart chamber deemed inoperable, suffered stroke. Condition improved greatly after taking bee pollen.
11. Woman, late twenties, suffered numerous health problems: had stopped menstruating, lost hair, frequent headaches and backaches, fatigued, and sensitivity to cosmetics. On taking bee pollen had

more relaxed feeling in her body, and in just days was sleeping better. After eight months on pollen began having regular menstrual periods for the first time in seven years. Had increased strength, sounder sleep, more cheerful disposition, thicker and healthier hair, no more problems with chills. Another woman, after giving birth to last child, was depressed and hormones messed up, with irregular periods. Within three months of taking bee pollen, started having normal periods and moods leveled off. Nails started growing strong and long, and no longer split and chipped off.

12. Woman, aged seventy-two, suffered great pain from arthritis in knees, feet, hands, back and right hip complicated by osteomyelitis which had left one leg shorter than the other. Took teaspoonful of bee pollen granules before meals for thirty days, whence had more energy than for a long time. . . . At age seventy-five, and still on bee pollen, a recent physical exam found her in "text-book perfect" health with perfect blood pressure and an excellent blood analysis.
13. Male of fifty-five had had psoriasis for fourteen years. Two heaping teaspoons of granules for two months noted a reduction in areas of psoriasis, with more energy and strength.
14. Eighty-one year old former scoutmaster could not walk alone, and not far even with help. After two months on bee pollen he can now walk a mile, and does not lean on wife's arm to walk any longer.
15. Elderly lady with senility vastly improved by fresh granules daily.
16. Senior citizen feels wonderful with bee pollen.
17. Hair growing on bald spot and more energy, stable temper, loves people more, more patience, and no longer drinks beer or other alcoholic beverages.
18. Fighting radiation sickness, feels better with bee pollen.
19. Two skin lesions about face and head had refused to heal for over six months, have now vanished. More endurance, and stamina and requires less sleep.
20. Allergies much improved; no problem with irregularity.
21. Gray hair is turning back to black! Another says that thin hair is really thickened, lustrous and jet black as it used to be.
22. No longer have to get up every two hours to relieve kidneys and no longer chronic constipation or fatigue.
23. Don't take antacids anymore.

24. After taking bee pollen for ten months, arthritis of spine no longer wears me out and constant dizziness is gone; have good complexion.
25. For a year and a half suffered with eczema. Fingers cracked open and bleeding. Now healed.
26. Four pound poodle with arthritis could hardly drag himself. One teaspoon in food and he no longer suffers from arthritis. Preacher says he had arthritis in painful state in left foot and limped. Now its completely gone.
27. Leg pains gone, have lost fifty pounds and works every day of five day week.
28. Have had no cold, flu, or digestive troubles.
29. Suffers from emphysema, but now breathes more easily and is eating better.
30. Took pollen for forty-one days which took away bloatedness and is helping arthritis.
31. Seventy year old Noel Johnson, based on exercise, diet and bee pollen, was able to reverse long-standing heart condition, going from bed-ridden to champion long-distance runner, boxer and, as he describes it, stud at 80. Also lost arthritis, gout and bursitis.

Scientifically Established Miracles of Bee Pollen

A doctor wrote about a five year old child: "This is a severely developmentally delayed floppy child whose differential includes a structural abnormality in the brain or a genetic abnormality, some of which may be diagnosed by chromosome analysis or genetic screen." Parent's tried every possible approach with no improvement. The Easter Seals Rehab Center listed the child as "(1) Severe receptive and expressive speech/language delay; (2) Immature neuromotor functioning; (3) Delay in development of play/cognitive skills; (4) Questionable hearing acuity/perception; (5) Severe delays in all areas of development; (6) Severe hypotonia."

Her mother began to give Bee-Young tablets, and slow progress began: lost rag-doll floppiness, clung to mother when held. Later noted that her eyes fixed on colorful objects with interest; able to scoot body forward while sitting on couch; rolled over for the first time; reached with operational arm for articles; skin color better; able to drink from cup.

Improvement continued onward: Colleen is alert and interested in things around her -- this fact alone is "medically impossible" -- and is beginning to speak -- she smiles and laughs, loves hugs and kisses.

"A British physician rediscovered this old treatment and now successfully treats hay fever patients with his own unfiltered pollen-laden honey. He reports that during the first year of treatment, attacks are reduced. During the second year of treatment, his patients are entirely free of hay fever symptoms.

"Leo Conway, M.D. . . . treats his patients directly with pollen itself by oral ingestion, explaining, 'All patients who had taken the antigen (pollen) for three years remained free from all allergy symptoms, no matter where they lived and regardless of diet. Control has been achieved in 100 percent of the earlier cases and the field is expanding. . . . Ninety-four percent of all my patients were completely free from allergy symptoms. Of the other six-percent, not one followed directions, but even this small percentage were partially relieved nonetheless. Relief of hay fever, pollen-induced asthma, with ever-increasing control of bronchitis, ulcers of the digestive tract, colitis, migraine headaches and urinary disorders were all totally successful'."

In nutritional tests, "Hundreds of mice have demonstrated that pollen is a complete food and that it is possible to let several successive generations be born and live without the least sign of distress while nourishing them exclusively on pollen."

"Bee pollen stimulates the production of hemoglobin . . . we have noted counts rising to 4 to 4.5 million. The large proportions of free amino acids, especially methionine, a specific medicine for the liver, explains the favorable action of bee pollen on that organ.

"Bee pollen contains all the essential components of life; it corrects the failings due to deficient or unbalanced nutrition. . .

Lecture by Gunther Vorwhol at a recent German Apiarist Convention in Sontra, Germany: ". . . the vitamin balance can be improved by eating this complete food from the bee hive," but additionally, "rutin . . . favorably

influences the permeability of capillaries. . . ." and there are "important hormonal factors, substances which act like the estrogenic or gonadatropic hormones which so greatly aid the human reproductive functions, both male and female. . . ." and also, " bacteria-inhibiting effects of the pollen collected by bees. . . . medical experience teaches that the ingestion of bee pollen is recommended in the case of digestion difficulties, arteriosclerosis, and liver dysfunctions. It also improves the hemogram (blood production)."

Published in La Revue de Pathologie Generale et de Physiologie Clinique "The Physiological & Therapeutic Effects of Various Bee Pollen Extracts," Bee pollen contains "variable quantities of an antibiotic potent against E. coli and Proteus, as well as a substance which significantly accelerates healthy growth of mice receiving a complete and balanced diet from other sources. . . . the effect of bee pollen acts favorably on the intestines, on the hemoglobin level of the blood, and in the renewal of strength in convalescents and in the aged."

From the Institute of Apiculture, Taranov, U.S.S.R.: Bee pollen has a "very high content of the nucleics, RNA and DNA."

Alain Callias, Ph.D., Academy of Agriculture, Paris, France: "Bee pollen is more rich in proteins than any animal source. It contains more amino acids than beef, eggs, or cheese of equal weight."

From Techniques du Directorat des services Veterinaires: "There exists in bee pollen a principle which accelerates healthy growth. . . . Experiments have shown that bee pollen contains an antibiotic factor effective on Salmonella and some strains of Colibacillus."

From Romania, in a paper by G. Calcaianu and F. Cozma entitled, "Treatment with Bee Products of the Behavior Troubles in Young People in the Period of Puberty and Teenage," "Given regularly, bee products (pollen, royal jelly, and honey) lead to favorable results. . . . we can prevent important behavioral troubles."

In "Administration of Biological Pollen Products to the Undernourished," translated from Spanish Children's Hospital of Cordoba: [Out of thirty

children under two years of age with varying degrees of malnutrition] "red blood cells and hemoglobin increased in 14 cases; calcium increased in 12 cases; urinalysis improved in 10 cases; proteins increased in 19 children. There was an 83.33 percent improvement in appetite."

In a special reporting from Naturheilpraxis, "A Summary of Clinical Tests Concluded With Bee Pollen," . . . a reduction of cholesterol and triglycerides and also of S-lipo-proteins and albumins, while K and S globulins increase. A normalization of cholesterol count . . . in 40 patients who suffered from cerebral sclerosis. . . . A treatment with a combination of bee pollen, royal jelly, and honey has positive effects during the biological crises of puberty and adolescence, during behavioral disturbances, with problems of adjustment, learning disabilities, neurotic disturbances, and excessive neuromuscular sensitivity. . . . increase work performance and favor blood circulation in the brain.

From Department of Agriculture, "Delay in the Appearance of Palpable Mammary Tumors in C3H Mice Following the Ingestion of Pollenized Food," by William Robinson, Bureau of Entomology, Agriculture Research Administration: Mice that were bred to produce tumors were supplied bee pollen, while a control group was not. Tumor incidence was 100% in the control group after 31.3 weeks, as expected. The bee pollen group delayed onset of tumors 41.1 weeks. Seven mice were tumor free at 56 and 62 weeks when the tests were terminated. Conclusion: ". . . bee pollen contains an anticarcinogenic principle that can be added to food."

L.J. Hayes, M.D., Apiculteur Haut-Chinois, Guebwiller in Mittelwigen: "Bees sterilize pollen by means of a glandular secretion which is antagonistic to tumors."

Sigmund Schmidt, M.D., The Natural Health Clinic, Bad Bothenfelds: "Bee pollen contains all the essential elements for healthy tissue and may well prove to be the natural cancer preventive all the world is seeking."

Ernesto Contreras, M.D., cancer specialist: "To my knowledge, there is no better and more complete natural nutrient than honeybee pollen."

Dr. Peter Hernuss, University of Vienna "conducted a study of 25 women suffering from inoperable uterine cancer. . . . [Surgery being impossible, they were all given chemotherapy]. . . . The lucky women given bee pollen with their food quickly exhibited a higher concentration of cancer-fighting immune system cells, their antibody production increased, and the level of their infection-fighting and oxygen-carrying red blood cells markedly improved. . . . The control group receiving a placebo did not experience relief."

In a Yugoslav paper, "Therapeutic Effects of Melbrosin in Irradiation of Diseases," [Melbrosin is a Swedish preparation of bee pollen, royal jelly, and honey.] ". . . 84 female patients were separated from a group of tumor-dose irradiated patients who suffered from gynecological carcinoma and who showed clear signs of X-ray disease: fatigue, lack of dynamism, anorexia, nausea, vomiting, diarrhea, headache, unconsciousness, insomnia, heat and perspiration strokes, tachycardia, increased temperature, etc. . . . After taking the preparation [Melbrosin], 30.5 percent . . . had no sign of fatigue; 66.7 percent felt light fatigue; only 2.8 percent still complained of severe fatigue; 38.9 percent no longer suffered from anorexia; 41.6 percent exhibited light anorexia; 8.3 percent moderate anorexia; 44.4 percent suffered no longer of nausea; in 50 percent, nausea was reduced to the mildest form; in only 5.6 percent did the intensity remain unchanged. Great improvement was also achieved in psycho and neurovegetative complaints. . . . it was possible to conclude that improvement was obtained in 88.8 percent of the cases. . . ."

From the Argonomic Institute, Faculty of Zootechnics, Rumonia, an animal study showed the "immune-strengthening effects of bee-pollen."

From Yugoslav, by Prof. Dr. Izet Osmanagic, University of Sarajevo, "Reduced Sexual Potency:" "Summary: . . . forty patients were examined. Eighty percent suffered from relative or absolute reproductive impotence and some from reduced capacity for intercourse. . . . 1. An improvement in the general state of health and subjective condition. 2. An increase in sexual activity. 3. Improved sperm production . . . obvious proof of the positive effects of the preparation in cases of reduced sexual and procreative potency."

A joint Swedish/German study of 212 male patients using twelve different urologists, showed improvement in a variety of sexual dysfunction and chronic prostatitis.

Using Cernilton, a Swedish pollen preparation, Dr. Gosta Leander of Stockholm reported in "A Memorandum Concerning a Statistical Evaluation of the Results of a Clinical Investigation of Cernilton," stating, "... it can be confirmed that a statistically highly significant effect of the compound could be demonstrated in prostatovesiculitis, estimated on the basis of a double-blind control study of 93 patients, 50 of whom received the compound, and 43 of whom received the placebo. A 92 percent ascertained improvement was confirmed in the group given the compound. The effects of the compound found during the course of this study has been established as statistically highly significant."

From Kyoto, Japan, "Use of Cernilton in Patients with Prostatic Hypertrophy," "... Of the ten cases which showed improvement, three were in the first degree of hypertrophy, four cases in the second degree, and three cases in the third degree. In two cases, symptoms recurred within one month after withdrawal of the drug; these patients eventually underwent prostatectomy. All patients in the third degree of hypertrophy subsequently underwent prostatectomy."

A later Japanese study concluded, "Of a total of 15 cases in the Cernilton group, 10 cases were effective; 3 cases slightly effective. Results obtained in the placebo group were much less favorable; effective in 7 cases; ineffective in 9 cases." No side effects reported in the 38 cases.

Egyptian scientists, F.A. Soliman and A. Soliman, in "The Gonad Stimulating Potency of Date Palm Pollen Grains," from the French journal *Experientia*, "Several investigators have extracted estrogenic materials from palm kernels and date pollen grains. . . . a gonad-stimulating principle was extracted from pollens. . . . combined activity of the two hormones present in 1 gram of pollen is close to 10 I.U."

From Rumania, Gh. Salajan and Gh. Baltan, in "Influence of Maize Pollen on Ovulation: Results of Incubation & Biological Value of Hen Eggs," Pigs, chickens and calves, pollen protein reduced food

consumption, stimulated growth, increased ovulation, and in eggs, improved quality of incubation and the biological value of eggs.

From Yugoslavia, L. Pokrajcic and I. Osmanagic, entitled, "The Treatment With Melbrosin of Dysmenorrhea in Adolescence." [Melbrosin is a bee pollen/royal jelly compound.] One hundred and twenty 15 to 20 year old girls were included in this study which showed good results on "patients with underdeveloped constitutions and irregular menstrual cycles."

From Yugoslavia, Endocrinological Department of the University Clinic for Women at the Medical Faculty in Sarajevo, in "A Clinical Testing of The Effect of the Preparation Melbrosin on Women Suffering from Climacteric Syndrome," ". . . it may be said that in addition to causes of menopausal disturbances in general, this treatment offers justifiable indications that the preparation should be used in the treatment of all patients subjected to irradiation."

"A two-year study conducted by former Russian Olympic coach, Remi Korchemny . . . this study confirms is that bee pollen actually does improve the crucial recovery power of athletes after stressed performance."

"A study reported by Aerospace Medicine & Life Sciences proved that the average daily consumption of food falls by 15 to 20 percent when bee pollen is a regular item on the menu."

Dr. Lars-Erik Essen, M.D., . . . dermatologist of Halsinborg, Sweden, says, "Through transcutaneous nutrition, bee pollen exerts a profound biological effect. It seems to prevent premature aging of the cells and stimulates growth of new skin tissue. It offers effective protection against dehydration and injects new life into dry cells. It smooths away wrinkles and stimulates a life-giving blood supply to all skin cells."

G. Liebold, a holistic physician and psychologist of Karlsruhe, Germany, in Bee Pollen: Valuable Good Nutriment & Remedy, "Bee pollen should be used as prophylaxis and therapeutical treatment against all the disease of modern civilization. . . . Bee pollen is an excellent prophylaxis and

therapeutical treatment against all the precocious symptoms of old age. It should be considered a universal geriatric treatment in the form of a natural remedy."

Naum Petrovich Ioyrish, Chief of the former Soviet Academy of Vladivostok reported, "Long lives are attained by bee pollen users. It is one of the original treasure-houses of nutrition and medicine. Each grain contains every important substance necessary to life."

Propolis

"Propolis is the sticky resin which seeps from the buds of certain trees, the bees prefer poplar, and oozes from the bark of other trees, chiefly conifers."

Sometimes called "bee glue," propolis is blended with flakes "secreted from special glands on the underside of the bee's adomen. It is used by the bee to (1) reduce the size of the hive entrance, (2) plaster up unwanted holes to the outside, (3) cover over and sterilize dead organic matter [insects] that are too huge for the bees to remove, (4) line the interior of brood cells, (5) to keep the hive antiseptic.

Propolis offers "antiseptic, antibiotic, antibacterial, antifungal, and even antiviral properties."

Propolis was handmixed as varnish for Antonius Stradivarius (1644-1737), "for his incomparable musical instruments."

Part of the antimicrobial properties against various bacteria and fungal infections is due to galangin, caffeic acid, and ferulic acid.

Empirical evidence, testimonials, and scientific evidence for the benefits of propolis "are as many and varied as are those for bee pollen," but not widely known in the United States.

Royal Jelly

"Royal Jelly is the rich royal milk fed to the Queen bee for the whole of her life." By feeding larvae Royal Jelly, a Queen is produced, otherwise

the outcome is not a Queen bee.

"Royal Jelly, a thick fluid of creamy consistency and milky-white in appearance, "is synthesized in nurse bees' bodies during the digestion of bee pollen, accounting for its remarkable quantities of hormonal substance and the strong proteins found in its highly nitrogenous composition."

Contents of Royal Jelly

"Royally jelly is chemically very complex." Moisture content is "66.05%; proteins 12.34%; lipids 5.46%; reducing substance 12.49%; minerals. 0.82%; with unidentifiable elements totally 2.84%.

"It is . . . exceptionally rich in natural hormones, offers an abundance of B vitamins (including thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, biotin, inositol, and folic acid) plus vitamins A, C, and E. With twenty amino acids, royal jelly is a highly concentrated source of rich proteins, including cystine, lysine, and arginine. It possesses important fatty acids, sugars, sterols, phosphorus compounds, as well as acetylcholine. . . . rich in nucleic acids . . . DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) . . . Gelatin, one of the precursors of collagen. . . gamma globulin . . . immuno-stimulating factor . . . decanoic acid which exhibits strong antibiotic activity against many bacteria and fungal infestations."

Scientifically Established Benefits of Royal Jelly

From Dr. A. Saenz, Head of the Laboratory of the Anti-Rabies Institute of Montevideo, Uruguay, later joining the Pasteur Institute of Paris, in a paper, "Biology, Biochemistry & The Therapeutic Effects of Royal Jelly in Human Pathology," says:

"When those who are suffering from arteriosclerosis are subjected to royal jelly treatment, the readings correct themselves. This correction of the plasma protein dispersion thus reestablishes normal activities of the metabolic process where lipoproteins originate."

". . . very significant improvements in thromboangitis obliterans

(Buerger's disease).

"Simple stress, physical or mental exhaustion, so frequent in modern life, is rapidly corrected by treatment with royal jell.

"In manifestations of sexual involution, as well as in endocrine asthenias, royal jelly in association with classic therapies accelerates the normal re-establishment of disturbed functions by means of its action on the adrenal cortex."

Effects on weight of nursing infants is clearly evident, and improved tonic effect on child.

"Mimics [the action of] amphetamines without the harmful side effects.

"Cases of anxiety, depression, shock, and senility all benefit by royal jelly treatment . . . insomnia . . . corrected."

In gastroduodenal ulcer, "Its specific action is due especially to the presence of pantothenic acid, known to be necessary in the protection of the mucosa and the healing of ulcerations.

Several cases have been published of arthritics being helped.

"A satisfactory remission of Parkinson's disease. . .

"Several specialists have employed royal jelly treatment with success in eczema, in neurodermatitis, and in impetigo. Its use is indicated in skin ailments with a very alkaline pH. Royal jelly has an acid pH which re-establishes the acid mantle of the skin."

H.W. Schmidt, M.D., in a lecture before the German Medical Association, topic, "Royal Jelly in Diet, Prophylaxis, and Therapy," says "The action of the active substances and nutrients contained in royal jelly takes place throughout the entire body and acts to regulate all the functions of the body. . . it is apparent this is a powerful agent composed of hormones, nutrients, enzymes and biocatalysts which starts up and revives the functions of cells, the secretions of glands, the metabolism, and blood circulation. . . it is the interplay of all the

complex factors present in royal jelly which works to preserve life and strength in the organism, which delays the aging process, and which retains for as long as possible the youthful physical freshness of the body, elasticity of the mind, and psychic buoyancy."

How to Shop For Bee Pollen

1. Do not run to the nearest store and buy bee products without first learning about how they must be harvested, shipped, packaged and stored!
2. Buy bee pollen that comes from a widely varying geographic distribution, where its bulk source is from many different plants, and where the pollen has been blended and standardized.
3. 3. Do not buy flower pollen, as the bee adds to the pollen, making it nutritionally active for human use.
4. Buy only bee pollen that has been deep frozen at the site of collection, and kept dry, unpolluted and frozen until packaged. Heat-treated pollen is robbed of nutrition. Pollen collected in humid climates is often poor.
5. If you can, buy pollen collected from unpolluted sources: no pesticides, herbicides, as far away from industrial pollution as possible.
6. Your taste test should be "sweet, fresh, and delicious;" your see test should note pollens of varying shades of gold, ranging from pale straw through oranges, browns, purples, to almost black; your feel test between thumb and middle finger should be soft and springy. If it crunches in your mouth and refuses to dissolve on your tongue, it has been destroyed and has little nutrient value.
7. Insure that the husk which surrounds the pollen has been prepared for human digestion and assimilation by means other than heat, chemicals, radiation or alcohol.
8. Insure that the bee pollen purchased and used has available a listing of nutritional content, and that the content is not deficient in certain appropriate vitamins, minerals, etc.
9. Purchase from only a reputable, reliable dealer.

In the words of Health Freedom News, October 1990, "From the Forum," by James F. Scheer: "What other health product contains 185 of the

known nutritional ingredients -- 22 amino acids and higher amounts of the eight essential ones than most high protein foods, 27 mineral salts, the entire range of vitamins, hormones, carbohydrates and fats and more than 5,000 enzymes and coenzymes, necessary for digestion, healing and for the continuity of life itself?"

The Rheumatoid Disease Foundation expresses its appreciation and thanks to C.C. Pollen Company for permission to use the foregoing materials, and especially to Royden Brown who has diligently researched and applied his findings for the purpose of bringing to us the very best possible bee products.

References

1. Royden Brown, C.C. Pollen Company, 3627 E. Indian School Rd., Suite 209, Phoenix, AZ 85018-5126.

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The Do's and Don'ts of Bee Venom Therapy

Michael Broffman, L.Ac.

DO promote the use of BVT.
DON'T over-sell BVT as a cure.

DO provide assistance to those inquiring about BVT.
DON'T recommend starting BVT without the help from an experienced assistant.

DO send information on what to expect during BVT.
DON'T encourage self treatment without full understanding of proper procedure.

DO include information on risks and reactions during BVT.
DON'T suggest that full benefit always occurs right away without some adverse temporary reaction.

DO make it clear that relief from symptoms depends on each individual.
DON'T promise immediate results.

DO advise importance of test sting before BVT.
DON'T recommend BVT without test sting even if the person says they have been stung by bees before.

DO test also the person or spouse doing the treatment and others handling the bees.
DON'T forget that the spouse or new person doing stings may also be allergic.

DO insist on presence of sting kit during test sting as well as during entire treatment.
DON'T expose or subject yourself to liability or risk without a bee-sting kit present.

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very technical to read
To use bee venom therapy one must give up NSAIDs for a minimum of 2 months preferably six.

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COLLECTING AND HANDLING BEES

by Jim Higgins, AAS Member

There are all kinds of ways to collect and hold bees but I like to keep it simple. I use a 2 1/2 lb. square honey jar but any jar can work (peanut butter jars are good). If the jar is too big it becomes difficult to reach in with tweezers and get a bee.

I cut a paper towel into four equal parts, take a piece fold it in half and place it in the bottom of the jar and put some honey on it (liquid or crystallized). Now take a toilet paper tube and cut two V notches in one end and put it in the jar with the notches down. A 2 1/2 lb. Jar is just the right size and the tube will stand up and wedge into opposite corners. This gives the bees something to climb on (a piece of cardboard will also work). Put plenty of air holes in the lid.

Now out to the beehive. If your one of those beekeepers who likes a ventilation hole just below or beside the hand hold on the hive body set up your hive so its facing the rear of the hive. Now put the open jar over the hole and rub it around gently. Guard bees will come out to see what's causing the commotion and when you have collected enough bees just slide the jar over to the side of the hive and put the lid on quickly. If your gentle about it you won't disturb the hive and get stung, but always wear a veil. An irritated guard bee could sting you on the eye otherwise. Why take the chance.

If you don't use the ventilation hole on the hive body build an entrance block which solves the problem. Take a thin piece of plywood and cut it the same width as the depressed area of the bottom board (about 14 3/8" wide) by 6" high and drill a 3/4 to 7/8" hole in the center. Now nail 3/4x3/4 blocks behind both ends and one side, so that when placed at the entrance of the hive it is shimmed 3/4" away from the hive, thus allowing bees out of the hive where they are trapped on the front of the hive unless they go out the hole. Put your jar over the hole and rub it around as before and collect your bees.

Don't stand around when your done. You may also find a 3/4 x 3/4 piece nailed to the opposite side at the bottom reinforces the plywood.

As the weather cools in the fall you may find it necessary to bang on the side of the hive a bit. They know better than to come out when it's cold you know.

Near freezing and below you have to change. The bees are in a cluster and will not come out. Prepare your hive for winter by placing a 1" piece of blue Styrofoam on top of the inner lid, which has been cut to the same dimensions and place the outer lid on top of that.

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You have created a 3/8" cavity on top of the inner lid which is kept warm by the Styrofoam. Bait the area around the hole in the inner lid with a bit of your own honey, sugar, or sugar water. Much of the time you can remove the outer lid and Styrofoam and there will be a bunch of bees on the inner lid that can be scooped up with a serving spoon and put into your jar. Close the hive and return to the house. As the bees warm up they will come to life.

If there are no bees on the inner lid, with your hive tool, break the upper hive body loose and tip it back, thus exposing the cluster. Scoop up some bees as before and when you lower the hive body back into place be gentle about it.

I have done this at 20 below zero and never killed a hive of bees. The bees can live in the jar for a week very easily but make sure they don't run out of honey. Keeping them in a dark place like a closet at room temperature is best. Use a honey bear to squirt honey through the holes in the lid when they run low on honey but don't drown them.

Generally bees do not defecate in the hive and won't in the jar either but will die if held too long (so would you). You can collect a couple of hundred bees in the jar but try not to collect more than will be used in a few days or you may lose them.

If you are taking a trip and need a two week supply collect enough bees in one or two jars to take with you and be off. After a few days (less than a week) when getting to a motel for the evening, take the jar out before dark and set it down in the shade on the ground and take the lid off. The bees will fly around a bit, relieve themselves and since they are in strange territory they will return to the jar (its now home). At dark put the lid back on and go on about your day. There is no practical limit to how long you can keep bees alive by this process.

When ready to apply stings make sure you have a pair of tweezers that are at least 5 1/2" long, a spray bottle of just plain water, a marker (I use a Crayola washable marker found in every grocery store) Kleenex, ash tray and some ice.

Mark the trigger points to be stung with the marker and begin stinging at the top and work your way down (less pain that way). Ice each trigger point before you apply the stinger.

Icing acts as a local anesthesia and is highly recommended. It can be as simple as holding an ice cube on the trigger point if you don't mind getting a little wet as the ice cube melts. You can also put ice cubes in a zip lock bag and hold that on the trigger point.

I use small cans (6 pack tomato juice cans) filled with the goop taken from scotch packs (used to keep lunch boxes cool) and resealed with duct tape. These are kept in a freezer and taken out as needed. The can conducts the cold rapidly thus cooling the spot quickly and when done the can goes back in the freezer.

Crack the lid of the jar just enough to reach in with the long tweezers and grab a bee. (If the bees are real active spray them

with water and they will calm down.) Grab the bee by the head or thorax (mid section). Avoid the abdomen if possible (the rear section with the stinger sticking out the rear). You'll find it very difficult at first but with a little practice you'll get good at it. (The first time makes for a lot of laughs). Now just touch the bees rear end to the marked spot and the stinger instantly sticks in the skin (once in awhile you'll get a dud). If the pain is to severe put a finger on each side of the stinger and press (you can also rub). It will give immediate relief and only needs to be held for a short time. (Younger bees pack more wallop).

After the stinger has been in for 3 to 5 minutes the muscles of the venom sack will quit pumping and you can remove the stinger with the tweezers and put it into the Kleenex. Caution! If you remove it before it quits you can get stung through the Kleenex. Thrill! Thrill!

That's all there is to it and you'll have a better day, in most cases starting right away.

Good Luck!

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Bee-Sparing Screens for Apitherapy

by Michael Simics, AAS Member

Don't you often feel sorry for the bees that die when you use them for treatment?

One of the solutions is to use the Multiple Treatment Mesh (MTM) or Raminski's Bee Mesh. In Poland, Apimondia awarded Mr. Raminski special recognition for a lifetime of work devoted to apitherapy. Part of this work was the invention of a unique device which allowed the apitherapist to save the life of the bees used for treatment.

In 1995, his original bee mesh and its use was demonstrated by Dr. Stefan Stangaciu at the Toronto American Apitherapy Society Convention and created considerable interest in those who attended. This little device allows you to use a bee four to six times without the bee losing her stinger.

Some of the advantages are:

- it is light weight;
- the venom quantity of the venom sac divides into small portions;
- the venom amount is controlled by the therapist and patient;
- the smaller portion of venom results in less pain, swelling and redness;
- the bee will not lose her stinger—she survives and returns to her colony.

More details on the Multiple Treatment Mesh are available from Michael Simics, Apitronic Services, 4640 Pendlebury Rd., Richmond, B.C., Canada, V7E 1E7, Ph./Fax: (604) 271-9414.
E-mail: msimics@direct.ca
<http://www.beevenom.com>

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difference in observation data furnished by authors, by the different methods of bee venom application, by the different composition of preparations available and last but not least by the peculiar care paid to individual application.

In Czechoslovakia there are special reasons not to let bee venom fall into oblivion. On the one hand, it was Terc, a Czech from Vienna, who was one of the first to examine in terms of a clinical experiment the effect of bee venom on rheumatic diseases, on the other hand, the standard of Czechoslovak pharmacological research of bee venom is considerably high and the same applies to the production of a high quality, stable and reliable brand of bee venom.

The composition of bee venom is not quite exactly understood and we do not know as yet all the mechanisms of its therapeutic action. However, the most important components of this mixture of numerous substances seem to be histamine, lecithinase and hyaluronidase. Histaminic substances provoke local pain, oedema and hyperemia and act like a potent counter-irritant. This vasodilatory effect passes by the way of axon - reflexes even into the deep tissues and may exert a favourable influence upon chronic inflammation increasing the tissue metabolism and eliminating noxious inflammatory products.

Lecithinase transforms lecithine into lysolecithine (phospholipase B) which has a pronounced hemolytic effect destroying erythrocytes and other tissue cells, as well and participating perhaps in the fibrolytic property of bee venom. Hyaluronidase acts as a spreading factor depolymerizing the hyaluronic acid of the connective tissue. Other substances of protein character are carriers of antigenic properties. They exert a non-specific protein action altering the sensitivity and immunologic mechanisms of the body. The question whether the curative effect of bee venom, especially in the case of a direct bee sting, is due to other factors as well, has not yet been answered.

For the purpose of our study we used native, purified, sterile, lyophilized apitoxin Virapin Spofa A 45 in a mesocaine solution containing 2 mg apitoxin per ml. Apitoxin is in essence a product of two glands connected with the poison sac of the bee, one of them producing strongly acid components, the other weakly basic ones. This preparation is rather stable and even in solution can be kept effective for several days.

In most cases, the intradermal injection resembling a direct bee sting proved to be most effective. The effect of subcutaneous and intraarticular injection was markedly lower. Periarticular and intraarticular injections provoked an inadequately painful reaction. We applied the injections within painful sites either over the joints or muscles or along the headzones, when aiming at influencing the deeper-lying organs.

With regards to individual differences in sensitivity the treatment was started with a minimum dose of 0.05-0.1 ml. The subsequent injections were always applied only after subsidence of all manifestations of local reaction. With sensitive patients the minimum dose had to be increased very slowly. With poor reaction, the dose could be raised quickly to 0.25, 0.5 and 1.0 ml. At the spot of

puncture a papilla formed after the injection which became red, itching and burning for several hours up to several days. Stronger reaction, was accompanied by a confluent warm swelling about the injected site.

In certain patients that usual topical reaction might also be associated with side effects such as pains in other joints and other parts of the musculoskeletal system, fatigue, congestions, headaches, nausea or even vomiting, drop of blood pressure, chills and elevated body temperature. Those side effects did not impair the therapeutic efficiency in allergic subjects. The bee venom may provoke a serious shock associated with general rash and edema of the glottis which, however, responds well to adrenaline and calcium gluconate, somewhat less to antihistaminics. It should, therefore, be ascertained whether the patient was stung by a bee before and what had been his reaction. After the injections the patients were sitting for at least 15 minutes in the waiting room. The dose provoking slight or medium reaction lasting, 1-2 days proved to be the most effective. Minor systemic troubles were not considered a serious obstacle. The optimum interval between the injections seemed to be 5-7 days. More frequent applications resulted in undesirable topical and general reactions. Asthmatics, patients with allergic or drug dermatitis, acute psoriasis, febrile states with marked systemic symptoms or cachexia were excluded from this study. However, there is no absolute contraindication to local treatment with apitoxin even in cases with medium systemic activity which, as a rule, does not get deteriorated.

The observation consisted in examining carefully after each injection the signs of inflammation, subjective and objective pains, mobility of the joints and the amount of exudate when present. Two months after the treatment had been stopped all patients were controlled again and the final result of the treatment was classified according to four grades, the first signifying the total disappearance of troubles for the sake of which the treatment had been started for a period of at least 2 months, the second a marked improvement for at least two months, the third only a temporary betterment after each injection and the fourth no improvement at all or even a change for the worse. Moreover, we compared the difference between the effect of intradermic and the intraarticular injections of Virapin in 35 patients, further the effect of intradermal application of Virapin with that of intraarticular injection of hydrocortisoneacetate (HCA) and, finally, the effect of simultaneous intradermal application of Virapin and intraarticular injection of HCA. In all comparative studies Virapin and HCA had been applied alternatively in the same site after the subsidence or stabilisation of the reaction of the previous injection. We are aware of the methodologic inadequacy of such comparisons. Therefore, we tried to compensate the errors due to the natural course of the disease by increasing the number of observations. All in all, we treated with Virapin 284 patients suffering from various rheumatic diseases.

In the group of rheumatoid arthritis (Table 1) we selected patients with definitive or classical rheumatoid arthritis, according to the A.R.A. criteria, in various stages and functional classes. Most of these patients had been treated before either with gold, antimalarial drugs, corticosteroids or subjected merely to conservative measures. In most of them the course of the disease was stabilized

and the activity showed only insignificant fluctuations. By means of Virapin we tried to influence the marked signs of local inflammation responding poorly to the current treatment, i.e. torpid exudates in joints and synovial cysts, recent flexion deformities especially of the big joints, permanent pains both in joints and in soft tissues, as well as rheumatoid nodules. The general treatment was not changed during the period of observation and the evaluation of effects focused just on those changes which were decisive in selecting the patient for the experiment. The effect of Virapin on the systematic activity was judged only in rough outlines. An objective evolution was not possible as all the patients were submitted at the same time to other treatments.

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In 71 patients, first and second grade improvement was achieved in 19 (i.e. not one third). In the same number of patients no success could be observed. In more than one third of patients the improvement was but temporary in spite of many injections. The best response to treatment was that of pain, somewhat worse that of mobility and the worst that of exudations. Striking, however was the effect of Virapin in another 15 patients treated with injections directly into the rheumatoid nodules. The disappearance or marked reduction of nodules was observed in 14 subjects. Recent nodules, lasting less than a month, often disappeared after a single injection, but even large nodules, many years old, showed a marked diminution as well. When comparing Virapin with HCA, a better effect of HCA was observed in about half the cases, a better effect of Virapin in about one fourth of the cases. When comparing HCA with a combined administration of HCA and Virapin, the good effect of the combination was four times higher than that of the HCA alone.

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A Short Introduction to Bees



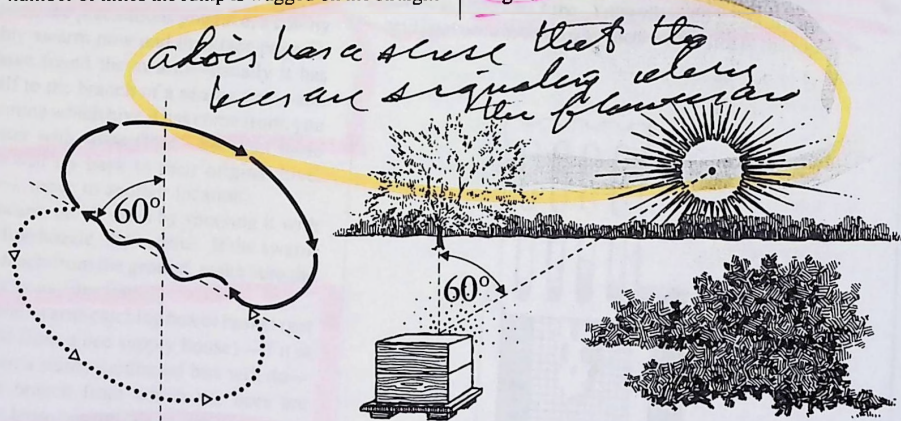
The "wag-tail dance" is used to convey information about a food source that is located more than 300 feet (100 m) from the hive.

forth. Then she circles back—without tail wagging—to the beginning of the straight line, dances along it again, and then circles back, turning the other way this time (see drawing above). The number of times the rump is wagged on the straight

line within a given time period indicates the distance between the hive and the food source. The slower the wagging, the farther away is the food source.

The sun is used by the bees as a reference point in conveying the direction in which the food is to be found. The angle formed by the line from the hive to the sun and the line from the hive to the food source is the same as the angle between a vertical line and the straight line of the dance (see drawing below). If the straight line of the dance points straight up, this means that food is to be found by flying directly in the direction of the sun.

As the position of the sun moves, so does the angle of the dance. If the sky is overcast, a small break in the clouds is enough for the bees to determine the position of the sun because they are able to detect the vibrations of polarized light in the patch of blue. Even when the cloud cover is unbroken (as long as it is not too thick), bees are able to sense the position of the sun because they sense ultraviolet light.



The wag-tail dance also conveys in which direction the food source is to be found. The angle formed by the line from the hive to the sun and the line from the hive to the food source corresponds to the angle formed by a vertical axis and the direction of the straight middle line of the wag-tail dance (the dance is performed on the surface of the combs, which hang down vertically).

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Care and Management

If the colony is queenless, the bees will enlarge some of the cells into queen cells.

If that happens, place a small nucleus with a mated queen (see page 34) into the hive. (You should always have such a nucleus in reserve.) The comb with the eggs and the started queen cells must be removed first.

There are two more methods to prevent swarming: forming an artificial swarm and forming a brood nucleus. Since both methods require mated queens, however, I describe them in connection with rearing queens (see the next column) rather than here.

How to Deal with a Swarm

In spite of all the precautions you take, a colony will inevitably swarm now and then (see page 7). Once you have found the swarm—usually it has attached itself to the branch of a nearby tree—and want to determine which hive it has come from, you dust the cluster with some flour. Some of these “white” bees will fly back to their original hive, which you now move to another location.

Wet the swarm on all sides by spraying it with water from a fine nozzle. Be careful: If the swarm is too high to reach from the ground, make sure the ladder you use is on firm footing.

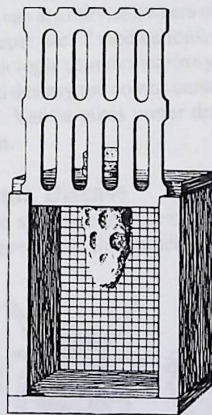
Now hold the swarm-catching box or basket (get the proper kind from a bee supply house)—if it is not raining even a sturdy cardboard box will do—and shake the branch from which the bees are hanging. If the branch is too big to shake, you can dislodge most of the cluster with a brush. Leave the box or basket with the bees in it on a stand or step-ladder underneath the branch from which the cluster was hanging.

By evening all the bees will have moved into the catching container, and you will be able to transfer them into a new hive by giving the box or basket a good shake. With a movable-frame hive, you take out some of the combs, shake the bees in from the

top (see page 22), and then replace the frames. With a leaf hive you work from behind. Attach the tray in back, and move the bees onto it by turning the catching box upside down and whacking it once or twice. The bees will immediately start crawling into the new hive. Then move the hive with the swarm to the spot where the old colony from which the swarm took off was located.

Rearing Queens

When you want to form an artificial swarm (see page 33) or a brood nucleus (see page 34), or if you want to requeen an old colony (see page 34), you need young queens. This is why you should rear some in June and July. You will need a box for an artificial swarm (a wooden box with a slot in the top



Hatching cage with a queen cell in it. One wall of the cage has a grate that can be pulled up. Nurse bees can pass through the slots to feed the hatched queen. The queen is too big, however, and cannot escape. The queen cage can also be used to store a queen temporarily (protective confinement).

* The last time
Alonso has left swarms & he found it in
the tree.

See note
on next page (54)

P53 12/95

Diseases, Pests, Dangers

If you let the bees draw new combs from foundations (see page 26) every year for the brood nest—or, better yet, for the entire brood chamber—pathogens will have very little chance to establish themselves in your hives. In spite of this precaution and in spite of conscientious care, however, diseases may invade your colonies. To learn how to recognize and counteract diseases in the hives and to get some practical experience in dealing with them, you should take some courses on this topic. Beekeepers' associations and extension agents (see page 67) will be able to inform you about when and where courses on bee and brood diseases are offered.

As soon as you suspect disease in your hives, you must immediately notify the expert on bee diseases in your beekeeper's association. This person and, if necessary, the official state veterinarian, will diagnose the disease and tell you whether the disease must be reported and what treatment is recommended or mandated.

Diseases of Adult Bees

Acarine Disease:

This must be reported!

The mite *Acarapis woodi* penetrates into the tracheae of bees one to eight days old and bites through the tracheal walls to suck the bees' blood. In the process, blood enters the tracheae, where it coagulates and clogs the air passage. The bees cannot absorb enough air and, unable to fly, they merely hop in front of the hive.

Prevention: Keep your colonies strong and the population renewing itself rapidly.

Treatment: Should be treated by an official member of an apiculture research branch or of your local county agricultural extension service.

Varroaosis: This must be reported!

The mite *Varroa jacobsoni* was first found by Jacobson in Java in 1904 as a parasite on Indian

bees. This mite lives on the surface of adult bees and on brood and feeds on their body fluids. A number of non-European bee races have existed with this ectoparasite for decades, without their health being significantly affected. For European bees, however, and that includes the carniolan bee, varroa mites represent a deadly danger. Colonies that are infested with this mite and are not treated die within four to five years.

The light brown mites are visible to the naked eye (females: oval, 1 mm long and 2 mm wide; male: roundish, with a diameter of approximately 0.8 mm). The varroa mite is often mistaken for the harmless bee louse (*Braula coeca*). If you use a magnifying glass you can easily distinguish the two parasites: The mite has eight legs, the louse, only six (see drawing below).

Treatment: In the United States various chemicals for treating varroaosis are given (in controlled amounts) in the spring and fall: Phenothiazine, Naphthalene, Varroazin, Tedion and Folbex. The expert on bee diseases for your beekeeper's association can also advise owners of bees on the choice and proper use of medications.

A biologic countermeasure you can take is to cut out and destroy the combs containing sealed drone brood. Varroa mites prefer drone cells for reproduction.

Nosema Disease

The single-celled parasite *Nosema apis* is always present in the alimentary tract of bees. If a



Bee louse (left) and varroa mite (right). It is easy to tell these two ectoparasites apart: The relatively harmless bee louse has only three pairs of legs, the dangerous varroa mite has four.

Also visualize all this

Could be moved to Sept. Great it is needed in December.

12/95

Diseases, Pests, Dangers

colony is weakened. Individual bees are worn out from physical exertion, or if insufficient pollen (protein) is available, the parasites can multiply rapidly and destroy the cells of the bees' intestines. Infected colonies decline in the spring, the brood combs are no longer covered by bees, the temperature in the brood nest drops, and the larvae die. The sick bees are unable to fly; their abdomens are swollen, and they can be seen crawling around with trembling wings in front of the hive. You can tell if a bee died from nosema disease by pulling her intestines out of the abdomen and looking at them. In a healthy bee the intestines are reddish brown; in bees suffering from nosema disease, they are milky white.

Prevention: Take good care of your bees, and keep the colonies strong. Make sure, particularly in the fall, that the bees have enough pollen; if there is too little, supply pollen substitute (see page 25).

Treatment: You can treat nosema disease yourself. Fumidil B, an antibiotic drug made by Abbott Laboratories is mixed—following the instructions in the package exactly—into the sugar syrup or bee candy fed to the bees in the spring or late summer. This very effective drug is at the moment not available on the market because it is being tested once again. You can find out from your beekeeper's association when it will become available again.

A drug called Nosemac (made by Drageno Pharm and available from dealers in beekeepers' supplies) is also effective. This drug, too, is given in the spring or late summer in accordance with the directions that come with it. A normal package of 15 tablets is enough for five colonies.

Brood Diseases

You can spot brood diseases only if you know what healthy brood looks like:

Brood nest: Areas covered with brood should be interrupted by only very few unsealed brood cells.

Cells: The caps of the cells should be slightly

convex and of a uniform light brown color.
Larvae: Plump, color of mother-of-pearl.
Odor: Odorless

European Foulbrood

Causative agent: The bacterium *Streptococcus pluton*.

Brood nest: Has gaps in the brood.

Cells: The cell caps are discolored, sunken, and punctured; inside the cells there are rubbery, brownish black, smooth scabs that the bees can easily remove during the early stages of the disease.

Larvae: Dark brown color, doughlike to sticky or slimy consistency. There are dead larvae in sealed as well as unsealed cells, usually lying in the lower part of the cell. If you do the match test, * no strings or filaments form.

Odor: Sour.

***Match test:** Stick a match into a cell with a dead larva in it and pull it out again. Sacbrood and European foulbrood are often mistaken for American foulbrood. American foulbrood, which is far more damaging than the other brood diseases, is present only if the match pulls up stringy filaments from the dead larvae.

Treatment: The disease will subside on its own at the end of the brood season.

American Foulbrood: This must be reported!

Causative agent: The bacterium *Bacillus larvae* (spore bearing).

Above, left: A honeybee with pollen in her pollen baskets on a coltsfoot flower. Right: Bees on dwarf aster flowers (excellent source of pollen).

Below, left: A honeybee absorbing honeydew from spruce needles. Right: A carniolan bee (with gray bands on her abdomen) on a clover flower.

Could be
moving to about 26
See notes on p 54

12/95

Diseases, Pests, Dangers

The bee louse (*Braula coeca*), an insect with six legs that is about 1–1.5 mm in diameter (see drawing on page 53), usually attaches itself to the thorax of a bee and takes food from its proboscis. On queen bees as many as 20 lice have been counted, although on worker bees they occur only singly. Bee lice don't do any direct harm, but they bother the bees. Queens infested with them slacken their egg laying.

Remedy: Slip a piece of paper with some naphthalene sprinkled on it into the hive underneath the combs in the evening. The naphthalene paralyzes the lice, and they drop down on the paper. The next morning remove the paper carefully. Promptly burn the paper with the lice on it.

Wasps usually pick off only sick bees or bees that are unable to fly off the landing board in front of the hive. In the fall, however, wasps also try to get at the honey inside the hive. The guard bees at the entrance can easily ward off individual wasps (see page 11), but when many wasps attack all at once, there is danger of robbing.

Remedy: Partially block off the entrances in the fall. In the spring you can place bulging bottles with narrow necks, filled up to a quarter with thin honey water or fruit juice, near the hives. The wasps are attracted by the sweet smell and drown in the liquid.

Hornets have become comparatively rare and therefore pose no threat to honeybees.

Burrowing wasps of the *Philanthus* genus also prey on bees near the hive entrance, but they don't pose a serious threat to the colonies.

Larder beetles (*Dernonites lardarius*) are sometimes found in neglected hives, usually in the debris (small wax particles from the caps that have been chewed off brood and honey cells) on the bottom board of the hive body. The larvae have tufts of long hair, and the blackish brown beetles have a gray cross stripe. The beetles bother the bees and disrupt the brood rearing.

Prevention: Keep the bottom board clean, and don't leave pieces of comb lying around.

Remedy: Collect all bits of wax, and melt them down. Clean out and burn any debris from the bottom of the hive body in the spring.

Ants can do quite a bit of damage by chew through the hives and invading bee colonies.

Remedy: Put ant bait (available at drugstore from suppliers of beekeeping equipment) in hives (following the instructions of the product).

Mice tend to invade bee hives primarily in fall and winter. A mouse nest in a hive is enough a disruption for wintering bees that the colony usually perishes.

Prevention: Reduce the size of the entrances in fall to a slot about 1/4 inch (5 mm) wide, or install mouse grate.

Birds don't do much harm because they usually eat only sick or dead bees. They can, however, be a serious nuisance in queen rearing if they catch young queens during their nuptial flight.

Remedy: Set up scare crows near the hives, or hang strips of aluminum foil on trees near the hives.

The Dangers of Pesticides and Herbicides

Pesticides represent a constant danger to honeybees. Bees that come in contact with a pesticide the course of collecting nectar from plants die instantly or succumb on the flight back to the hive. A forage crop has been treated with a pesticide colony becomes progressively weaker until losses become too great for the colony to survive.

There are legal guidelines for the application of pesticides, specifying the degree of danger to honeybees. You can obtain this information from a number of sources, such as your beekeepers' association, the U.S. Department of Agriculture, and environmental protection agencies.

It should go without saying that you should not use pesticides. Ask your neighbors and acquaintances to abstain from the use of pesticides.

Herbicides (chemicals used to control weeds) seldom kill honeybees directly but destroy many of the plants that are important food sources for honeybees.

GLOSSARY

A Short Glossary of Beekeeping Terms

• **Afterswarm** The portion of a colony that leaves the parent hive with one or more virgin queens.

Allergy Excessive physical sensitivity to bees and their venom; see page 13.

Apimondia International organization of beekeepers with offices in Bucharest and Rome.

• ***Apis mellifera carnica*** Carniolan bees, a race that is especially gentle.

Antibiotics Substances that inhibit the growth of bacteria or kill them.

• **Bands, abdominal** Dense bands of hair on the abdomen of bees. These bands are especially wide in carniolans, which is why these bees appear gray (see page 22).

• **Bee candy** A mixture of powdered sugar and honey (proportions 3:1); also produced commercially without honey, using an inverting enzyme as a softener (see page 41).

? **Bee candy plug** The plug of the queen cage is replaced with a piece of bee candy about the size of a pigeon egg when the queen is introduced into a hive.

• **Bee escape** A device that allows bees to pass through one way but not to return.
Beehive See *Hive*.

• **Bee house** A protective structure for bee hives that is large enough for the beekeeper to enter and perform beekeeping chores inside it.

• **Bee language** Gestures (dancing) through which information is communicated to members of the colony. This behavior was first discovered and described by Professor Karl Ritter von Frisch (1886-1982), who received the Nobel Prize for his pioneering research (see page 9).

Bee pasture Wild and cultivated plants, bushes, and trees that supply nectar, honeydew, or pollen.

Bee space A space about $\frac{3}{16}$ inch (10 mm) wide through which bees can move freely. Bees tend to fill smaller spaces with propolis and build combs in larger ones.

• **Bee year** Starts in August because bees hatched during this month are the ones that will rear the spring population.

Begging for entrance Bees not belonging to the colony trying to become accepted.

• **Bottom insert** A piece of material, such as tar paper, that is slipped underneath the wintering colony and is removed in the spring with the debris that has collected on it.

Breeding stock Eggs or larvae from selected colonies used to breed queens with desirable traits.

• **Brood** The offspring produced by the colony (eggs and larvae).

• **Brood nest** All the combs of a colony with brood in them.

• **Builder bees** Bees that sweat wax and build combs (see page 5).

Building cluster Young bees hanging on to each other in a cluster and producing wax from which they construct combs.

Building frame An empty frame, which the bees—depending on the colony's mood—fill with either worker or drone brood cells. If the bees start modifying regular cells into queen cells, this is a sign that the colony may be getting ready to swarm.

• **Carniolan** See *Apis mellifera carnica*.

• **Cellar detention** Artificial swarms and mating boxes are kept in a cool room (approximately 60°F, 15°C) for two days to give the bees time to get used to the queen.

July '86 E

Cells

Cells Honeybees build wax combs made up of hexagonal cells for brood rearing and storage of honey and pollen.

Chitin The horny substance forming the exoskeleton of bees and other insects.

Cleansing flight Bees avoid defecating inside the hive. In the winter the waste collects in their intestines, and as soon as it is warm enough (50°–54°, 10°–12°C) the bees leave the hive to relieve themselves (See page 46).

Colonies, uniting Forming one strong colony out of two or more weak ones.

Colony, development of The brood-rearing phase starting after the winter rest and culminating around the summer solstice.

Colony, drone A colony of bees with an intentionally high proportion of drones.

Colony, queenless A colony without a queen.

Colony, queenright A bee colony that has a queen.

Colony, a shrinking Removing bees or brood combs from the hives to prevent swarming.

Combs Combs are made up of hexagonal cells (four per square centimeter) built at a slight upward angle.

Comb, age of If you hold a comb up against the sun or a bright lamp, some light should shine through. If it is completely opaque, the comb is too old and should be melted down.

Comb, egg A small piece of comb with eggs that is used for breeding purposes or to test for the presence of a queen (see page 30).

Comb, natural Combs built by bees without the aid of foundation (see *Foundation*).

Comb pliers Tool used with hives worked from the back (see drawing on page 21).



Dr. Alte

Drone Cell

Comb, settling Sometimes a swarm of bees moves out of a hive to which it has been transferred because the bees don't feel at home there. A comb with brood in open cells, hung into the hive before the swarm is introduced, stimulates them to take care of the brood and helps the swarm settle down in the hive.

Combs, capping Bees seal cells that are filled with ripe honey with a thin wax cover to preserve the honey.

Combs, old Dark combs that have been used repeatedly for brood rearing. They should be cut out of the frame, melted down, and the wax exchanged for new foundation.

Combs, spacing of The space between combs is usually about $\frac{3}{4}$ inch (see *Bee space*).

Combs, trimming Cutting combs to fit into different frames.

Consolidation Removing combs not occupied by bees.

Crawling Bees that are unable to fly often crawl. Possible causes for crawling are acarine disease (see page 53), varroaosis (see 53), or poisoning. If crawling is observed repeatedly, have the hive inspected.

Debris Tiny bits of wax from the chewed-off caps of brood and honey cells that drop to the bottom of the hive.

Diseases, mandatory reporting of The presence of certain bee and brood diseases must be reported to state and/or federal government inspection offices (see page 65).

Drone Male of the bee.

Drone cell A brood cell that is larger (6.91 mm diameter) than the normal worker brood cells (5.37 mm) and in which the queen deposits drone eggs.

6.91 - 5.37
7.00 - 5.45

7 to 5.5
14 to 11

5 to 4

~~Frames~~
9x15
or 9x17

$$\begin{array}{r} 15 \\ 25 \overline{) 375} \\ \underline{25} \\ 120 \end{array}$$
$$\begin{array}{r} 9.2 \\ 2.5 \overline{) 22.5} \\ \underline{22.5} \\ 0 \end{array}$$

Drone congregating areas

Drone congregating areas Geographically favorable spots that attract drones eager to mate with young queens.

Drone killing Expelling of drones in the late summer after the reproductive drive has passed and the drones are no longer of use to the colony.

Early flow area Area where the honey flow comes early, from March to about July.

Entrance An opening through which the bees can leave and enter the hive.

Equipment for harvesting honey See page 35.

Excluder grid A grate inserted between the brood chamber and the honey chamber with spaces wide enough (between $\frac{1}{8}$ and $\frac{3}{16}$ of an inch, 4.3 mm) for the worker bees to pass through but not the larger queen.

Extracting room A work room that is bee proof.

Fanning Rapid beating of the wings near the entrance that causes air to move through the hive (ventilation).

Feeding, fall Replenishing the colony's food stores for the winter.

Feeding to stimulate brood rearing When there is no food from natural sources, the beekeeper must feed the bees so that they will carry on the brood business.

Flower fidelity Bees usually visit only one kind of flower on a foraging trip. This plays an important role in the preservation of the purity of species. Other insects move indiscriminately from flower to flower.

Field bee Bees are subject to a strict division of labor. During the first 12 days of life they work inside the hive; afterward they serve as field bees, collecting nectar, honeydew, and pollen (see pages 6 and 12).

Hive, leaf

Flight direction The direction in which the entrance points.

Flour test See page 31.

Forage bee See *Field bee*.

Foundation A thin sheet of beeswax with the honeycomb pattern for workers' brood cells embossed on it. The bees build or "draw" complete cells on both sides of the foundation.

Frame A wooden frame that holds comb foundation and is reinforced by wire (see *Foundation*).

Frame sizes The two frame sizes most commonly used in Germany are the German normal size, 37 × 22.3 cm, and the Zander size, 42 × 22 cm.

Frames, self-spacing These ensure that the frame hang or stand about $\frac{3}{8}$ inches (10 mm) apart (see space).

Frame wire Wire used to reinforce frames to keep foundation from sagging.

Gassing Destroying a contaminated colony by burning sulfur.

Guard bees Worker bees that guard the hive entrance (see pages 7 and 11).

Hair Bees are covered almost completely with furlike hair. When they visit flowers, pollen sticks to the hair (see Feeding and Pollination, page 8).

Hive A wooden box in which bees live (see page 16–20).

Hive bee Young worker bee up to 20 days old that works only in the hive (see pages 6 and 7). Also called house bee.

Hive body Part of a hive.

Hive, leaf A hive that is worked from behind. The frames rest vertically on a grate of metal bars, the ends toward the entrance. When one frame is re-

⑤ This is new to ~~the~~ Ala's.

~~30 cm~~
30 cm = 1 ft.

Hive, movable-frame

moved, the others can be moved by flipping them like the pages of a book (see page 19).

Hive, movable-frame A hive composed of two or more stacked hive bodies (see page 16).

Hive scent All the worker bees of a colony produce a scent that is characteristic of their colony and is recognized by all the members (see *Smell, sense of*).

Hive tool A metal bar to loosen combs.

Honey See page 35.

Honey chamber A chamber, separated from the brood chamber by a queen excluder, with combs in which the bees store honey.

Honeydew A sweet liquid excreted by certain plant-feeding insects, such as plant lice (Aphididae), bark or scale insects (Coccidae), jumping plant lice (Psyllidae), and white flies (Aleyrodidae).

Honey, extracting See page 36.

Honey flow The period when the greatest amount of nectar is available within the bees' flight range.

Honey, kinds of See page 52.

Honey, leaf Honeydew from deciduous trees.

Honey, liquefying Gradual heating of crystallized honey up to 104°F (140°C).

Honey manipulation See page 35.

Honey stomach See page 8.

Humidity The relative air humidity inside a hive is about 60%. Higher humidity contributes to the spreading of disease and inhibits proper brood development; in the winter it can also cause mildew on the combs. To counteract rising humidity, consolidate the colony (see *Consolidation*).

Insemination, artificial Mechanical insemination with the sperm of selected drones. The queen is an-

Medications

esthetized with CO₂, and the procedure is performed under a microscope.

Interim feeding See page 39.

Lachnidae Family of aphids that feed on trees and produce honeydew.

Landing board A place where the bees can land in front of the entrance.

Larvae From the eggs the queen lays, larvae hatch that later pupate and eventually turn into adult insects (see page 6).

Late flow area Area where the honey flow comes late, usually from trees; generally from June to August.

Lecanidae Family of scale insects that produce honeydew.

Listening It is possible to hear the bees humming inside the hive in the winter (when the hive must not be opened) by taking a thin rubber tube and holding one end to the entrance and the other to your ear. The quality of the humming can give you important clues about the state of the colony.

Match test See page 54.

Mating The young queen takes several flights from the hive and copulates with five to eight drones, which die after the union. A queen stores between eight and ten million spermatozoa, enough to fertilize eggs for her entire lifetime.

Mating box Hive for a very small nucleus; point of departure for a young queen when she sets out on her nuptial flight.

Mating site A spot that is ideally situated for setting up mating boxes with selected drones for the purpose of planned breeding.

Medications See the chapter on diseases and their treatment, starting on page 53.

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Abis et al. 1981

Microclimate Maintenance of temperature within the hive.

Mobbing A queen can be attacked by hostile bees that surround her in a tight mob. The queen is usually injured or killed.

Nectar A sweet liquid secreted by glands (nectaries) in the flowers of plants. The nectar is converted by the bees into honey.

Nucleus Part of an established colony separated from the main colony without the queen. As the word implies, a nucleus is the beginning of a new colony.

Nucleus box A small hive used for housing a small colony or nucleus.

Nuptial flight Mating flight.

Nurse bee Young hive bee (see pages 6 and 12) whose task it is to feed the larvae.

Orientation flights Short flights taken by workers that are about to start working as field bees to become familiar with the surroundings of the hive. Also called play flights.

Ovaries Only the queen has fully developed ovaries; worker bees have only rudimentary ovaries.

Oxygen, lack of If bees are transported in hives, a shortage of oxygen may arise and cause the death of the entire colony.

Pheromone See *Queen substance*.

Pollen analysis Examination of the various kinds of pollen contained in honey to determine the source of the honey.

Pollen substitute A food, such as soy flour, brewer's yeast, or fat-free milk powder, given to bees when their stores of pollen are low.

Pollen trap A grate through which the bees must crawl that removes the pollen pellets from their legs as they enter the hive.

Propolis See page 51.

Queen See page 5. The queen determines the activities within the hive by giving off pheromones.

Queen cage Small cage housing a young queen that is to be introduced into a colony or a nucleus.

Queen, marking the See *Year colors*.

Queen nucleus See page 30.

Queen substance (pheromone) A substance produced in the queen mandibular glands (see drawing on page 5) that affects the colony's activities.

Queen test See page 30.

Record cards All the activities inside the colony and all the maintenance chores performed by the beekeeper are entered on the record cards.

Requeening Replacing one queen with another (see page 34).

Robbing This behavior usually results from the beekeeper's carelessness. Bees "steal" the honey from other colonies. This can cause the demise of a colony.

Royal jelly A food substance produced by nurse bees (see *Nurse bee*) in their pharyngeal glands and fed to larvae destined to become queens.

Scale colony If a hive is maintained on a scale, accurate observation of changes in weight is possible, which provides information on the abundance or scarcity of the honey flow.

Scent gland Also known as the Nassanoff gland, this gland is found on top of the abdomen of worker

* Transferring from a box to a shop
64 Also gets + carry

Shaking

bees and produces a scent characteristic of that particular colony.

Shaking Moving a swarm from a box into the hive by giving the box a good shake or whack.

Smell, sense of The scent receptors of bees, which are located on the antennae, are very sensitive.

Smoke Smoke is blown at the bees to calm them.

Smoker A metal fire pot with bellows and a funnel to aim the smoke at a given target.

Smoker fuels Tobacco, punky wood, or dry pine needles.

Spring dwindling Population loss in the spring when old bees die faster than new ones emerge to take their place. Within reasonable limits this is a normal development.

Spur embedder A small brass wheel with grooved spurs used to mount the foundation into the wired frames.

Soy flour Pollen substitute (protein).

Sulfur Sulfur is used to kill diseased colonies.

Supersedure A colony replaces an old queen with a young one without swarming.

Swarm, artificial See page 33.

Swarming Natural division of a colony: Some of the bees move out of the hive (see *Swarm, prime* and *Afterswarm*).

Swarming impulse Bees are moved to swarm when the hive becomes congested; this occurs at the high point of the colony's population increase (see pages 6 and 26).

Year color

Swarm, prime The portion of the colony that leaves the hive with the old queen.

Uncapping Removal of the wax covers of combs filled with honey.

Vision Bees can distinguish colors. They are color blind to red but can see ultraviolet. Painting a part of the hive near the entrance in accordance with their color sense helps bees orientate themselves.

Water source A stream or other body of water or some watering device set up near the hives that supplies the bees with the water they need for processing food and regulating hive temperature.

Wax Worker bees excrete wax from glands located on the underside of the body between the abdominal segments.

Wax melter, solar A glass-covered box used for melting wax (old combs) by means of solar heat.

Waxmoth A parasite that destroys the combs.

Winter bees Bees that hatch in August and winter over.

Winter rest Bees survive the winter by contracting into a tight cluster.

Wiring foundation Stabilizing of the combs.

Worker Female bee with only partially developed ovaries; workers perform all the jobs, both inside and outside the hive, necessary for the survival of the colony (see pages 6 and 8).

Year colors To make it easier to find a queen and to keep track of her origin and age, she can be marked with a tiny disk attached to her thorax. The disks come in five different colors, each signifying a different year (see page 32).

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A Short Introduction to Bees
Catherine & Swarming*

10/95

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Alvis + Alvis

discussing it

2/96

- a Brain (upper ganglion)
- b Head salivary gland
- c and d Food glands in head (c) and thorax (d)
- e Abdominal back plate
- f Midgut or ventriculus
- g Heart
- h Ovaries
- i Anterior intestine
- j Scent gland
- k Rectum
- l Anus
- m Antenna
- n Mouth cavity
- o Mandibular gland
- p Mandibles
- q Mouth opening
- r Tongue (proboscis)
- s Brain (lower ganglion)
- t Nerve cord
- u Heart spiral (nine turns)
- v Honey sac or stomach
- w and x Proventricular valve, a narrow, funnel-like passage
- y Wax gland
- z Sting

or several of the new queens with them (the after-swarm). Only the brood, some young nurse bees, and a few new queens are left in the hive. These latter will fight each other to the death until only one remains. After five days the virgin queen is sexually mature and takes off on her nuptial flight.

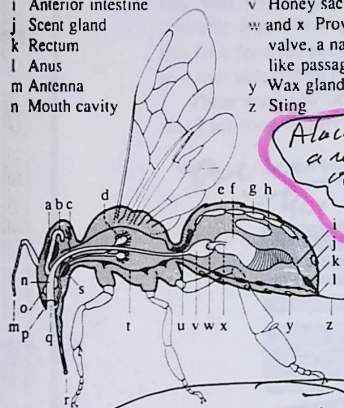
Drones that are ready to mate leave their hive in early afternoon usually between 2 and 3 o'clock. They fly around near their hives or gather in drone congregating areas where the weather conditions are favorable and where the drones stay aloft 15-40 feet (5-12 m) above the ground.

The mating always takes place in the air. In the act of copulation, the drone's genitalia, which are normally located inside the tip of the abdomen, are extruded by turning inside out and enter the queen's vagina pouch. The spermatozoa are discharged into the queen's vagina and gradually move from there to a sperm-holding reservoir called the spermatheca. The drone expires in the course of copulation. A queen may mate with five to eight drones during her five to six weeks of sexual receptivity. In the process she accumulates millions of spermatozoa, enough to last a lifetime of egg laying.

Sometimes the workers replace an old queen with a new one without the colony's swarming. The old queen either dies or is killed by a virgin queen or by the workers. This process, which is advantageous for the apiarist because the colony is rejuvenated without any effort on his or her part, is called superscedure.

Once the young queen has mated and started a good brood nest, the drones no longer serve a useful function. They consume food without contributing to the life of the hive, and the worker bees begin to expel them from the hive or kill them.

Worker bees born in August or later winter over and don't die until the next spring. From November on no more brood is raised, and the entire colony collects in a tight cluster around the queen. The bees feed on the honey they have gathered and stored for winter, converting carbohydrates into body heat. The temperature at the center of the cluster stays between 68 and 77°F (20-25°C) and drops to be-



*Alvis' worker
a reflection
of youth
of Paula*

Swarming

Lengthwise vertical section of a bee. The bee's tripartite body (head, thorax, and abdomen) is enclosed by an exoskeleton consisting of chitin. Three pairs of legs and two pairs of wings are attached to the thorax. Bees breathe through tracheal tubes that open through breathing pores in the thorax, called spiracles.

discourage swarming (see page 26). If the beekeeper stands by idly, the queen will soon leave the hive with about a third of the workers (the prime swarm). The bees usually alight on a branch and hang there in a tight cluster with the queen in the middle. If the beekeeper does not catch the swarm at this point (see page 31), the bees will scout out and take off for a new permanent home in a hollow tree, a hole in the ground, or a rock crevice and will then be lost to the beekeeper for good. Almost half of the remaining bees may also move out seven days after the departure of the prime swarm, taking one

*In Alvis
queen
all that
at last*

see pg in book for more

X

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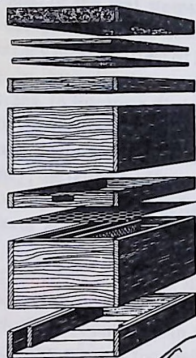
Bee Hives, Equipment, and Colonies

What Kind of Hives Are Practical?

The two types of hives most commonly used are movable-frame, such as the Langstroth hives and the William Broughton Carr or WBC hives, top-opening hives, and the so-called leaf hives that are worked from behind. Leaf hives must be kept in a bee house, whereas movable-frame hives can be set up outdoors or in a bee house. Since not many beginning beekeepers are likely to buy or build a house and will therefore probably keep their bees in movable-frame hives, I will in the following chapters first describe each work procedure as it applies to a movable-frame hive.

There are a few other methods of housing bees that I mention briefly on page 20.

The honey coming in the comb to describe the Langstroth



A movable-frame hive is worked from above. It consists of (from bottom to top): a bottom board; a hive body (brood chamber) with room for eight to ten hanging frames; a queen excluder (to keep the queen out of the honey chamber); a separator board; an upper hive body or super (honey chamber); a feeding cover with feeder trough; a grate that allows air exchange during transport; an insulating cover; an outer cover.

Movable-frame Hives

Spring 96

A movable-frame hive (sometimes called the Langstroth hive, after L. L. Langstroth, a great nineteenth century pioneer of modern beekeeping and of this type of hive design) consists of a rectangular bottom board with a rim 1-4 inches (3-10 cm) high, onto which two or more wooden boxes without tops or bottoms, called hive bodies, are set. (The hive body on the bottom is called the brood chamber, and the ones on top, used by the bees for honey storage, are generally referred to as supers.) On top of the hive bodies is a cover and, perhaps, an inner lid of insulating material for colder weather or a ventilation screen (a layer of wire mesh fitted into a narrow wooden frame) that is inserted for transporting the bees. All the parts—from the bottom board to the lid—have the same rectangular dimensions so that they can be stacked neatly. The hive entrance, a small rectangular opening, is located on the front of the hive in the rim of the bottom board. With this type of hive the frames for the honeycombs are hung into and taken out of the hive bodies from the top, which means that the work with the colonies is done from the top.

As protection against moisture from underneath, the hives should be set up a foot or a foot and a half off the ground on hive stands or a stack of beams or wooden boards. The top of a hive standing by itself should be protected against the weather with a protruding outer cover of waterproof material; several hives set up in a row can be covered with a roof of wood, metal, or roofing paper.

It is possible to set up movable-frame hives in a bee house (see page 21), but it is easier to work this type of hive outdoors.

Exchange of ideas and experience is an important prerequisite for successful beekeeping. When you handle bees, appropriate, bee-proof clothing is essential.

No.

A Short Introduction to Bees

photo on page 37). When the water content has been reduced to between 17 and 20%, the honey is ripe, and the bees seal the full honey cells with a thin cover of wax. As soon as this is done, the beekeeper can start extracting honey (see page 36).

Depending on the productiveness of the plant sources, bees must make about 40,000 trips and visit between three and five million blossoms to harvest 2 pounds (1 kg) of honey. The capacity of a bee's honey stomach is about 50–60 mg.

A bee colony that is located in a forested area can start harvesting honeydew in June. This honeydew is produced by aphids of the Lachnidae family and various scale insects of the Lecanidae family. These insects suck the sap of pine, fir, and spruce needles and sometimes also of the leaf stems of oaks, maples, and other deciduous trees to absorb the nutritional substances they need. The rest of the sap is excreted and hangs in shiny droplets on the needles or leaves of the trees. In Europe a distinction is made between honey that comes from evergreen trees and honey from deciduous trees: The former is called forest honey; the latter, leaf honey. Honeydew, which is processed in the hive just like nectar, has an inferior flavor and is not properly acceptable as honey.

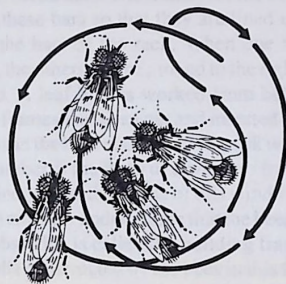
The honey that is deposited in combs is intended for rearing the brood and as food for the cold winter months. The carbohydrates contained in it supply the bees with the energy needed for their activities.

Bees need not only carbohydrates, which they obtain from nectar and honeydew; they also gather pollen, which supplies them with protein. While they fly from flower to flower, they brush the pollen off their hairy coats with the help of brush-like hairs on their legs and pack it into pocketlike indentations, called pollen baskets, in their hind legs (see drawing on page 7). There the pollen is mixed with a bit of honey the bee carried with her from the hive and kneaded into a solid clump. An experienced beekeeper can tell what flowers a bee has visited from the color of the pollen pellets. Back at the hive the bee strips off the pollen into an

empty cell, where young hive bees compress it by "stamping" it in place with their forelegs and heads.

Round Dance and Wag-tail Dance

When a bee has found a good source of food within a radius of about 300 feet (100 m) and on level terrain, she can announce this to the bees in the hive by performing what is called a round dance. What she does is to fly around rapidly in a circle,



Bees perform the "round dance" to communicate to other field bees that there is a food source within 300 feet (100 m) of the hive.

first to the left, then to the right (see drawing above). Some of the surrounding bees touch the dancing bee and then start dancing, too. With the olfactory organs at the tips of their antennae they have picked up the scent of the flower, which lingers on the field bee's hairy coat. A precise description of the location is unnecessary if it is within 300 feet of the hive, but the abundance of the source is indicated by the speed of the dance. The faster the dance, the richer the source and the closer to the hive. A food source that is farther away requires that more information be communicated. Direction and exact distance are expressed by means of the "wag-tail dance." Here the bee dances straight ahead on the honeycomb while wagging the tail end of her rump back and

Alain Buechel

Bee Hives, Equipment, and Colonies

Advantages of Movable-frame Hives

- There is no need for a bee house.
- The hive space can be adjusted to the size of the colony by adding supers as needed. An easy way to form nucleus colonies is to add supers with queen excluders (see page 34).
- There is no need for special nucleus boxes (small hives).
- In the winter you can use the empty hive bodies for storing empty combs. Use separator boards as tops and bottoms for stacked hive bodies to keep out mice. This means that you don't need to buy or build special, rodent-proof cabinets for the combs.
- The frames filled with honey can be transported to an extractor inside the hive bodies, thus eliminating the need for special transport boxes.
- You will have a greater honey harvest than with leaf hives because the colonies are stronger.

The Disadvantages of Movable-frame Hives

Movable-frame hives require more physical strength than leaf-hives because sometimes hive bodies full of combs must be lifted. A super with all the frames filled with honey can weigh close to 50 pounds (20 kg).

Also feels the need for jammer

Leaf Hives

A leaf hive (see drawing on page 20) consists of a wooden box that is subdivided by a horizontal metal grid into two equal spaces, the brood chamber below and the honey chamber above. The spaces of

Above: A comb with sealed worker brood. The brood nest is solidly filled and extends over the entire comb. In the two upper corners, honey and pollen are stored. Below, left: Bees are being brushed off a comb with a bee brush. Right: A comb occupied by bees (left in photo) has been removed from the brood chamber and is about to be replaced with fresh foundation.

this excluder grid are large enough for the worker bees to pass through but too small for the queen. This way only worker bees can get at the combs in the upper chamber to deposit honey there. The combs containing the brood (the brood nest) are all in the chamber below. Since only combs from the top are taken out for honey extraction (see page 36), there is no chance of larvae being in the combs meant for honey production.

An inch or so above the bottom of the leaf hive and above the built-in excluder grid are racks of horizontal metal bars. The frames for the combs are slid onto these bars so that they are lined up vertically on the bars of the rack. When one frame is removed, the others can be moved to the right or left as needed. A leaf hive is worked from behind because the frames are taken out and inserted from the side opposite the hive entrance. The back wall of the brood chamber is made up of a wooden frame with a glass window. On the inside of this window frame there is an empty wooden frame that the bees can fill with combs. This is called the building frame. The type of cells constructed by the bees in this frame—worker, drone, or queen cells—indicates the mood of the colony (see page 25). (In a movable-frame hive an empty frame hung next to the brood nest fulfills the same function of "mood-indicator.") On the back wall of the honey chamber there is a wooden frame with a glass window or wire screen. The entire back side of the leaf hive is closed off by a wooden door. Most leaf hives come with pads that help insulate the brood and honey chambers.

Advantages of a Leaf Hive

- Leaf hives can be stacked one on top of the other.
- If leaf hives are located in a row at the right height, work with the bees can be done sitting down, a feature that is especially advantageous for older or physically handicapped persons.
- The glass window makes it possible to watch the bees without disturbing them, and the building frame that serves as mood indicator of the colony is open to view.

Bee Hives, Equipment, and Colonies

Disadvantages of a Leaf Hive

- Leaf hives must be housed in a building.
- A fitted tray (a wooden board with rims 2–5 inches, 5–10 cm, high on three sides) is needed. It is hung on the back of the hive. Bees that are brushed off a frame that is taken out of the hive (see page 29) drop onto this tray and can return easily to the hive.
- The frames that are taken out of the hive are placed in a frame rack with slots for 8–10 frames. The slots are spaced so that the bees are not squashed between the frames when you set down the frames.
- You must have a special storage cabinet for frames that are not in use during winter. The storage cabinet should have built-in racks into which the frames fit individually.
- To work comfortably behind the hives in the bee house, you should have a small worktable where your tools are handy and you can deposit the filled frames in the frame rack. If you have two or three hives on top of each other, you should have a table that can be raised or lowered so that it is always at a convenient level for the hive you happen to be working with.

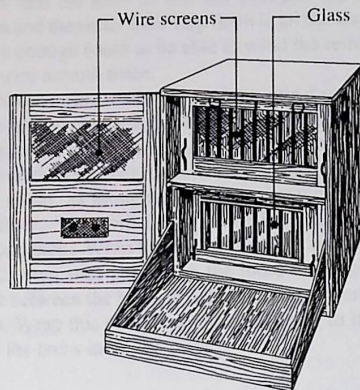
Other Types of Hives

A *trough hive* is worked from above and must be protected against the weather. Consequently it must be set up in either a bee house or a small outdoor shelter (see page 21).

Original *Zander hives* are still used quite extensively in Germany and many other parts of Europe. These hives are a precursor of the modern movable-frame hive but are not suitable for an outdoor apiary.

Before the introduction of modern hives, beekeepers used inverted baskets of wicker or straw, called *skeps*. Skeps are still used in parts of Europe and the United States today, but their primary function is decorative.

Another ancient method of housing bees is the "bee gum" or log hive. This is, of course, the kind of housing wild bees choose. A bee gum consists of a



A leaf hive is worked from behind, and this drawing shows the rear of the hive. The hive is made up of a brood chamber (below) and a honey chamber (above). The queen excluder is built in. A ventilation window in the upper half of the door and a wooden frame that closes off the honey room are both filled with wire screening. A building frame is mounted on the frame of the brood chamber window. The brood chamber window is also equipped with a thin board that can be inserted in the window during transport or when the bees are brushed off the combs. The attachable tray is used only when the back door of the hive is open.

hollow log with crossed sticks at the top to support honeycombs. The top is then covered with a board, and a hole in the bottom serves as the entrance.

Necessary Equipment

Bee journals and specialized catalogs advertise hives and all the standard equipment. You can also get parts for the different types of hives, which will be sent to you with instructions on how to assemble them. In the literature on beekeeping (see page 66),

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(less color illust.)

Care and Management

In this chapter I explain all the chores a beekeeper must perform in order to harvest as much honey as possible. A chronological listing of what needs to be done month by month is given under the heading The Beekeeper's Yearly Work Cycle (see page 46).

Assembling the Frames

To add stability to the combs that the bees build, the foundation in the frames has wires embedded in it. In the United States and England, unfortunately, many different sizes of frames are in use. I recommend to the beginner the most common frame, the Hoffman or self-spacing frame. With this type it is impossible to make the mistake of putting too many or too few frames in each hive. The frames are spaced by the extra thickness of wood at the top of the side bars. This spacing, often called the Hoffman spacing, is usually $1\frac{1}{2}$ or $1\frac{3}{4}$ inches (3.8 or 3.5 cm) center to center.

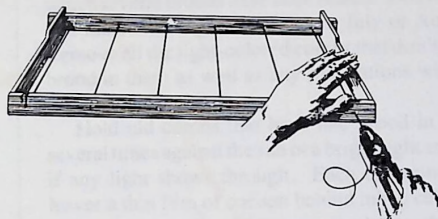
If you want to build your own frames, you should make sure to get the standard thickness of wood from a supplier of bee equipment. The ends of the frame bars are coated with a water-insoluble glue before they are nailed together at a 90° angle at the corners.

Wiring the Frames

The foundation is a sheet of wax the size of the inside dimensions of the frame. To attach it securely to the frame, the frame must be reinforced or "wired" (see drawing in next column). Use a hand or electric drill or a special beekeeper's awl (available from beekeepers' suppliers) to drill four or six small holes (depending on the make of the equipment you are using) along the centerline of the two bars that make up the longer sides of the frame. The outer holes are drilled about 1 inch (3 cm) from the ends; the remaining two or four holes are spaced so that all holes are at an equal distance from each

other. Then take two small nails or tacks and tap them into the ends of one bar between the outer holes and the ends. Don't tap them in all the way but leave enough room to be able to wind the reinforcing wire around them.

Now you are ready to thread the wire through the hole next to one tack, then through the corresponding hole on the opposite bar, then through the next hole on the same bar, back to the slat you started on, and so on, as though you were stitching the bars together. You will finish at the hole next to the second tack. Wrap the end of the wire around this tack; then start pulling on the loose end until the wire between the tacks is tight but doesn't bend the bars. Wrap this end around the tack next to it, and nail the tacks in all the way.



Wiring a frame. Tighten the threaded wire with pliers, and secure the ends of wire by wrapping them around a tack that is hammered into the wooden frame. The frame is now ready for the foundation, which can be embedded with a spur-wheel embedder or a transformer.

Fastening the Foundation

To fasten the foundation to the frame, you need a small wooden board a hair smaller than the frame's inside dimensions and half the thickness of the frame. (If the frame's depth is $\frac{1}{2}$ inch (10–12 cm), the board would have to be just barely $\frac{1}{4}$ inch (5–6 cm) thick. The wire can be embedded in the foundation either with a hand embedding tool (spur embedder) or with a small electric transformer.

Care and Management

You can also feed diluted honey (half a pint every other day, honey and water mixed in equal parts), but use only honey from your own bees. If you use honey from other sources, the danger of introducing disease (foulbrood) is too great. You must also supply a pollen substitute (brewer's yeast or soy flour). This is particularly important for bees foraging in forests, where enough summer and fall blossoms are often not available for the bees (2 pounds of pollen substitute lasts for three to four weeks).

Since the limited availability of food offered by the beekeeper resembles conditions when the honey flow is too sparse to permit storing honey for future use, the bees tend to respond by raising new brood. Interim feeding can thus be regarded as a stimulus to increase population. If the natural food sources start flowing again, supers or honey chambers must be reopened (see page 26).

At times when natural food sources dry up, there is danger of robbing. Bees from other colonies or from neighboring apiaries may clean out all the honey from your hives. This is why you should take the following precautions:

Scold the kids

- Don't leave honey or food combs exposed.
- Don't take too much time checking the colonies, and don't leave the hives open long.
- Don't spill any syrup; if some does spill, wipe it up thoroughly, down to the last tiny drop.
- Reduce the hive entrance by two-thirds; in nucleus boxes leave open only a small slit ($\frac{3}{8} \times \frac{3}{4}$ inch, 1×2 cm). The guard bees must be able to defend the entire entrance.
- Don't feed liquid food until the evening when the bees have stopped flying.

Management of Weak Colonies

Don't try to winter over a weak colony; it is bound to die before spring. If you have two weak colonies, one with a good and one with a poor queen

(too old or damaged, or that is likely to produce be that sting, see page 34), combine the two colonies in August. Find the undesirable queen and dispose of her (see page 34). In a movable-frame hive, place the hive body with the queenless bees either on top or underneath the colony with a queen. In a Langstroth frame, hang the combs with the queenless bees next to the bees with a queen.

If you have two weak colonies with poor queens, kill both the queens (see page 34) and add the brood combs to a mediocre colony that has a good queen.

Rearranging the Combs

In the fall the bees occupy only those combs which several broods have been reared. This is why you must rearrange the combs in July or August. Remove all the light-colored combs that don't have brood in them as well as any foundations with drawn combs.

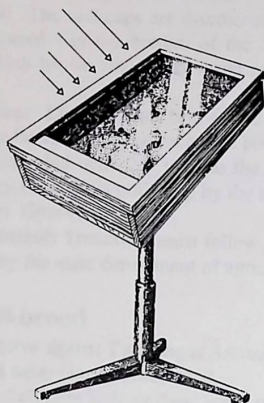
Hold old combs that have had brood in them several times against the sun or a bright light and if any light shows through. Each emerging bee leaves a thin film of cocoon behind in the cell, and if there are enough of these cocoon layers that light is no longer visible, the cells are too small for new brood. Cut dark combs (combs that block light) out of the frames and melt them in a solar wax melter or exchange them for foundation. Leave combs that are still diaphanous should be stockpiled together with foundations until spring in hive box or a special comb-storage cabinet.

If any drone combs are present (combs made entirely of drone cells, see page 6), these too should be removed.

Feeding to Stimulate Brood Production and Fall Feeding

For beekeepers in areas with early honey flows, especially important to start the winter

Care and Management



A solar wax melter that uses solar energy to melt old combs. The sun's rays, which hit the sloping glass top, heat the inside of the box to as much as 180°F (80°C), and a slate bottom stores the heat. Beeswax, which melts at about 150°F (65°C), drips into a receiving pan and hardens overnight.

strong colonies. Only strong colonies can take full advantage of the spring honey flow and collect an optimum amount of honey. In areas where the honey flow comes early one cannot count on harvesting honey after the end of July. To encourage the bees to keep rearing brood, you should start feeding them after removing the supers (see page 40). There are three possible methods: you can give them half a pint of sugar water (one part sugar to one part water) every other day, you can feed them bee candy (2 pounds every two weeks), or you can give them half a pint of diluted honey (half honey and half water) every other day. (Make sure you use honey only from your own bees!) Continue the feeding until the end of August. If there are no natural pollen sources, you must also make ready some pollen substitute (see page 25).

In areas with late honey flow, feeding to stimu-

late brood production is usually not necessary because the woods normally provide food until August. (If there is no honeydew, you should of course start feeding to stimulate brood production.)

The nectar, honeydew, and pollen that the bees collect and store from August on (from natural food sources or food provided by the beekeeper) are not enough to carry them through the winter and into the spring, and you must help them with additional feeding.

You should start the fall feeding in early September (two weeks earlier at altitudes above 1500 feet, 500 m), whether the honey flow is late or early. Note: Forest honey must be extracted before it is given to the bees.

You must assess how much food the bees will need. A common estimate of the food needs of a colony wintering over in one hive box is 17–22 pounds (8–10 kg); bees wintering over in two hive boxes need about 33 pounds (15 kg).

You can determine approximately how much the bees have already stored for the winter by using the following information:

- A piece of comb measuring 4 × 4 inches (10 × 10 cm) contains about 12 ounces of food or honey.
- A comb in a Hoffman frame (usually 4½ × 16¾ inches, 11 × 42.5 cm) and with sealed cells on both sides holds about 4 pounds of food or honey.

Figure out how much food the bees are short by subtracting your estimate of how much the bees have already stored from the amount needed for survival (see above). If you use bee candy, however, you must give the bees about 10% more than the amount you calculated. The candy must be processed by the bees before it is ready for storage, an activity that requires energy, which has to be provided in the form of food.

If you have movable-frame hives, remove the cover and the plastic sheet and place an insulating cover of appropriate size and with a hole in it on top of the combs. This "bunghole" should be ¾ inches (80 mm) in diameter. The bee candy is placed on

Start his colony in Sept. feeds them sugar water

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Diseases, Pests, Dangers

Brood nest: Gaps in the brood.

Cells: The cell caps are discolored, sunken, and punctured. In the bottom of the cells there are blackish brown scabs that resist removal by the bees.

Larvae: Light to dark brown and slimy. Dead larvae lie stretched out flat on the bottom of sealed and unsealed cells. If you do the match test, a stringy filament is pulled up by the match.

Odor: Glue-like.

Treatment: Treatment must follow guidelines issued by the state department of agriculture.

Chalkbrood

Causative agent: The fungus *Ascosphaera apis*.

Brood nest: Gaps in the brood.

Cells: Cell caps light or dark, some of them punctured.

Larvae: White, later grayish black, hard, and chalklike in consistency. Dead larvae in sealed cells. Odorless.

Treatment: The disease will subside on its own; cut out and burn infected combs.

Stonebrood

Causative agent: The fungus *Aspergillus flavus*

Brood nest: Has gaps in the brood.

Cells: Some caps are punctured; affected cells can look greenish and mildewy.

Larvae: Greenish yellow, hard, and shriveled; larvae cling to the cell edges; dead larvae in sealed and

unsealed cells.

Odor: Musty.

Treatment: The disease will subside on its own (bees chew off and dispose of the affected cells).

Sacbrood (rare)

Causative agent: A virus whose exact identity has not yet been established.

Brood nest: Gaps in the brood.

Cells: Cell caps are dark, sunken, and punctured; inside the cells there are yellowish brown or dark gray scabs that the bees can easily remove.

Larvae: Gray to black, watery and granular consistency; dead larvae in sealed and unsealed cells, usually with the head sticking straight up. No filament forms when you do the match test.

Odor: Sour.

Treatment: The disease subsides on its own.

Pests

Waxmoths lay their eggs on both combs in hives and on combs that have been removed for storage. The emerging larvae, which feed on wax, destroy the combs. A waxmoth infestation can easily be recognized by the fine gray webs with which the larvae have lined the paths they have eaten through the comb. In strong colonies, the bees keep the waxmoths under control by killing the emerging larvae and carrying them out of the hive.

Prevention: After removal from the hive of any combs you want to store in hive bodies or in a comb storing cabinet, you should fumigate them two or three times after removal from the hive at intervals of three to four weeks. (You can buy fumigants with directions on how to use them from suppliers of beekeeping equipment.) Store the combs at room temperature or, better, somewhat cooler.

Treatment: If you have a major waxmoth infestation, the nests must be burnt and the ruined combs with holes in them must be cut out and melted

Above: Movable-frame hives in a flowering rape field. Below, right: The honey chamber of an open movable-frame hive filled with white wax cells that are full of honey (containing a good 30-40 pounds (15-20 kg) of honey. This kind of harvest is proof that the beekeeper has treated the bees right. Right: The author is demonstrating how gentle his bees are. The larger cells house drone brood, the darker cells below, worker brood.

Diseases, Pests, Dangers

bees. Help convince officials, as well as the public, that it is better not to destroy wild plants and "weeds" around the edges of fields, along roadsides, on the banks of rivers, and along the shores of lakes. If it is essential that these plants be removed, it can be done by mowing rather than by spraying.

If your colonies are suffering from poisoning through pesticides or herbicides, inform:

- the president of your beekeepers' association or his or her representative,

- the appropriate official of the state environmental protection agency,

- the person or company responsible for the damage, if known,

- the police in case of extensive damage.

Your beekeepers' association can supply you with information on how to get a sample to test the extent of poisoning. The association can also tell you how to prepare a report of the damage for your insurance company.

August

better the chance that the colony will be able to ~~maintain the necessary~~ temperature inside the hive.

The warmer the bees keep, the stronger the colony will be in the spring and the more bees will be able to collect nectar and honeydew to turn into honey.

- Last harvest of honey in areas with late flow.
- If you haven't done so yet, requeen old colonies (see page 34).
- If you haven't yet checked and reorganized the brood nest (see page 43), do so now.

Important Food Plants for Bees



Apple blossoms

These, like the flowers of all other fruit trees, are an important source of early honey.



Red clover

Flowers from early summer until fall, as do other types of clover.



Black locust

Black locusts grow along the edges of forests and hill sides. Their white flowers are a good nectar source.



Dandelion

Flowers at the same time as fruit trees provides nectar for summer blossom honey.



Linden or basswood blossoms

The scent of these blossoms is preserved in the honey-derived from their nectar.



Forest blossoms

Buckthorn, raspberry, blackberry, wild cherry, and germander blossoms supply nectar for forest flower honey.



Flowering rape

Rape is grown more often now, and apiarists transport their bees to rape fields in bloom.



Chestnut

This tree with its long flower panicles is a good food source in July.



Summer flowers

Dandelion, dogwood, and clover provide nectar for summer blossom honey.



Heather

Heather plants of the *Erica* and *Calluna* genera flower from August to September.



Forest trees

Spruce, larch, oak, beech, and other kinds of trees supply the honeydew that is made into forest honey.

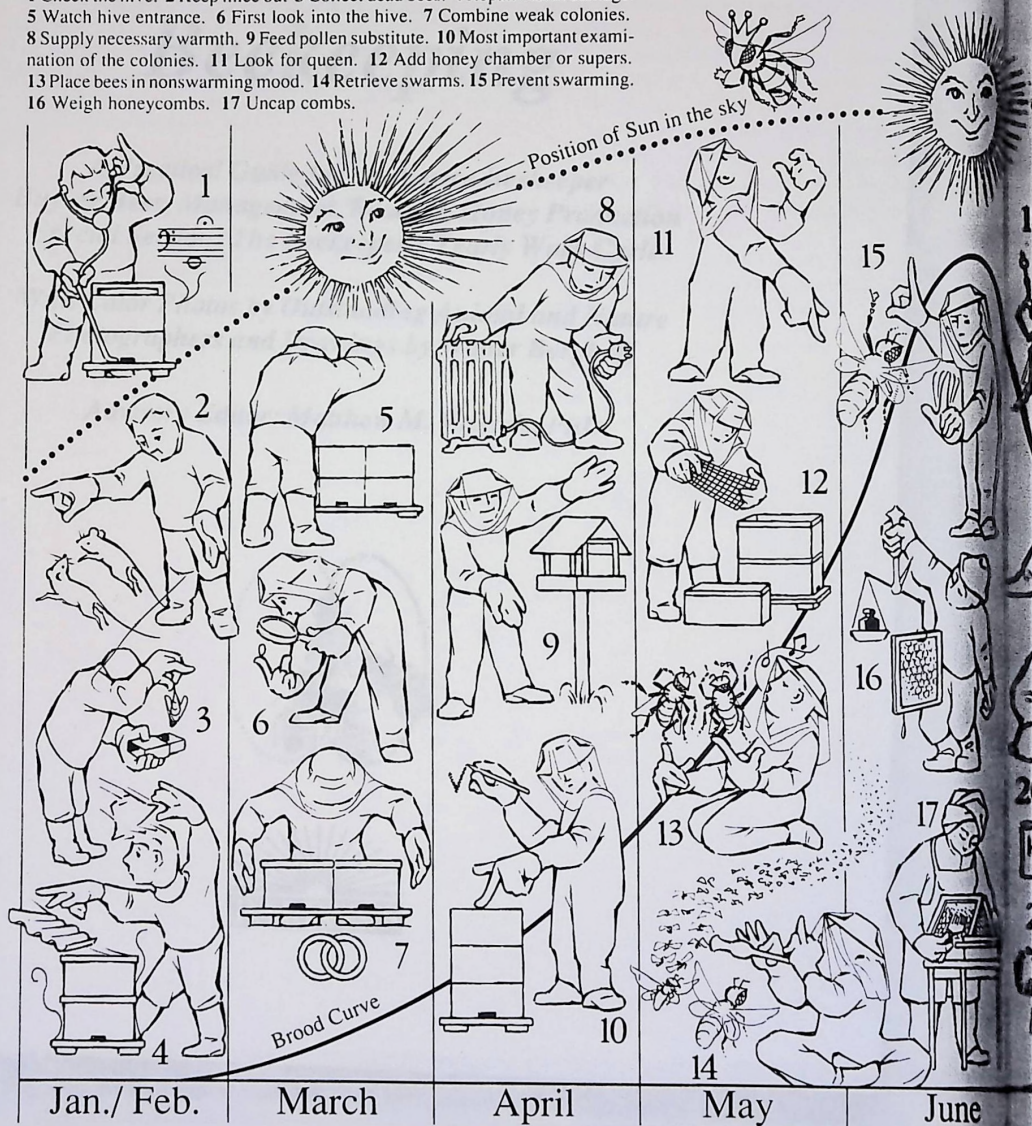


Fir

(*Abies alba*) Grows in forests. Through the intermediary of aphids, it provides the raw materials of fir honey.

The Bee Year at a Glance

1 Check the hive. 2 Keep mice out 3 Collect dead bees. 4 Repair storm damage.
5 Watch hive entrance. 6 First look into the hive. 7 Combine weak colonies.
8 Supply necessary warmth. 9 Feed pollen substitute. 10 Most important examination of the colonies. 11 Look for queen. 12 Add honey chamber or supers.
13 Place bees in nonswarming mood. 14 Retrieve swarms. 15 Prevent swarming.
16 Weigh honeycombs. 17 Uncap combs.



Werner Melzer

Beekeeping

*A Practical Guide for the Novice Beekeeper
Buying Bees, Management, Rearing, Honey Production
Special Section: The Beekeeper's Yearly Work Cycle*

*With Color Photos by Outstanding Animal and Nature
Photographers and Drawings by Walter Berghoff*

Advisory Editor: Matthew M. Vriends, PhD



A Short Introduction to Bees

How Bees Defend Themselves

There are always some hive bees stationed at the entrance as guards, and almost every bee that approaches is sniffed. If the guards recognize the characteristic odor of the hive, the bee is allowed to enter. A field bee from another colony that is carrying nectar or honey is allowed to pass too. Bees not carrying food may be potential robbers, however, and are driven away.

Bees hardly ever get lost trying to find their way home to the hive because in good flying weather there are not only guard bees stationed at the entry but also other workers that fan the hive scent toward the returning foragers by beating their wings fast with the rump raised high. This helps the field bees recognize their particular hive.

If wasps or hornets approach the hive entrance, their evil intentions are obvious. These insects are not only carnivorous but they also like to eat honey. Their appearance triggers instant attack. Additional hive bees quickly come to the aid of the guards. In such a battle the bees sometimes resort to their venomous stings, which they can extract again after use from the unelastic chitin shell of a wasp or hornet. If a bee stings a human or some other mammal, however, the elastic tissue of the stung victim contracts around the wound, and the barbs of the sting become embedded. When the bee flies off, she leaves the sting behind and with it usually the stinging mechanism and nerve strands. Having lost these parts of her anatomy, she dies.

If the sting with its poison sac is not removed instantly (see page 14), the venom is automatically pumped through the sting into the wound.

Bees Sting and Allergies

Bees sting only when provoked, and the sting is a defense mechanism. The sting is a barbed organ, and the barbs are made of chitin, the same material that makes up the bee's exoskeleton. The sting is located at the rear of the abdomen, and it is used to pierce the skin of an enemy. When a bee stings, it injects venom into the wound. The venom is a mixture of enzymes and other substances that cause pain and swelling. The sting is also used to defend the hive. If a bee senses a threat to the hive, it will sting the intruder. The sting is a very effective defense mechanism, and it is one of the reasons why bees are so successful as a species.

Conditions for Keeping Bees

The Right Location for Your Bees

Where will you put your bees? This is a question you must settle before you embark on beekeeping. The hives should be away from human dwellings. A place near an orchard, the edge of woods, or some unused land is ideal—somewhere where the colonies are undisturbed and have access to good forage within a radius of 1 or 2 miles (1.6–3.2 km) and where you can perform the necessary chores undisturbed. If you plan to keep bees in your garden (which should be at least about an acre), the hives must be placed at some distance from a neighbor's land. A visual barrier about 6 feet (2 m) high made up of bamboo mats or, better yet, a hedge of tall bushes or other plants will keep the bees from being a nuisance to your neighbors. If your garden includes fruit trees and thus offers a ready source of food for your bees, this is of course a great advantage. Setting up a small pond to satisfy the bee's need for water is also a good idea. Most states require registration and have laws regulating honeybees and beekeeping. For more details, please contact the U.S. Department of Agriculture and your county extension services, which publish pamphlets on various aspects of beekeeping.

A colony of bees uses up about 120 pounds (50 kg) of nectar or honeydew and about 45 pounds (20 kg) of pollen from March through September for its own needs (see page 8). The plants that provide this food are sometimes called forage or honey plants. You can assist your bees' labors and enhance the strength of the colonies by sowing nectar-producing plants in your own garden or on land nearby that is not being used for anything else. (Discuss the idea first with the owner of the land and get whatever permission may be necessary from local authorities.) When you pick the spot for your hives, try to find an experienced beekeeper to advise you. You will also want this person's advice if you decide to plant a forage crop for your bees.

Practical Training

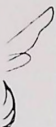
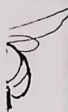
Before you acquire bees you should spend a season helping an established beekeeper look after his or her colonies. Sometimes weekend courses are offered by state agricultural colleges or by beekeepers' organizations, in which you can get some firsthand experience working with bees. For more theoretical learning you can turn to a number of textbooks. If your ambition is simply to keep some bees in your backyard and perhaps make a little money from selling honey—which is the case for the majority of beekeepers—you will not need any further training. A professional beekeeper, however, must go through more extensive preparations. In Germany an apprenticeship of 3 years plus 5–10 years of experience as an apiarist are required before an individual is allowed to operate a professional beekeeping operation. To become a professional apiarist you must also be willing to accept some risk and not be afraid of hard physical work.

Bee Stings and Allergies

Bee breeders in our day are particularly intent on producing nonaggressive strains, of which the Americanized Italian bee, the carniolan bee, and the caucasian bee are the most popular. Carniolan bees, which are the race I mainly work with and which I recommend to any beginner, are exceptionally gentle. Still, bee stings cannot be avoided altogether. Since bees sting only when they feel threatened, however, you can modify your behavior to minimize the chances of being stung. Whenever you work with bees, you should avoid abrupt or hectic movement. You should also make sure you're not wearing perfume or using toiletries that are perfumed because these scents arouse the bees. Wearing appropriate clothing (see page 22) also helps protect against bee stings.



Collects nectar and pollen



when
t 40
old

Conditions for Keeping Bees

If you are stung, it is important to remove the sting with its poison sac quickly so that as little of the venom as possible enters the body. Don't try to grasp the sting with your fingers and pull it out. This only causes the poison sac to empty out the rest of the venom into the wound. Instead, either brush the sting off with your fingernail without compressing it, or get hold of it between the poison sac and your skin with pincers and pull it out.

The swelling caused by bee stings can be alleviated by applying a compress of rubbing alcohol, saltwater, or onion juice, or with a commercial medicine, of which there are many.

If an individual is stung inside the mouth or in the throat or responds to being stung with dizziness or vomiting, or if an individual collapses after a massive attack of bees, call a doctor immediately.

First aid for swelling inside the mouth or throat—this could lead to suffocation: Sprinkle table salt all over the oral cavity by the spoonful (make sure none of the salt is swallowed!); spit out, and repeat several times. Get the victim to a doctor as quickly as possible.

If you know you are allergic but are not sure whether the allergy is triggered by exposure to bees or only in response to being stung, there are tests allergists can give you to find out the answer. There are effective countermeasures for allergies to bee venom, so the fact that you are allergic doesn't necessarily mean that you have to give up the idea of beekeeping. (For more information, write to the Office of Apiculture, Department of Entomology, Cornell University, Ithaca, New York 14850.)

Costs and Time Commitment

It is difficult to give a specific answer to the question of costs. Beekeeping is affected by weather and the health of the colonies, and the annual outlay for food and the prevention or treatment of disease is hard to predict accurately—and so is the likely income you may expect from the sale

of honey and other beekeeping products.

You must figure on initial costs for three hives (hive bodies, supers, accessories, clothes, and other equipment) amounting to approximately \$500. The price of bees for two colonies is about \$200. Add to this annually about \$10 for disease control, \$60 for food for the bees, \$40 for dues, and about \$50 for literature. This means that if you start with new equipment you will invest between \$800 and \$900 the first year.

You don't need to buy expensive harvesting equipment, such as an extractor (see page 36), to start with. Chances are that an apiarist in your area will let you borrow this equipment or you may be able to buy one cooperatively with another beekeeper.

If you take over bees and equipment from a beekeeper who wants to give up bees, your costs will of course be much less. You will probably be able to get 10 colonies with all the necessary equipment for about \$2000. Beekeepers' magazines often have ads for bees and equipment for sale by retiring apiarists. Before you commit yourself to buying, however, ask the advice of an experienced beekeeper.

Beginners and people wanting to keep bees as a hobby will not count the hours they spend with the bees as work. Apiarists with several years of experience figure they put in six to eight hours a year per colony. This includes only the time spent actually working with the bees, not the job of keeping the equipment in good shape and repairing it.

Apiary Organizations

I urge you strongly to join a beekeepers' organization. Membership not only provides you with advice on legal and insurance questions but also entitles you to take advantage at lower rates of many services offered by local and state groups.

There are state beekeeping organizations in every state, many local beekeepers' associations,

Bee Hives, Equipment, and Colonies

If you are clever with tools you can also build a pollen feeder (similar to a small birdhouse) and the worktable for a leaf hive (see drawing on page 20) yourself.

Clothing

Overalls made of a light, white material have proven useful protective clothing for working with bees. To keep the bees from crawling inside the clothes, the suit is equipped with a zipper in front, and the cuffs of the sleeves and pants have elastic bands in the seams. Don't wear dark or woolen clothes; dark colors and wool seem to irritate bees.

To protect your face, head, and hands from being stung wear light-colored gloves and a beekeeper's hat with a veil. Once you feel more comfortable handling bees you can dispense with the gloves, but there is no need to test your courage as a beginner.

Choosing the Right Race

For a beginner I recommend starting out with the Italian bee, *Apis mellifera linguistica*, America's most popular race, or, my favorite, the Carniolan or Austrian bees, *Apis mellifera carnica* (see photo on page 55). The latter, which are characterized by gray bands on the abdomen but are very similar to the Italian bee, offer a number of advantages:

- They are so gentle that you will be able to work with them soon without wearing gloves.
- They remain on the combs without becoming excited when you work with the hive. This is a particularly useful trait when you are looking for the queen. More excitable bees may retreat to the hive walls or some dark corner as soon as you remove a comb.
- Carniolan bees develop brood quickly, and the colonies therefore grow rapidly.
- Through selective breeding, this race can be

adapted well to existing conditions, such as the size of the hives and the location.

The Right Time to Get Started

The best time to buy bees or take over colonies in their hives is the spring. With this timing you will be able to harvest some honey the first year. Colonies with or without queens (see pages 30 and 34) and swarms (see page 7), that is, bees without hives, can be bought in June or July. If you attend beekeepers' meetings, you can ask around about who is selling new or established colonies, or you can consult beekeepers' magazines.

Transporting the Bees

It doesn't matter whether a novice starts with an established colony, a colony without a queen, or a swarm. There are a few rules that must be observed, however, both in transporting bees and in getting them established in their new location. The best time to move bees is evening. Hives with bees in them must never be left in the full sun. It is essential that the bees get enough oxygen because they panic if the oxygen gets low. In their agitation they use up more oxygen, which in turn excites them more, and gradually the temperature in the hive begins to rise. If it reaches 140°F (60°C), the wax begins to melt, the combs collapse, and the colony perishes.

So if you plan to move a colony in its hive, make sure to replace the inner insulating lid with a ventilation grid (see drawing on page 16). An even better way is to use hives with transport floors, that is, bottom boards with rims about 5 inches (10 cm) high and with fine wire screening on two opposite sides. During travel, the bees can leave their combs and hang in clusters from the bottom bars of the frames, where they get plenty of fresh air through the screening.

Bee Hives, Equipment, and Colonies

Advantages of Movable-frame Hives

- There is no need for a bee house.
- The hive space can be adjusted to the size of the colony by adding supers as needed. An easy way to form nucleus colonies is to add supers with queen excluders (see page 34).
- There is no need for special nucleus boxes (small hives).
- In the winter you can use the empty hive bodies for storing empty combs. Use separator boards as tops and bottoms for stacked hive bodies to keep out mice. This means that you don't need to buy or build special, rodent-proof cabinets for the combs.
- The frames filled with honey can be transported to an extractor inside the hive bodies, thus eliminating the need for special transport boxes.
- You will have a greater honey harvest than with leaf hives because the colonies are stronger.

The Disadvantages of Movable-frame Hives

Movable-frame hives require more physical strength than leaf-hives because sometimes hive bodies full of combs must be lifted. A super with all the frames filled with honey can weigh close to 50 pounds (20 kg).

Leaf Hives

A leaf hive (see drawing on page 20) consists of a wooden box that is subdivided by a horizontal metal grid into two equal spaces, the brood chamber below and the honey chamber above. The spaces of

Above: A comb with sealed worker brood. The brood nest is solidly filled and extends over the entire comb. In the two upper corners, honey and pollen are stored.

Below, left: Bees are being brushed off a comb with a bee brush. Right: A comb occupied by bees (left in photo) has been removed from the brood chamber and is about to be replaced with fresh foundation.

this excluder grid are large enough for the worker bees to pass through but too small for the queen. This way only worker bees can get at the combs in the upper chamber to deposit honey there. The combs containing the brood (the brood nest) are all in the chamber below. Since only combs from the top are taken out for honey extraction (see page 36), there is no chance of larvae being in the combs meant for honey production.

An inch or so above the bottom of the leaf hive and above the built-in excluder grid are racks of horizontal metal bars. The frames for the combs are slid onto these bars so that they are lined up vertically on the bars of the rack. When one frame is removed, the others can be moved to the right or left as needed. A leaf hive is worked from behind because the frames are taken out and inserted from the side opposite the hive entrance. The back wall of the brood chamber is made up of a wooden frame with a glass window. On the inside of this window frame there is an empty wooden frame that the bees can fill with combs. This is called the building frame. The type of cells constructed by the bees in this frame—worker, drone, or queen cells—indicates the mood of the colony (see page 25). (In a movable-frame hive an empty frame hung next to the brood nest fulfills the same function of "mood-indicator.") On the back wall of the honey chamber there is a wooden frame with a glass window or wire screen. The entire back side of the leaf hive is closed off by a wooden door. Most leaf hives come with pads that help insulate the brood and honey chambers.

Advantages of a Leaf Hive

- Leaf hives can be stacked one on top of the other.
- If leaf hives are located in a row at the right height, work with the bees can be done sitting down, a feature that is especially advantageous for older or physically handicapped persons.
- The glass window makes it possible to watch the bees without disturbing them, and the building frame that serves as mood indicator of the colony is open to view.

Care and Management

- A spur embedder is a small, movable cogwheel with grooved teeth (see drawing on page 21). Lay a sheet of foundation on the small wooden board, and then place a wired frame on top of the foundation. Heat the embedding tool over a small flame, and then run it along the wire in the frame. The heat of the tool warms the wire, which melts the wax of the foundation and becomes embedded in it.

- If you have more than ten colonies, it makes sense to invest in a small electric transformer (about \$50). With this device you can use low-voltage electricity to fasten the foundation. For this procedure you place the wired frame on the wooden board and the foundation on top of the frame. Then, touch the two ends of the electric cable to the heads of the tacks so that the electric circuit is closed. The wire and the wax on top of it are warmed by the current, and the foundation's own weight causes it to combine with the wire. When the wire cools, frame and foundation are securely connected. The entire process takes no more than a few seconds.

Insulating Hives and Spring Feeding

During spells of cold weather it is especially hard for the bees to maintain an even brood temperature of 95°F (35°C). Think of it this way: The more heat the bees must generate themselves, the shorter their life span. This is why you should wrap the hives with thick cloth and cover them with a tarpaulin. You should also angle a board 4–8 inches (10–20 cm) wide from the entrance to the ground. This ramp makes it easier for the bees to make their way back into the hive when it rains.

When it is cold and rainy, bees cannot go out foraging. Thus it can happen that there is not enough food for the brood. To prevent this most dire situation, observe the following rule of thumb: In the spring, there should be at least four or five filled combs in the outer frames of every hive, the

combs partially occupied by bees, and about two-thirds of the cells capped. This is the equivalent of approximately 20–25 pounds (10–12 kg) of food. If there are fewer-filled combs, you can take out empty combs close to the brood nest and replace them with filled ones that you remove from a colony that has a plentiful store of food.

You can also give the bees a boost by feeding them Candy for Bees, Hard Candy for Winter (or "sugar boards," as thin slabs of this prepared material are usually called), or sugar syrup. Once you have established how much food the bees need, you give them the appropriate amount (for amounts and feeders, see pages 40–42).

Feeding bees in the spring also has another purpose, namely, to stimulate brood rearing. For this purpose, however, bee candy or sugar syrup alone is not enough. The bees also need pollen. This is why you should offer your bees a pollen substitute (brewer's yeast or soy flour) in the spring in a pollen feeder ("birdhouse" feeder). Set up the pollen feeder in a sunny spot near the hives, making sure that the distance between the feeding surface and the roof of the feeder is at least 8–10 inches (20–25 cm). The bees need room to hover while they are packing the food into their pollen baskets (see page 8).

It is important not to start a feeding intended to stimulate brood rearing too early. Wait until after the gooseberry bushes flower. Otherwise the bees build too large a brood nest and will not be able to maintain the necessary temperature during cold weather. If the brood nest becomes too cool, the brood dies, and the overworked bees become susceptible to sickness and may die prematurely.

Cutting Out the Building Frame

A strong colony begins to occupy the building frame in April (see page 47). Some building bees attach themselves to the upper frame bar and form a cluster there. These bees proceed to "sweat" the

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Cutting Out the Building Frame

A strong colony begins to occupy the building frame in April (see page 47). Some building bees attach themselves to the upper frame bar and form a cluster there. These bees proceed to "sweat" the

Care and Management

wax (see page 5), with which they build combs. They usually start in several spots all at once, building heart-shaped sections of comb that are later connected into one seamless comb. While the days lengthen (see drawing on page 44), that is, until the summer solstice, bees build primarily drone cells, since drones must be raised in time for a virgin queen's nuptial flight in June or July (see page 7). When the building activity in the building frame lets up and the worker bees start shaping queen cells, the bees may be getting ready to swarm. The building frame thus serves as a kind of mood indicator of the colony. Every time the frame has filled, you should cut out the comb (run a sharp knife along the inside of the frame) so that the bees can start building combs again and you can again assess their mood.

Place combs you have cut out in the garden for a few days. Birds like to pick the grubs out of them. The wax can be melted in a solar wax heater (see drawing on page 41) and bartered in exchange for foundation, or you can keep the wax yourself and perhaps make beeswax candles out of it in the winter.

Methods to Prevent Swarming

Since bees intent on swarming (usually as early as March in the Southern states, and in July in the far north) lose interest in collecting nectar and raising brood and some of the honey harvest is lost if a colony swarms, you will want to try to suppress the swarming impulse or prevent the bees from taking off. The measures that need to be taken for this purpose are some of the most important activities of a beekeeper interested in obtaining maximum honey production.

Colony Expansion

As soon as a colony has filled all the cells in the brood chamber and if there is still room in the hive body, the bees must be given more space. To ac-

complish this, hang a frame with foundation (see page 24) or an empty comb next to the brood nest. From June on you can also hang these expansion frames directly into the brood nest. Keep adding frames until the brood chamber is full. When you add foundation, you should each time move the combs with the oldest brood to the outer edge of the brood nest. Then, when the brood has hatched, the combs can be filled with honey and, at the end of the honey season, they can be cut out (see disease prevention, page 57).

Opening up the Honey Chamber or Adding Supers

In May—in warmer regions as early as April—you should examine each colony carefully and check to see how healthy it is, whether the brood nest is well filled, and if there are any signs of disease (see page 57). In a normally developed colony, a good three-fourths of the combs are filled with brood by early May (or earlier in warmer climates), with the bees hanging below the combs in a cluster. This is the time to open up the honey chamber.

If you are working with a movable-frame hive, the following items should be ready: an empty super, a queen excluder (see drawing on page 16), a queen cage (a small cage made of wood or synthetic material; see drawings on pages 31 and 32), a queen-catching glass (see drawing on page 32), one or two frames with foundation (see page 24), and eight or nine frames with empty combs.

Above: An apiary with leaf hives. The small nucleus boxes (on the right, next to the regular hives) are used for rearing queens.

Below: A temporary hive stand that can be disassembled for transport. The entrances to the hives are marked in different colors to help returning bees find their own colony.

Care and Management

Introducing a Queen into a Brood Nucleus

Introducing a queen into a brood nucleus is also a good way to forestall swarming. What you need for this are a queen in a hatching cage, an empty hive body (for movable-frame hives) or a nucleus box (for leaf hives), a food comb (that is, a comb that is largely filled with honey but has no brood) from another colony, an empty comb, and a frame with foundation.

Before noon on a good foraging day, remove two or three brood combs without the queen from a strong colony and combine these combs with the food comb, the frame with foundation, and the empty comb that you have sprayed with a little water. Place all these combs in the empty hive body or nucleus box. In the evening, hang the queen cage with the queen in it between two brood combs. Wait 24 hours, and then replace the plug of the queen cage with one of bee candy. The bees will eat the candy and thus release the queen. If you are working with a nucleus box, the nucleus must be moved to a hive after three or four weeks.

Replacing Queens in Old Colonies

If you want to replace the old queen in a colony, you must be certain that the bees are not in a swarming mood. A queen introduced at such a moment would instantly be killed by the bees. Reasons for replacing an old queen are:

- A queen should never be kept more than three years because a colony with an older queen is likely to lose strength. The time to replace an old queen is August or September.
- If the brood nest shows gaps or remains small, it is usually because the queen is missing a fore or hind leg and can no longer hold on properly to the edges of the cells when laying eggs. In this case, requeening is the only solution.

- If the bees sting more than usual even with proper handling, the genetic makeup of the queen is probably to blame. Here, too, requeening can help. There are several methods of replacing queens.

Requeening a Colony That is Left Queenless for Nine Days

Remove the old queen along with two or three brood combs from a hive to form a nucleus (see page 30). The queenless bees left in the hive will build queen cells, which you break out after nine days. The bees will get restless three or four hours later because in the course of the nine days all the cells were sealed and there is now no longer any possibility of rearing new queens. Place your new queen in the nucleus box after plugging the opening of her cage with bee candy (see left).

In the fall you can dispose of the old queen by squashing her against the frame with your thumb. The brood combs of the nucleus can be added to weak colonies.

When you requeen a colony that has been queenless for 9 days, the queen is usually accepted without problems, but there is a period of 10–12 days during which no new brood is produced.

Quick Requeening

The two methods described below can be used only before and after swarming season.

Lock the old queen in a queen cage, which you then hang between two brood combs. The next day you remove the old queen and substitute a new one but leave the cage in place. After another day you replace the plug of the queen cage with bee candy.

If you want to requeen in one day, you must follow another procedure for which you need a small wooden frame with plastic or wire screening (available from bee supply houses).

Remove the old queen from the colony. Brush the bees from a light-colored comb with hatching larvae, and set the new queen on it. Press the screen frame over the queen and into the wax deep enough

Care and Management

You can also feed diluted honey (half a pint every other day, honey and water mixed in equal parts), but use only honey from your own bees. If you use honey from other sources, the danger of introducing disease (foulbrood) is too great. You must also supply a pollen substitute (brewer's yeast or soy flour). This is particularly important for bees foraging in forests, where enough summer and fall blossoms are often not available for the bees (2 pounds of pollen substitute lasts for three to four weeks).

Since the limited availability of food offered by the beekeeper resembles conditions when the honey flow is too sparse to permit storing honey for future use, the bees tend to respond by raising new brood. Interim feeding can thus be regarded as a stimulus to increase population. If the natural food sources start flowing again, supers or honey chambers must be reopened (see page 26).

At times when natural food sources dry up, there is danger of robbing. Bees from other colonies or from neighboring apiaries may clean out all the honey from your hives. This is why you should take the following precautions:

- Don't leave honey or food combs exposed.
- Don't take too much time checking the colonies, and don't leave the hives open long.
- Don't spill any syrup; if some does spill, wipe it up thoroughly, down to the last tiny drop.
- Reduce the hive entrance by two-thirds; in nucleus boxes leave open only a small slit ($\frac{3}{4} \times \frac{1}{4}$ inch, 1×2 cm). The guard bees must be able to defend the entire entrance.
- Don't feed liquid food until the evening when the bees have stopped flying.

Management of Weak Colonies

Don't try to winter over a weak colony; it is bound to die before spring. If you have two weak colonies, one with a good and one with a poor queen

(too old or damaged, or that is likely to produce bees that sting, see page 34), combine the two colonies in August. Find the undesirable queen and dispose of her (see page 34). In a movable-frame hive, place the hive body with the queenless bees either on top or underneath the colony with a queen. In a leaf frame, hang the combs with the queenless bees next to the bees with a queen.

If you have two weak colonies with poor queens, kill both the queens (see page 34) and add the brood combs to a mediocre colony that has a good queen.

Rearranging the Combs

In the fall the bees occupy only those combs on which several broods have been reared. This is why you must rearrange the combs in July or August. Remove all the light-colored combs that don't have brood in them as well as any foundations without drawn combs.

Hold old combs that have had brood in them several times against the sun or a bright light and see if any light shows through. Each emerging bee leaves a thin film of cocoon behind in the cell, and if there are enough of these cocoon layers that the light is no longer visible, the cells are too small for new brood. Cut dark combs (combs that block the light) out of the frames and melt them in a solar wax melter or exchange them for foundation. Light combs that are still diaphanous should be stored together with foundations until spring in hive boxes or a special comb-storage cabinet.

If any drone combs are present (combs made up entirely of drone cells, see page 6), these too should be removed.

Feeding to Stimulate Brood Production and Fall Feeding

For beekeepers in areas with early honey flow it is especially important to start the winter with

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window to the brood chamber closes tightly. Drafts are harmful to bees, and the flight entrance provides enough air exchange for the hive.

Hives that are left outdoors must be covered with roofing paper that is weighed down with laths and rocks. To keep out mice, you should plug the entrance with blocks that have 1/2 inch slits in them or with wire screening. Both are available from suppliers of beekeeping equipment.

In the fall and winter, birds often catch bees that venture outside the entrance. To prevent this you can put netting in front of the hives. I myself don't use netting because so far I have found no evidence of birds preying on my bees. Often only those bees that are weakened by cold and have trouble returning to the hive are picked off by the birds.

Chores for Winter

You should inspect your hives periodically during the winter. Never open up the hives. Just look to see if the roofing paper has been damaged by storms and if the mouse blocks are still in place. Any damage should be fixed. Proceed quietly, and don't make knocking noises. On these inspection tours you will see many old, dead bees. Remove them carefully, but don't disturb the colony. Place a few of the dead bees in a small box, and keep them in a cool place until you can have them checked for nosema and acarine disease (see page 53) at your state testing laboratory (ask your beekeepers' association for the address).

Winter is the best time to build new hives and frames (see page 24). You can also repair equipment that is not in use at this time of year.

This is also the time to assemble all the current year's records you have entered on cards for each hive and analyze the information. This allows you to compare the performance of the different colo-

nies. Keeping accounts (of expenses as well as income) shows you whether you have made a profit and how much.

If you keep your bees in a bee house, throw some cloths and blankets over the hives in February. The bees begin to forage for nectar and pollen (willow blossoms) in February and start a brood nest. For them to be able to maintain a brood temperature of 95°F (35°C), they need this extra insulation. Don't remove the covers until you open up supers for honey storage.

Spring Chores

As soon as the weather is warm enough in March, it is time for the first look into the hives:

Check to see if a functioning queen is present. A colony without a queen hums restlessly; fecal droppings are near the hive entrance, and there is no sign of brood. If this is what you find, the only solution is to combine the bees with a "queenright" colony, a colony with a queen (see page 34).

If you have a weak colony with a cluster only about the size of a fist and the combs are stained with droppings, the bees must be gassed. The bees are too few in number and too sick to survive, and if they were added to a stronger colony, they would endanger those bees' health. Light a piece of sulfur (available from suppliers of beekeeping equipment), replace the hive lid, and plug the entrance. The sulfuric gases kill the sick bees very quickly.

Check to make sure that the bees have enough food close to the brood nest. Full combs should be moved over to replace the empty ones near the brood nest. Don't forget to replace the insulating lid after your examination of the hive.

The next management chores are spring feeding and various measures to prevent swarming (see page 26).

Diseases, Pests, Dangers

bees. Help convince officials, as well as the public, that it is better not to destroy wild plants and "weeds" around the edges of fields, along roadsides, on the banks of rivers, and along the shores of lakes. If it is essential that these plants be removed, it can be done by mowing rather than by spraying.

If your colonies are suffering from poisoning through pesticides or herbicides, inform:

- the president of your beekeepers' association or his or her representative,

- the appropriate official of the state environmental protection agency,

- the person or company responsible for the damage, if known,

- the police in case of extensive damage.

Your beekeepers' association can supply you with information on how to get a sample to test the extent of poisoning. The association can also tell you how to prepare a report of the damage for your insurance company.

Drone congregating areas Geographically favorable spots that attract drones eager to mate with young queens.

Drone killing Expelling of drones in the late summer after the reproductive drive has passed and the drones are no longer of use to the colony.

Early flow area Area where the honey flow comes early, from March to about July.

Entrance An opening through which the bees can leave and enter the hive.

Equipment for harvesting honey See page 35.

Excluder grid A grate inserted between the brood chamber and the honey chamber with spaces wide enough (between $\frac{1}{4}$ and $\frac{3}{16}$ of an inch, 4.3 mm) for the worker bees to pass through but not the larger queen.

Extracting room A work room that is bee proof.

Fanning Rapid beating of the wings near the entrance that causes air to move through the hive (ventilation).

Feeding, fall Replenishing the colony's food stores for the winter.

Feeding to stimulate brood rearing When there is no food from natural sources, the beekeeper must feed the bees so that they will carry on the brood business.

Flower fidelity Bees usually visit only one kind of flower on a foraging trip. This plays an important role in the preservation of the purity of species. Other insects move indiscriminately from flower to flower.

Field bee Bees are subject to a strict division of labor. During the first 12 days of life they work inside the hive; afterward they serve as field bees, collecting nectar, honeydew, and pollen (see pages 6 and 12).

Flight direction The direction in which the entrance points.

Flour test See page 31.

Forage bee See *Field bee*.

Foundation A thin sheet of beeswax with the honeycomb pattern for workers' brood cells embossed on it. The bees build or "draw" complete cells on both sides of the foundation.

Frame A wooden frame that holds comb foundation and is reinforced by wire (see *Foundation*).

Frame sizes The two frame sizes most commonly used in Germany are the German normal size, 37 x 22.3 cm, and the Zander size, 42 x 22 cm.

Frames, self-spacing These ensure that the frames hang or stand about $\frac{3}{4}$ inches (10 mm) apart (see *Bee space*).

Frame wire Wire used to reinforce frames to keep foundation from sagging.

Gassing Destroying a contaminated colony by burning sulfur.

Guard bees Worker bees that guard the hive entrance (see pages 7 and 11).

Hair Bees are covered almost completely with furlike hair. When they visit flowers, pollen sticks to the hair (see Feeding and Pollination, page 8).

Hive A wooden box in which bees live (see pages 16-20).

Hive bee Young worker bee up to 20 days old that works only in the hive (see pages 6 and 7). Also called house bee.

Hive body Part of a hive.

Hive, leaf A hive that is worked from behind. The frames rest vertically on a grate of metal bars, their ends toward the entrance. When one frame is re-

Shaking

bees and produces a scent characteristic of that particular colony.

Shaking Moving a swarm from a box into the hive by giving the box a good shake or whack.

Smell, sense of The scent receptors of bees, which are located on the antennae, are very sensitive.

Smoke Smoke is blown at the bees to calm them.

Smoker A metal fire pot with bellows and a funnel to aim the smoke at a given target.

Smoker fuels Tobacco, punky wood, or dry pine needles.

Spring dwindling Population loss in the spring when old bees die faster than new ones emerge to take their place. Within reasonable limits this is a normal development.

Spur embedder A small brass wheel with grooved spurs used to mount the foundation into the wired frames.

Soy flour Pollen substitute (protein).

Sulfur Sulfur is used to kill diseased colonies.

Supersedure A colony replaces an old queen with a young one without swarming.

Swarm, artificial See page 33.

Swarming Natural division of a colony: Some of the bees move out of the hive (see *Swarm, prime* and *After swarm*).

Swarming impulse Bees are moved to swarm when the hive becomes congested; this occurs at the high point of the colony's population increase (see pages 6 and 26).

Year color

Swarm, prime The portion of the colony that leaves the hive with the old queen.

Uncapping Removal of the wax covers of combs filled with honey.

Vision Bees can distinguish colors. They are color blind to red but can see ultraviolet. Painting a part of the hive near the entrance in accordance with their color sense helps bees orientate themselves.

Water source A stream or other body of water or some watering device set up near the hives that supplies the bees with the water they need for processing food and regulating hive temperature.

Wax Worker bees excrete wax from glands located on the underside of the body between the abdominal segments.

Wax melter, solar A glass-covered box used for melting wax (old combs) by means of solar heat.

Waxmoth A parasite that destroys the combs.

Winter bees Bees that hatch in August and winter over.

Winter rest Bees survive the winter by contracting into a tight cluster.

Wiring foundation Stabilizing of the combs.

Worker Female bee with only partially developed ovaries; workers perform all the jobs, both inside and outside the hive, necessary for the survival of the colony (see pages 6 and 8).

Year colors To make it easier to find a queen and to keep track of her origin and age, she can be marked with a tiny disk attached to her thorax. The disks come in five different colors, each signifying a different year (see page 32).

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• A spur embedder is a small, movable cogwheel with grooved teeth (see drawing on page 21). Lay a sheet of foundation on the small wooden board, and then place a wired frame on top of the foundation. Heat the embedding tool over a small flame, and then run it along the wire in the frame. The heat of the tool warms the wire, which melts the wax of the foundation and becomes embedded in it.

• If you have more than ten colonies, it makes sense to invest in a small electric transformer (about \$50). With this device you can use low-voltage electricity to fasten the foundation. For this procedure you place the wired frame on the wooden board and the foundation on top of the frame. Then, touch the two ends of the electric cable to the heads of the tacks so that the electric circuit is closed. The wire and the wax on top of it are warmed by the current, and the foundation's own weight causes it to combine with the wire. When the wire cools, frame and foundation are securely connected. The entire process takes no more than a few seconds.

Insulating Hives and Spring Feeding

* During spells of cold weather it is especially hard for the bees to maintain an even brood temperature of 95°F (35°C). Think of it this way: The more heat the bees must generate themselves, the shorter their life span. This is why you should wrap the hives with thick cloth and cover them with a tarpaulin. You should also angle a board 4–8 inches (10–20 cm) wide from the entrance to the ground. This ramp makes it easier for the bees to make their way back into the hive when it rains.

When it is cold and rainy, bees cannot go out foraging. Thus it can happen that there is not enough food for the brood. To prevent this most dire situation, observe the following rule of thumb: In the spring, there should be at least four or five filled combs in the outer frames of every hive, the

combs partially occupied by bees, and about two-thirds of the cells capped. This is the equivalent of approximately 20–25 pounds (10–12 kg) of food. If there are fewer-filled combs, you can take out empty combs close to the brood nest and replace them with filled ones that you remove from a colony that has a plentiful store of food.

You can also give the bees a boost by feeding them Candy for Bees, Hard Candy for Winter (or "sugar boards," as thin slabs of this prepared material are usually called), or sugar syrup. Once you have established how much food the bees need, you give them the appropriate amount (for amounts and feeders, see pages 40–42).

Feeding bees in the spring also has another purpose, namely, to stimulate brood rearing. For this purpose, however, bee candy or sugar syrup alone is not enough. The bees also need pollen. This is why you should offer your bees a pollen substitute (brewer's yeast or soy flour) in the spring in a pollen feeder ("birdhouse" feeder). Set up the pollen feeder in a sunny spot near the hives, making sure that the distance between the feeding surface and the roof of the feeder is at least 8–10 inches (20–25 cm). The bees need room to hover while they are packing the food into their pollen baskets (see page 8).

It is important not to start a feeding intended to stimulate brood rearing too early. Wait until after the gooseberry bushes flower. Otherwise the bees build too large a brood nest and will not be able to maintain the necessary temperature during cold weather. If the brood nest becomes too cool, the brood dies, and the overworked bees become susceptible to sickness and may die prematurely.

Cutting Out the Building Frame

A strong colony begins to occupy the building frame in April (see page 47). Some building bees attach themselves to the upper frame bar and form a cluster there. These bees proceed to "sweat" the

where bees is short on needs by giving them from the meat partner

food Rainy season in February 25

* This is the period when bees are closest to die

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You can also feed diluted honey (half a pint every other day, honey and water mixed in equal parts), but use only honey from your own bees. If you use honey from other sources, the danger of introducing disease (foulbrood) is too great. You must also supply a pollen substitute (brewer's yeast or soy flour). This is particularly important for bees foraging in forests, where enough summer and fall blossoms are often not available for the bees (2 pounds of pollen substitute lasts for three to four weeks).

Since the limited availability of food offered by the beekeeper resembles conditions when the honey flow is too sparse to permit storing honey for future use, the bees tend to respond by raising new brood. Interim feeding can thus be regarded as a stimulus to increase population. If the natural food sources start flowing again, supers or honey chambers must be reopened (see page 26).

At times when natural food sources dry up, there is danger of robbing. Bees from other colonies or from neighboring apiaries may clean out all the honey from your hives. This is why you should take the following precautions:

- Don't leave honey or food combs exposed.
- Don't take too much time checking the colonies, and don't leave the hives open long.
- Don't spill any syrup; if some does spill, wipe it up thoroughly, down to the last tiny drop.
- Reduce the hive entrance by two-thirds; in nucleus boxes leave open only a small slit ($\frac{3}{4} \times \frac{3}{4}$ inch, 1×2 cm). The guard bees must be able to defend the entire entrance.
- Don't feed liquid food until the evening when the bees have stopped flying.

Management of Weak Colonies

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(too old or damaged, or that is likely to produce bees that sting, see page 34), combine the two colonies in August. Find the undesirable queen and dispose of her (see page 34). In a movable-frame hive, place the hive body with the queenless bees either on top or underneath the colony with a queen. In a leaf frame, hang the combs with the queenless bees next to the bees with a queen.

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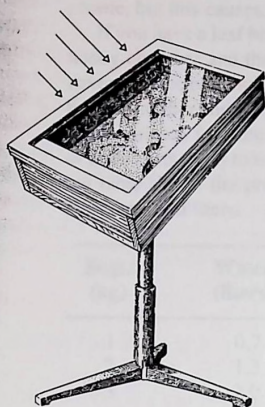
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Feeding to Stimulate Brood Production and Fall Feeding

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A solar wax melter that uses solar energy to melt old combs. The sun's rays, which hit the sloping glass top, heat the inside of the box to as much as 180°F (80°C), and a slate bottom stores the heat. Beeswax, which melts at about 150°F (65°C), drips into a receiving pan and hardens overnight.

strong colonies. Only strong colonies can take full advantage of the spring honey flow and collect an optimum amount of honey. In areas where the honey flow comes early one cannot count on harvesting honey after the end of July. To encourage the bees to keep rearing brood, you should start feeding them after removing the supers (see page 40). There are three possible methods: you can give them half a pint of sugar water (one part sugar to one part water) every other day, you can feed them bee candy (2 pounds every two weeks), or you can give them half a pint of diluted honey (half honey and half water) every other day. (Make sure you use honey only from your own bees!) Continue the feeding until the end of August. If there are no natural pollen sources, you must also make ready some pollen substitute (see page 25).

In areas with late honey flow, feeding to stimu-

late brood production is usually not necessary because the woods normally provide food until August. (If there is no honeydew, you should of course start feeding to stimulate brood production.)

The nectar, honeydew, and pollen that the bees collect and store from August on (from natural food sources or food provided by the beekeeper) are not enough to carry them through the winter and into the spring, and you must help them with additional feeding.

You should start the fall feeding in early September (two weeks earlier at altitudes above 1500 feet, 500 m), whether the honey flow is late or early. Note: Forest honey must be extracted before it is given to the bees.

You must assess how much food the bees will need. A common estimate of the food needs of a colony wintering over in one hive box is 17–22 pounds (8–10 kg); bees wintering over in two hive boxes need about 33 pounds (15 kg).

You can determine approximately how much the bees have already stored for the winter by using the following information:

- A piece of comb measuring 4 × 4 inches (10 × 10 cm) contains about 12 ounces of food or honey.
- A comb in a Hoffman frame (usually 4½ × 16¾ inches, 11 × 42.5 cm) and with sealed cells on both sides holds about 4 pounds of food or honey.

Figure out how much food the bees are short by subtracting your estimate of how much the bees have already stored from the amount needed for survival (see above). If you use bee candy, however, you must give the bees about 10% more than the amount you calculated. The candy must be processed by the bees before it is ready for storage, an activity that requires energy, which has to be provided in the form of food.

If you have movable-frame hives, remove the cover and the plastic sheet and place an insulating cover of appropriate size and with a hole in it on top of the combs. This "bung-hole" should be 3¼ inches (80 mm) in diameter. The bee candy is placed on

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this hole, and an empty hive body placed over the cover with the candy. Or you can simply fold back a corner of the plastic and place the bee candy on the plastic, but this causes more loss of heat.

If you have a leaf hive, remove the combs in the honey chamber and the queen excluder. Place the cover with the bunghole directly on the combs of the brood chamber and the bee candy on the bunghole.

Or you can feed the bees a sugar solution made of three parts sugar to two parts water. The following table shows the proper mixing proportions in kilograms and liters:

Sugar (kg)	Water (liters)	Amount Produced (kg)
1	0.7	1.2
2	1.3	2.4
3	2.0	3.6
4	2.7	4.8
5	3.3	6.0

The sugar and water are mixed together, heated (but not boiled!), and stirred until the sugar is completely dissolved. Liquid food must be given to the bees in feed troughs or special feeders. The most common type of feeder for both movable-frame and leaf hives is a 5 liter jar with a cover made of a fine bronze mesh. The full jars are placed upside down on the bunghole above the brood combs. The force of the vacuum keeps the sugar water from pouring out but allows the bees to absorb it through the tiny spaces in the bronze mesh.

In addition to feeder jars there are also food troughs in drawers (holding between 5 and 6 liters) that fit exactly into the hive body on top of the brood chamber.

Leaf hives are available, with a feeding trough holding 1 liter built into the side wall.

The bees should be fed 1 liter of sugar water a day. The feeder must be washed with clean, hot water after every feeding.

Here is an example of how the feeding works:

You estimate that a colony occupying two hive bodies has stored about 5 kg of food. Assuming that the bees need about 15 kg to make it through the winter, there is a shortage of 10 kg. By mixing 9 kg of sugar with 6 liters of water, you get 10.8 kg of winter food. If you feed liquid syrup, you can give each colony 1 liter a day or 5–6 liters per week.

Feeding the bees daily is more work than less frequent feeding, but the queen will lay more eggs. If you feed Candy for Bees, or Hard Candy for Winter (see page 00), start by putting half a 15 kg package on the bunghole. Depending on how much food you expect your bees to need, you can add more as needed later. Feeding bee candy always has the effect of stimulating brood production.

Regardless of your method of feeding and whether you rely on an early or late honey flow, the feeding should always be completed by mid-September. If you live at altitudes above 1500 feet (500m), the winter feeding should be completed by the first of September.

Important note: The last time you check your hives, you must ascertain if there is enough food to last the winter. All the combs occupied by bees should have at least two-thirds of the cells capped by the end of September or beginning of October; that is, they must be filled with food. If this is not the case, supply extra food in liquid form immediately.

Last Preparations for Winter

After you have removed and cleaned the feeders, you should collect all the record cards in October. On days when the weather is above freezing and when there is only minor flying activity, you can repaint outdoor hives with an odorless paint that is safe for bees (buy the paint from a supplier of beekeeper's equipment). Make sure the covers fit tightly, and if necessary, make a tighter seal by fitting a sheet of clear plastic or a cloth of natural fiber over the hive body. If you have a leaf hive, install the insulating lid and check to make sure that the

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window to the brood chamber closes tightly. Drafts are harmful to bees, and the flight entrance provides enough air exchange for the hive.

Hives that are left outdoors must be covered with roofing paper that is weighed down with laths and rocks. To keep out mice, you should plug the entrance with blocks that have 1/2 inch slits in them or with wire screening. Both are available from suppliers of beekeeping equipment.

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The next management chores are spring feeding and various measures to prevent swarming (see page 26).

Examine them for disease

Care and Management

In this chapter I explain all the chores a beekeeper must perform in order to harvest as much honey as possible. A chronological listing of what needs to be done month by month is given under the heading The Beekeeper's Yearly Work Cycle (see page 46).

Assembling the Frames

To add stability to the combs that the bees build, the foundation in the frames has wires embedded in it. In the United States and England, unfortunately, many different sizes of frames are in use. I recommend to the beginner the most common frame, the Hoffman or self-spacing frame. With this type it is impossible to make the mistake of putting too many or too few frames in each hive. The frames are spaced by the extra thickness of wood at the top of the side bars. This spacing, often called the Hoffman spacing, is usually $1\frac{1}{2}$ or $1\frac{3}{4}$ inches (3.8 or 3.5 cm) center to center.

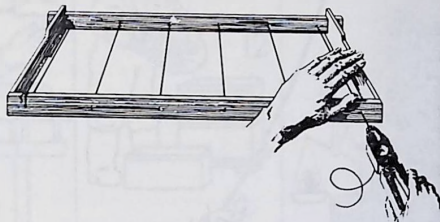
If you want to build your own frames, you should make sure to get the standard thickness of wood from a supplier of bee equipment. The ends of the frame bars are coated with a water-insoluble glue before they are nailed together at a 90° angle at the corners.

Wiring the Frames

The foundation is a sheet of wax the size of the inside dimensions of the frame. To attach it securely to the frame, the frame must be reinforced or "wired" (see drawing in next column). Use a hand or electric drill or a special beekeeper's awl (available from beekeepers' suppliers) to drill four or six small holes (depending on the make of the equipment you are using) along the centerline of the two bars that make up the longer sides of the frame. The outer holes are drilled about 1 inch (3 cm) from the ends; the remaining two or four holes are spaced so that all holes are at an equal distance from each

other. Then take two small nails or tacks and tap them into the ends of one bar between the outer holes and the ends. Don't tap them in all the way but leave enough room to be able to wind the reinforcing wire around them.

Now you are ready to thread the wire through the hole next to one tack, then through the corresponding hole on the opposite bar, then through the next hole on the same bar, back to the slat you started on, and so on, as though you were stitching the bars together. You will finish at the hole next to the second tack. Wrap the end of the wire around this tack; then start pulling on the loose end until the wire between the tacks is tight but doesn't bend the bars. Wrap this end around the tack next to it, and nail the tacks in all the way.



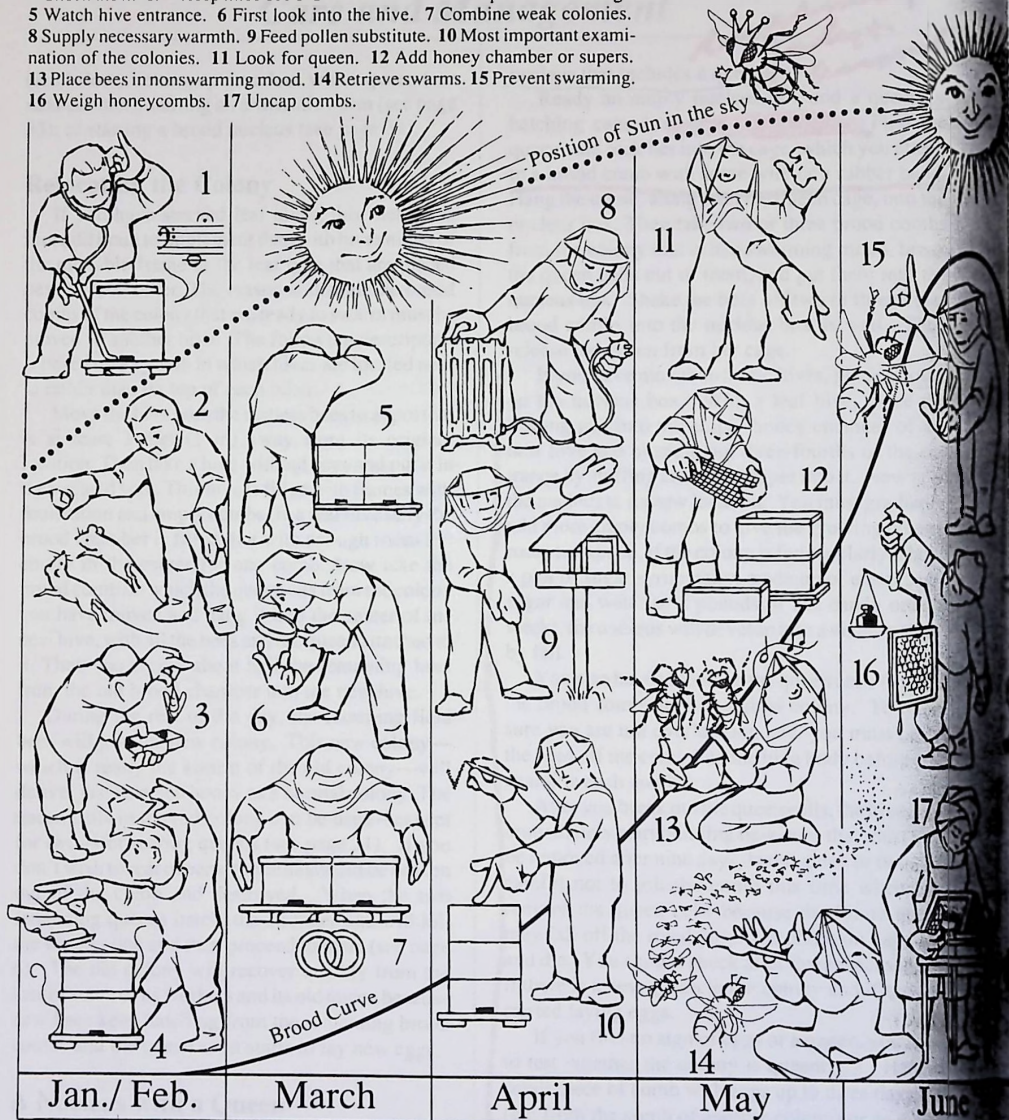
Wiring a frame. Tighten the threaded wire with pliers, and secure the ends of wire by wrapping them around a tack that is hammered into the wooden frame. The frame is now ready for the foundation, which can be embedded with a spur-wheel embedder or a transformer.

Fastening the Foundation

To fasten the foundation to the frame, you need a small wooden board a hair smaller than the frame's inside dimensions and half the thickness of the frame. (If the frame's depth is $\frac{1}{2}$ inch (10–12 cm), the board would have to be just barely $\frac{1}{4}$ inch (5–6 cm) thick. The wire can be embedded in the foundation either with a hand embedding tool (spur embedder) or with a small electric transformer.

The Bee Year at a Glance

1 Check the hive. 2 Keep mice out 3 Collect dead bees. 4 Repair storm damage.
5 Watch hive entrance. 6 First look into the hive. 7 Combine weak colonies.
8 Supply necessary warmth. 9 Feed pollen substitute. 10 Most important examination of the colonies. 11 Look for queen. 12 Add honey chamber or supers.
13 Place bees in nonswarming mood. 14 Retrieve swarms. 15 Prevent swarming.
16 Weigh honeycombs. 17 Uncap combs.



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(see below), setting up a nucleus with a queen (see next column), starting an artificial swarm (see page 33), or starting a brood nucleus (see page 34).

Relocating the Colony

If you have stacked leaf hives, this method is more difficult to implement than with hives either of the movable-frame or the leaf type that are placed next to each other. The reason is that all the brood combs of the colony that are ready to swarm must be moved to another hive. The following description is based on a system in which hives are located next to rather than on top of each other.

Move the hive with the restless bees to a spot that is at least 3 feet (1 m) away from its original location. Then take a hive without bees and put it in the vacated spot. This hive is filled with frames with foundation and empty combs (in a leaf hive only the brood chamber is filled) but with enough room left empty in the center for one comb. Now take the brood comb on which the queen sits from the colony you have moved and hang it into the center of the new hive, with all the bees and the queen attached to it. Then you empty about half the remaining bees from the old brood chamber into the new hive.

During the rest of the day, the returning field bees will join the new colony. This new colony—which is really the swarm of the old colony—will deliver just as much honey as a normal colony. The queen cells in the old colony can be used—except for two—for rearing queens (see page 31). If you don't wish to rear queens, the cells should be broken out of the comb and destroyed. When the two remaining queens hatch, the stronger one will kill the weaker one and then proceed to mate (see page 6). The old colony will recover quickly from the loss of some of its workers and its old queen because new bees keep hatching from the remaining brood combs and the queen soon starts to lay new eggs.

A Nucleus with a Queen

Another way to forestall swarming when larvae are already developing in queen cells is to form a

nucleus that includes a queen.

Ready an empty nucleus box and a queen or hatching cage (see pages 31 and 32). Find the queen, and lock her into the cage, which you attach to a brood comb with some wire or a rubber band. Hang the comb, along with the queen cage, into the nucleus box. Then take two or three brood combs from the colony that is in a swarming mood, break the queen cells out of them, and put them into the nucleus box. Shake the bees off two or three other brood combs into the nucleus box as well. Then release the queen from her cage.

If you have movable-frame hives, place a cover on the nucleus box. With a leaf hive, place the heating pad into the empty honey chamber of the new hive and block about three-fourths of the entrance by stuffing crumpled paper into it. Now take the nucleus to its new location. You must gradually add more empty combs to give the growing colony room to expand. If the colony is fed regularly (about a pint of sugar syrup daily, made up of equal parts sugar and water or 2 pounds of bee candy once a week), the nucleus will develop into a viable colony by fall.

You also have to remove the queen cells from all the brood combs in the original colony. To make sure you are not overlooking any, you must brush the bees off the comb into the hive body before you examine each comb.

After you break out the queen cells, the hive bees immediately start building new ones that must also be removed after nine days, leaving one or two. Be careful not to jolt the comb this time when you remove the queen cells because the future queen may fall off the royal jelly (see photo on page 38) and die. You should check after three weeks to see if there is a new queen in the colony and if she has started laying eggs.

If you find no sign of eggs or a queen, you have to test whether the colony is queenright. Hang a small piece of comb with eggs up to three days old (cut from the comb of another colony) or an entire comb with eggs and young larvae up to three days old into the hive. Mark the comb with a thumbtack.

Diseases, Pests, Dangers

The bee louse (Braula coeca), an insect with six legs that is about 1–1.5 mm in diameter (see drawing on page 53), usually attaches itself to the thorax of a bee and takes food from its proboscis. On queen bees as many as 20 lice have been counted, although on worker bees they occur only singly. Bee lice don't do any direct harm, but they bother the bees. Queens infested with them slacken their egg laying.

Remedy: Slip a piece of paper with some naphthalene sprinkled on it into the hive underneath the combs in the evening. The naphthalene paralyzes the lice, and they drop down on the paper. The next morning remove the paper carefully. Promptly burn the paper with the lice on it. *Klara*

Wasps usually pick off only sick bees or bees that are unable to fly off the landing board in front of the hive. In the fall, however, wasps also try to get at the honey inside the hive. The guard bees at the entrance can easily ward off individual wasps (see page 11), but when many wasps attack all at once, there is danger of robbing.

Remedy: Partially block off the entrances in the fall. In the spring you can place bulging bottles with narrow necks, filled up to a quarter with thin honey water or fruit juice, near the hives. The wasps are attracted by the sweet smell and drown in the liquid.

Hornets have become comparatively rare and therefore pose no threat to honeybees.

Burrowing wasps of the *Philanthus* genus also prey on bees near the hive entrance, but they don't pose a serious threat to the colonies.

Larder beetles (Dernoeites lardarius) are sometimes found in neglected hives, usually in the debris (small wax particles from the caps that have been chewed off brood and honey cells) on the bottom board of the hive body. The larvae have tufts of long hair, and the blackish brown beetles have a gray cross stripe. The beetles bother the bees and disrupt the brood rearing.

Prevention: Keep the bottom board clean, and don't leave pieces of comb lying around.

Remedy: Collect all bits of wax, and melt them down. Clean out and burn any debris from the bottom of the hive body in the spring.

Ants can do quite a bit of damage by chewing through the hives and invading bee colonies.

Remedy: Put ant bait (available at drugstores or from suppliers of beekeeping equipment) in the hives (following the instructions of the product).

Mice tend to invade bee hives primarily in the fall and winter. A mouse nest in a hive is enough of a disruption for wintering bees that the colony usually perishes.

Prevention: Reduce the size of the entrances in the fall to a slot about 1/4 inch (5 mm) wide, or install a mouse grate.

Birds don't do much harm because they usually eat only sick or dead bees. They can, however, be a serious nuisance in queen rearing if they catch young queens during their nuptial flight.

Remedy: Set up scare crows near the hives, or hang strips of aluminum foil on trees near the hives.

The Dangers of Pesticides and Herbicides

Pesticides represent a constant danger to honeybees. Bees that come in contact with a pesticide in the course of collecting nectar from plants die instantly or succumb on the flight back to the hive. If a forage crop has been treated with a pesticide, the colony becomes progressively weaker until the losses become too great for the colony to survive.

There are legal guidelines for the application of pesticides, specifying the degree of danger to honeybees. You can obtain this information from a number of sources, such as your beekeepers' association, the U.S. Department of Agriculture, and environmental protection agencies.

It should go without saying that you yourself should not use pesticides. Ask your neighbors and acquaintances to abstain from the use of pesticides, too.

Herbicides (chemicals used to control weeds) seldom kill honeybees directly but destroy many of the plants that are important food sources for honey-

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If you practice marking drones, which do not sting and are somewhat larger than bees, you will soon get good enough at it to hold a queen between your fingers for the marking procedure. The colors of the disks conform to international norms and always follow the same order:

1986 1987 1988 1989 1990 1991 ...
white yellow red green blue white ...

Clipping a Queen's Wings

As soon as the queens have mated, you should cut back one wing with sharp nail scissors to about half to a third of its original length. This is especially important if you cannot check your bees frequently. This way, if a colony swarms, the queen can fly only a few yards and will then drop to the ground, where a handful of bees will stay and protect her. The rest of the swarm returns home without the queen, and you will be able to find the queen with her attendants even days later. If she is marked, preferably with a numbered disk, you will know which colony she came from.

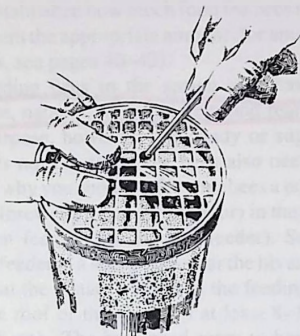
Introducing a Queen into an Artificial Swarm

Creating an artificial swarm is also a good method of preventing swarming when the woods are not producing honeydew (see page 9).

What you need for this is a box for an artificial swarm, that is, a box with a lid to which a hatching cage with a queen inside it is attached. Pour about 15,000 bees (3 pounds) from brood and honeycombs with plenty of workers on them—but no queen—into the funnel of the box. The bees will cluster inside the box.

Place the box into the cellar, and feed the bees. You can give them a pint of sugar syrup (mixing

equal amounts of sugar and water, e.g., 1 quart of water to 2 pounds of sugar). Place the syrup in a glass jar, cover it with a piece of linen, and set it upside down on the bunghole of the box. The linen keeps the sugar solution from dripping into the box but allows the bees to suck it through the cloth.



Device for marking queens. Use the foam rubber plunger to push the queen carefully up to the grate of the device. Push her close enough that she can no longer move. Then dab a little glue on her thorax, and stick a disk with the year's color onto the glue.

After two days you transfer the artificial swarm into a new hive. Replace the plug of the hatching cage with one of bee candy. Use a piece of Apifonda about the size of a pigeon egg, or make your own bee candy by mixing one part honey with three parts powdered sugar. Then hang the queen cage between two combs. The bees will eat the candy, thus releasing the queen.

If there is no honey flow, the artificial swarm must be fed a pint of sugar syrup (composed as described above) every two or three days or 2 pounds of bee candy per week (see page 41).

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• A spur embedder is a small, movable cogwheel with grooved teeth (see drawing on page 21). Lay a sheet of foundation on the small wooden board, and then place a wired frame on top of the foundation. Heat the embedding tool over a small flame, and then run it along the wire in the frame. The heat of the tool warms the wire, which melts the wax of the foundation and becomes embedded in it.

• If you have more than ten colonies, it makes sense to invest in a small electric transformer (about \$50). With this device you can use low-voltage electricity to fasten the foundation. For this procedure you place the wired frame on the wooden board and the foundation on top of the frame. Then, touch the two ends of the electric cable to the heads of the tacks so that the electric circuit is closed. The wire and the wax on top of it are warmed by the current, and the foundation's own weight causes it to combine with the wire. When the wire cools, frame and foundation are securely connected. The entire process takes no more than a few seconds.

Insulating Hives and Spring Feeding

During spells of cold weather it is especially hard for the bees to maintain an even brood temperature of 95°F (35°C). Think of it this way: The more heat the bees must generate themselves, the shorter their life span. This is why you should wrap the hives with thick cloth and cover them with a tarpaulin. You should also angle a board 4–8 inches (10–20 cm) wide from the entrance to the ground. This ramp makes it easier for the bees to make their way back into the hive when it rains.

When it is cold and rainy, bees cannot go out foraging. Thus it can happen that there is not enough food for the brood. To prevent this most dire situation, observe the following rule of thumb: In the spring, there should be at least four or five filled combs in the outer frames of every hive, the

combs partially occupied by bees, and about two-thirds of the cells capped. This is the equivalent of approximately 20–25 pounds (10–12 kg) of food. If there are fewer-filled combs, you can take out empty combs close to the brood nest and replace them with filled ones that you remove from a colony that has a plentiful store of food.

You can also give the bees a boost by feeding them Candy for Bees, Hard Candy for Winter (or "sugar boards," as thin slabs of this prepared material are usually called), or sugar syrup. Once you have established how much food the bees need, you give them the appropriate amount (for amounts and feeders, see pages 40–42).

Feeding bees in the spring also has another purpose, namely, to stimulate brood rearing. For this purpose, however, bee candy or sugar syrup alone is not enough. The bees also need pollen. This is why you should offer your bees a pollen substitute (brewer's yeast or soy flour) in the spring in a pollen feeder ("birdhouse" feeder). Set up the pollen feeder in a sunny spot near the hives, making sure that the distance between the feeding surface and the roof of the feeder is at least 8–10 inches (20–25 cm). The bees need room to hover while they are packing the food into their pollen baskets (see page 8).

It is important not to start a feeding intended to stimulate brood rearing too early. Wait until after the gooseberry bushes flower. Otherwise the bees build too large a brood nest and will not be able to maintain the necessary temperature during cold weather. If the brood nest becomes too cool, the brood dies, and the overworked bees become susceptible to sickness and may die prematurely.

Cutting Out the Building Frame

A strong colony begins to occupy the building frame in April (see page 47). Some building bees attach themselves to the upper frame bar and form a cluster there. These bees proceed to "sweat" the

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wax (see page 5), with which they build combs. They usually start in several spots all at once, building heart-shaped sections of comb that are later connected into one seamless comb. While the days lengthen (see drawing on page 44), that is, until the summer solstice, bees build primarily drone cells, since drones must be raised in time for a virgin queen's nuptial flight in June or July (see page 7). When the building activity in the building frame lets up and the worker bees start shaping queen cells, the bees may be getting ready to swarm. The building frame thus serves as a kind of mood indicator of the colony. Every time the frame has filled, you should cut out the comb (run a sharp knife along the inside of the frame) so that the bees can start building combs again and you can again assess their mood.

Place combs you have cut out in the garden for a few days. Birds like to pick the grubs out of them. The wax can be melted in a solar wax heater (see drawing on page 41) and bartered in exchange for foundation, or you can keep the wax yourself and perhaps make beeswax candles out of it in the winter.

Methods to Prevent Swarming

Since bees intent on swarming (usually as early as March in the Southern states, and in July in the far north) lose interest in collecting nectar and raising brood and some of the honey harvest is lost if a colony swarms, you will want to try to suppress the swarming impulse or prevent the bees from taking off. The measures that need to be taken for this purpose are some of the most important activities of a beekeeper interested in obtaining maximum honey production.

Colony Expansion

As soon as a colony has filled all the cells in the brood chamber and if there is still room in the hive body, the bees must be given more space. To ac-

complish this, hang a frame with foundation (see page 24) or an empty comb next to the brood nest. From June on you can also hang these expansion frames directly into the brood nest. Keep adding frames until the brood chamber is full. When you add foundation, you should each time move the combs with the oldest brood to the outer edge of the brood nest. Then, when the brood has hatched, the combs can be filled with honey and, at the end of the honey season, they can be cut out (see disease prevention, page 57).

Opening up the Honey Chamber or Adding Supers

In May—in warmer regions as early as April—you should examine each colony carefully and check to see how healthy it is, whether the brood nest is well filled, and if there are any signs of disease (see page 57). In a normally developed colony, a good three-fourths of the combs are filled with brood by early May (or earlier in warmer climates), with the bees hanging below the combs in a cluster. This is the time to open up the honey chamber.

If you are working with a movable-frame hive, the following items should be ready: an empty super, a queen excluder (see drawing on page 16), a queen cage (a small cage made of wood or synthetic material; see drawings on pages 31 and 32), a queen-catching glass (see drawing on page 32), one or two frames with foundation (see page 24), and eight or nine frames with empty combs.

Above: An apiary with leaf hives. The small nucleus boxes (on the right, next to the regular hives) are used for rearing queens.

Below: A temporary hive stand that can be disassembled for transport. The entrances to the hives are marked in different colors to help returning bees find their own colony.

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See the book (p 20)

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Below: A temporary hive stand that can be disassembled for transport. The entrances to the hives are marked in different colors to help returning bees find their own colony.

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If you have a leaf hive, you will need one or two frames with foundation and eight or nine with empty combs, a queen cage, and a queen-catching glass.

While you actually work in the hive, you should blow a little smoke into it now and then to calm the bees (see page 64).

The steps described in the following paragraphs are the same for both a movable-frame hive and a leaf hive.

To make sure that the queen does not get lost or hurt in the process of shifting frames, she should temporarily be isolated for her own protection. Search systematically through the combs to find her. When you have spotted her, invert the bulging end of the queen-catching glass over her. She will then start crawling up the glass tube. Remove the plug from the queen cage, set the bulging end of the queen catcher over the opening, and blow the queen into the cage, which you then close again with the plug. Experienced beekeepers remove the queen by hand, grasping her wings carefully with two fingers and guiding her into the cage.

Attach the queen cage with some wire to a brood comb from the brood chamber so that it is clearly visible, and return the comb to the brood chamber. Then move two or three other brood combs from the brood chamber into the super (in a movable-frame hive) or into the honey chamber (in a leaf hive).

If you fail to locate the queen, you must brush the bees off the combs that will be moved into the super or the honey chamber. Use a soft broom or a large goose feather, and hold the comb over the brood chamber of a movable-frame hive or the tray of a leaf hive.

Above, left: Removing honeycombs from a movable-comb hive. To calm the bees, a puff of smoke is aimed at them. Right: Lifting the wax covers off the honey cells with an uncapping fork.

Below, left: An extractor with the top opened. Right: The honey flows from the extractor's cock through a double strainer into the honey bucket.

Add one or two frames with foundation and a frame of empty comb next to the combs in the brood chamber. When the brood chamber is again filled with frames, you can release the queen into it. Then lay the queen excluder on top of the hive body housing the brood chamber and put the super with seven or eight frames of empty comb on top of the excluder. This super is now ready to be filled with honey.

If you have a leaf hive, set the empty combs you have gotten ready into the honey chamber, reinstall the windows of the honey chamber and of the brood chamber (the latter with the building frame), and replace the heating pad. Since they now have plenty of space for storing honey again, the bees can go on with their work and the danger of swarming is, for the time being, averted.

The fight is consigned to the offshoot of a swarm. Shrinking the Colony

A colony's population increases rapidly in the summer, with 1000-2000 new bees hatching every day. Since congestion is a major factor in swarming, you must take steps to prevent overcrowding. When you examine your colonies, remove one or two sealed brood combs with the bees on them (but without the queen) and replace them with empty combs or with foundation. The brood combs can be added to a weaker but healthy colony, or you can use them to form nuclei (see page 34).

This way you relieve the colony of about 5000-10,000 bees and give the remaining workers enough space to keep brooding activities going. You can repeat this procedure after one or two weeks, but don't remove bees more than three times. This method is about 80% effective in preventing swarming. It only works, however, if it is applied before the bees have started nursing brood in queen cells; that is, before the larvae are being lavishly fed with royal jelly.

As soon as you discover queen cells either in the building frame of a leaf hive or along the edges of the combs in movable-frame hives, you must take swarm-preventive steps by relocating the colony

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(see below), setting up a nucleus with a queen (see next column), starting an artificial swarm (see page 33), or starting a brood nucleus (see page 34).

Relocating the Colony

If you have stacked leaf hives, this method is more difficult to implement than with hives either of the movable-frame or the leaf type that are placed next to each other. The reason is that all the brood combs of the colony that are ready to swarm must be moved to another hive. The following description is based on a system in which hives are located next to rather than on top of each other.

Move the hive with the restless bees to a spot that is at least 3 feet (1 m) away from its original location. Then take a hive without bees and put it in the vacated spot. This hive is filled with frames with foundation and empty combs (in a leaf hive only the brood chamber is filled) but with enough room left empty in the center for one comb. Now take the brood comb on which the queen sits from the colony you have moved and hang it into the center of the new hive, with all the bees and the queen attached to it. Then you empty about half the remaining bees from the old brood chamber into the new hive.

During the rest of the day, the returning field bees will join the new colony. This new colony—which is really the swarm of the old colony—will deliver just as much honey as a normal colony. The queen cells in the old colony can be used—except for two—for rearing queens (see page 31). If you don't wish to rear queens, the cells should be broken out of the comb and destroyed. When the two remaining queens hatch, the stronger one will kill the weaker one and then proceed to mate (see page 6). The old colony will recover quickly from the loss of some of its workers and its old queen because new bees keep hatching from the remaining brood combs and the queen soon starts to lay new eggs.

A Nucleus with a Queen

Another way to forestall swarming when larvae are already developing in queen cells is to form a

nucleus that includes a queen.

Ready an empty nucleus box and a queen or hatching cage (see pages 31 and 32). Find the queen, and lock her into the cage, which you attach to a brood comb with some wire or a rubber band. Hang the comb, along with the queen cage, into the nucleus box. Then take two or three brood combs from the colony that is in a swarming mood, break the queen cells out of them, and put them into the nucleus box. Shake the bees off two or three other brood combs into the nucleus box as well. Then release the queen from her cage.

If you have movable-frame hives, place a cover on the nucleus box. With a leaf hive, place the heating pad into the empty honey chamber of the new hive and block about three-fourths of the entrance by stuffing crumpled paper into it. Now take the nucleus to its new location. You must gradually add more empty combs to give the growing colony room to expand. If the colony is fed regularly (about a pint of sugar syrup daily, made up of equal parts sugar and water or 2 pounds of bee candy once a week), the nucleus will develop into a viable colony by fall.

You also have to remove the queen cells from all the brood combs in the original colony. To make sure you are not overlooking any, you must brush the bees off the comb into the hive body before you examine each comb.

After you break out the queen cells, the hive bees immediately start building new ones that must also be removed after nine days, leaving one or two. Be careful not to jolt the comb this time when you remove the queen cells because the future queen may fall off the royal jelly (see photo on page 38) and die. You should check after three weeks to see if there is a new queen in the colony and if she has started laying eggs.

If you find no sign of eggs or a queen, you have to test whether the colony is queenright. Hang a small piece of comb with eggs up to three days old (cut from the comb of another colony) or an entire comb with eggs and young larvae up to three days old into the hive. Mark the comb with a thumbtack.

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If the colony is queenless, the bees will enlarge some of the cells into queen cells.

If that happens, place a small nucleus with a mated queen (see page 34) into the hive. (You should always have such a nucleus in reserve.) The comb with the eggs and the started queen cells must be removed first.

There are two more methods to prevent swarming: forming an artificial swarm and forming a brood nucleus. Since both methods require mated queens, however, I describe them in connection with rearing queens (see the next column) rather than here.

How to Deal with a Swarm

In spite of all the precautions you take, a colony will inevitably swarm now and then (see page 7). Once you have found the swarm—usually it has attached itself to the branch of a nearby tree—and want to determine which hive it has come from, you dust the cluster with some flour. Some of these white bees will fly back to their original hive, which you now move to another location.

Wet the swarm on all sides by spraying it with water from a fine nozzle. Be careful: If the swarm is too high to reach from the ground, make sure the ladder you use is on firm footing.

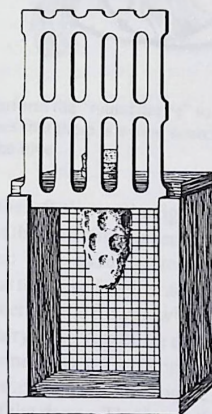
Now hold the swarm-catching box or basket (get the proper kind from a bee supply house)—if it is not raining even a sturdy cardboard box will do—and shake the branch from which the bees are hanging. If the branch is too big to shake, you can dislodge most of the cluster with a brush. Leave the box or basket with the bees in it on a stand or step-ladder underneath the branch from which the cluster was hanging.

By evening all the bees will have moved into the catching container, and you will be able to transfer them into a new hive by giving the box or basket a good shake. With a movable-frame hive, you take out some of the combs, shake the bees in from the

top (see page 22), and then replace the frames. With a leaf hive you work from behind. Attach the tray in back, and move the bees onto it by turning the catching box upside down and whacking it once or twice. The bees will immediately start crawling into the new hive. Then move the hive with the swarm to the spot where the old colony from which the swarm took off was located.

Rearing Queens

When you want to form an artificial swarm (see page 33) or a brood nucleus (see page 34), or if you want to requeen an old colony (see page 34), you need young queens. This is why you should rear some in June and July. You will need a box for an artificial swarm (a wooden box with a slot in the top



Hatching cage with a queen cell in it. One wall of the cage has a grate that can be pulled up. Nurse bees can pass through the slots to feed the hatched queen. The queen is too big, however, and cannot escape. The queen cage can also be used to store a queen temporarily (protective confinement).

A Short Introduction to Bees

photo on page 37). When the water content has been reduced to between 17 and 20%, the honey is ripe, and the bees seal the full honey cells with a thin cover of wax. As soon as this is done, the beekeeper can start extracting honey (see page 36).

Depending on the productiveness of the plant sources, bees must make about 40,000 trips and visit between three and five million blossoms to harvest 2 pounds (1 kg) of honey. The capacity of a bee's honey stomach is about 50–60 mg.

A bee colony that is located in a forested area can start harvesting honeydew in June. This honeydew is produced by aphids of the Lachnidae family and various scale insects of the Lecanidae family. These insects suck the sap of pine, fir, and spruce needles and sometimes also of the leaf stems of oaks, maples, and other deciduous trees to absorb the nutritional substances they need. The rest of the sap is excreted and hangs in shiny droplets on the needles or leaves of the trees. In Europe a distinction is made between honey that comes from evergreen trees and honey from deciduous trees: The former is called forest honey; the latter, leaf honey. Honeydew, which is processed in the hive just like nectar, has an inferior flavor and is not properly acceptable as honey.

The honey that is deposited in combs is intended for rearing the brood and as food for the cold winter months. The carbohydrates contained in it supply the bees with the energy needed for their activities.

Bees need not only carbohydrates, which they obtain from nectar and honeydew; they also gather pollen, which supplies them with protein. While they fly from flower to flower, they brush the pollen off their hairy coats with the help of brush-like hairs on their legs and pack it into pocketlike indentations, called pollen baskets, in their hind legs (see drawing on page 7). There the pollen is mixed with a bit of honey the bee carried with her from the hive and kneaded into a solid clump. An experienced beekeeper can tell what flowers a bee has visited from the color of the pollen pellets. Back at the hive the bee strips off the pollen into an

empty cell, where young hive bees compress it by "stamping" it in place with their forelegs and heads.

Round Dance and Wag-tail Dance

When a bee has found a good source of food within a radius of about 300 feet (100 m) and on level terrain, she can announce this to the bees in the hive by performing what is called a round dance. What she does is to fly around rapidly in a circle,



Bees perform the "round dance" to communicate to other field bees that there is a food source within 300 feet (100 m) of the hive.

first to the left, then to the right (see drawing above). Some of the surrounding bees touch the dancing bee and then start dancing, too. With the olfactory organs at the tips of their antennae they have picked up the scent of the flower, which lingers on the field bee's hairy coat. A precise description of the location is unnecessary if it is within 300 feet of the hive, but the abundance of the source is indicated by the speed of the dance. The faster the dance, the richer the source and the closer to the hive. A food source that is farther away requires that more information be communicated. Direction and exact distance are expressed by means of the "wag-tail dance." Here the bee dances straight ahead on the honeycomb while wagging the tail end of her rump back and

Care and Management

to leave about $\frac{1}{4}$ – $\frac{5}{16}$ inches (6–8 mm) between the screen and the comb. In the piece of comb underneath the screen about two-thirds of the bees should have hatched but no new eggs should have been laid in the empty cells. Some cells must also be filled with honey. The bees that hatch from the remaining larvae will soon look after the new queen, which can then start laying eggs. The bees will chew a hole through the wax comb through which they and the queen can pass. Wait at least 10 days before you check to see if the bees have accepted the queen and if there are eggs and young brood. If there are no eggs or new brood, test to see if the queen is still present (see page 34). This method of requeening is not as reliable as requeening bees that have been left queenless for nine days.

Controlled Breeding and Artificial Insemination

Controlled breeding and artificial insemination are basically of interest only to apiarists who have years of experience and are working on a large scale, but I mention these procedures at least briefly because they are of crucial importance in keeping certain races and strains of bees purebred.

To achieve controlled breeding, bee breeders set up special breeding sites. In a wind-protected location, a clearing in the woods, for instance, a few colonies of drones are set up and fed. Within a radius of 4 miles or so (6–7 km) only bees of the same race are kept. Breeders bring their queens in mating boxes attended by some worker bees.

Artificial insemination is done under the microscope with an instrument that is especially designed for this purpose.

Harvesting Honey

Where the honey flow comes early, the beekeeper can expect to harvest the first honey in early

June. In areas where the flow comes later, honey is ready for harvest two to four weeks later.

Removing the Honey

The best time to remove the honey from the hive is the late morning. Place next to the hive an empty hive body (for a movable-frame hive) or (for a leaf hive) a transport box that can be closed and some cloths or boards for covering exposed honeycombs. Then remove from the hive the combs that are completely or partially capped. Sweep the bees that are on the combs into the open hive or, in a leaf hive, onto the tray in back so that they can return immediately to their colony.

The job is easier if you can get the bees out of the honey chamber through a bee escape (an opening through which bees can move in only one direction). Close off the honey chamber from the brood chamber with a separator board. When the bees find themselves queenless, they seek a way to return to their queen. A bee escape in the separator board allows them to rejoin her but prevents them from getting back into the honey chamber. In two or three hours all the bees will have vacated the honey chamber. Of course, all the brood that was in the combs when you moved them into the honey chamber (see page 26) must have hatched by the time you want to remove the honey or the scheme will not work. This method is not only less arduous for you than sweeping the bees off the combs, but it is also easier on the bees.

If two-thirds of a honeycomb is sealed, it can be placed directly into the transport box that you have made ready. If you leave honeycombs standing around uncovered, foraging bees of the area will be attracted. Particularly at a time without honey flow, bees from other colonies—having learned of this free food source by their scouts—can quickly appear and cause fights around the honeycombs. This not only interferes with your work and upsets the colonies, but it can also be a serious nuisance for nearby neighbors because the bees start looking for food at all the windows, both open and closed.

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If the colony is queenless, the bees will enlarge some of the cells into queen cells.

If that happens, place a small nucleus with a mated queen (see page 34) into the hive. (You should always have such a nucleus in reserve.) The comb with the eggs and the started queen cells must be removed first.

There are two more methods to prevent swarming: forming an artificial swarm and forming a brood nucleus. Since both methods require mated queens, however, I describe them in connection with rearing queens (see the next column) rather than here.

How to Deal with a Swarm

In spite of all the precautions you take, a colony will inevitably swarm now and then (see page 7). Once you have found the swarm—usually it has attached itself to the branch of a nearby tree—and want to determine which hive it has come from, you dust the cluster with some flour. Some of these “white” bees will fly back to their original hive, which you now move to another location.

Wet the swarm on all sides by spraying it with water from a fine nozzle. Be careful: If the swarm is too high to reach from the ground, make sure the ladder you use is on firm footing.

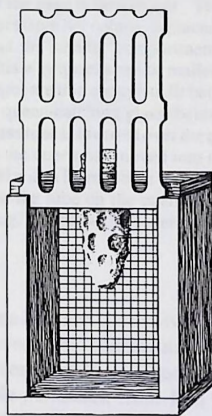
Now hold the swarm-catching box or basket (get the proper kind from a bee supply house)—if it is not raining even a sturdy cardboard box will do—and shake the branch from which the bees are hanging. If the branch is too big to shake, you can dislodge most of the cluster with a brush. Leave the box or basket with the bees in it on a stand or step-ladder underneath the branch from which the cluster was hanging.

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top (see page 22), and then replace the frames. With a leaf hive you work from behind. Attach the tray in back, and move the bees onto it by turning the catching box upside down and whacking it once or twice. The bees will immediately start crawling into the new hive. Then move the hive with the swarm to the spot where the old colony from which the swarm took off was located.

Rearing Queens

When you want to form an artificial swarm (see page 33) or a brood nucleus (see page 34), or if you want to requeen an old colony (see page 34), you need young queens. This is why you should rear some in June and July. You will need a box for an artificial swarm (a wooden box with a slot in the top



Hatching cage with a queen cell in it. One wall of the cage has a grate that can be pulled up. Nurse bees can pass through the slots to feed the hatched queen. The queen is too big, however, and cannot escape. The queen cage can also be used to store a queen temporarily (protective confinement).

Care and Management

into which a funnel is inserted), an empty frame modified with three slats running lengthwise along the center to create a long chamber, and one hatching cage (see drawing on page 31) per queen. You also need a "one-comb mating box,"—a small box made of Styrofoam or wood.

The sealed queen cells are placed in the hatching cages—one per cage—two to three days before the queens are due to emerge (the development period from egg to adult insect is 18 days). Dribble a small emergency ration of honey into the small hollow in the bottom of the cage that is designed for this purpose. Now place the hatching cages in a row in the long chamber of the modified empty frame and place the frame in the honey chamber.

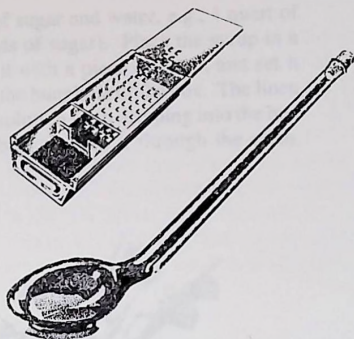
Once the queens have hatched, sweep about as many young bees as will fit into a 1-pound honey jar from fully occupied combs (taken from one or more colonies) into the funnel of the box for the artificial swarm. You must do this slowly so that the older bees have a chance to fly off.

Then take a honey jar full of bees from the box for the artificial swarm and pour them into a mating box. Do this for as many boxes as you are going to use. Then close the lids and the entrances of the mating boxes. After about an hour you can let the queens enter through the entrance holes. Place the mating boxes into a cool, dark, but well-ventilated room (a cellar) for two days. Then, in the evening, move the mating boxes outdoors and open the entrances. Within the next two weeks the young queens will mate and prepare to start laying eggs. They are now ready for use.

If you have a Kirchhainer mating box you can use it over again after two or three days, placing new queen cells or virgin queens in it. This saves you and the bees time. The "one-comb boxes" can be used only once.

Marking the Queen

To make it easier to find a queen and to check her age, queens are marked with five different colors



Queen cage used for mailing and to introduce queen into nucleus (above). Before the queen is introduced into the hive or nucleus, the perforated section on the narrow side of the cage is broken out. The queen, along with a few bees from her colony, is placed in the larger compartment, and the smaller compartment is filled with bee candy. This way queens can be mailed in regular envelopes. The cages are thin enough to fit between the combs in the hive. A queen-catching glass (below). The bulging end of the glass tube is inverted over the queen on the comb. As soon as the queen has moved into the tube, close off the open end with a foam rubber plug. If the queen is to be isolated, rest the tube on the open queen cage, remove the foam plug, and blow the queen gently into the cage.

(one for each successive year) as soon as they have mated. You can buy marking sets including all the accessories (tiny, colored, plastic disks, also available numbered from 1 to 99, and glue) from bee supply firms.

As a new beekeeper you should employ a marking tube (available for about \$3 or \$4) to label your queen. Place the queen in this tube, and carefully push her with a movable plunger against the wide mesh at the end of the tube. Dab a tiny drop of glue onto her thorax through a hole in the mesh. Then pick up a colored plastic disk with the moistened end of a matchstick and lightly press it against the queen's thorax (see drawing on page 33).

Care and Management

If you practice marking drones, which do not sting and are somewhat larger than bees, you will soon get good enough at it to hold a queen between your fingers for the marking procedure. The colors of the disks conform to international norms and always follow the same order:

1986	1987	1988	1989	1990	1991...
white	yellow	red	green	blue	white...

Clipping a Queen's Wings

As soon as the queens have mated, you should cut back one wing with sharp nail scissors to about half to a third of its original length. This is especially important if you cannot check your bees frequently. This way, if a colony swarms, the queen can fly only a few yards and will then drop to the ground, where a handful of bees will stay and protect her. The rest of the swarm returns home without the queen, and you will be able to find the queen with her attendants even days later. If she is marked, preferably with a numbered disk, you will know which colony she came from.

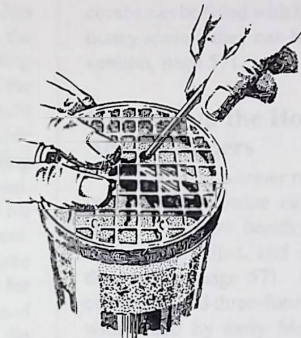
Introducing a Queen into an Artificial Swarm

Creating an artificial swarm is also a good method of preventing swarming when the woods are not producing honeydew (see page 9).

What you need for this is a box for an artificial swarm, that is, a box with a lid to which a hatching cage with a queen inside it is attached. Pour about 15,000 bees (3 pounds) from brood and honeycombs with plenty of workers on them—but no queen—into the funnel of the box. The bees will cluster inside the box.

Place the box into the cellar, and feed the bees. You can give them a pint of sugar syrup (mixing

equal amounts of sugar and water, e.g., 1 quart of water to 2 pounds of sugar). Place the syrup in a glass jar, cover it with a piece of linen, and set it upside down on the bunghole of the box. The linen keeps the sugar solution from dripping into the box but allows the bees to suck it through the cloth.



Device for marking queens. Use the foam rubber plunger to push the queen carefully up to the grate of the device. Push her close enough that she can no longer move. Then dab a little glue on her thorax, and stick a disk with the year's color onto the glue.

After two days you transfer the artificial swarm into a new hive. Replace the plug of the hatching cage with one of bee candy. Use a piece of Apifonda about the size of a pigeon egg, or make your own bee candy by mixing one part honey with three parts powdered sugar. Then hang the queen cage between two combs. The bees will eat the candy, thus releasing the queen.

If there is no honey flow, the artificial swarm must be fed a pint of sugar syrup (composed as described above) every two or three days or 2 pounds of bee candy per week (see page 41).

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wax (see page 5), with which they build combs. They usually start in several spots all at once, building heart-shaped sections of comb that are later connected into one seamless comb. While the days lengthen (see drawing on page 44), that is, until the summer solstice, bees build primarily drone cells, since drones must be raised in time for a virgin queen's nuptial flight in June or July (see page 7). When the building activity in the building frame lets up and the worker bees start shaping queen cells, the bees may be getting ready to swarm. The building frame thus serves as a kind of mood indicator of the colony. Every time the frame has filled, you should cut out the comb (run a sharp knife along the inside of the frame) so that the bees can start building combs again and you can again assess their mood.

Place combs you have cut out in the garden for a few days. Birds like to pick the grubs out of them. The wax can be melted in a solar wax heater (see drawing on page 41) and bartered in exchange for foundation, or you can keep the wax yourself and perhaps make beeswax candles out of it in the winter.

Methods to Prevent Swarming

Since bees intent on swarming (usually as early as March in the Southern states, and in July in the far north) lose interest in collecting nectar and raising brood and some of the honey harvest is lost if a colony swarms, you will want to try to suppress the swarming impulse or prevent the bees from taking off. The measures that need to be taken for this purpose are some of the most important activities of a beekeeper interested in obtaining maximum honey production.

Colony Expansion

As soon as a colony has filled all the cells in the brood chamber and if there is still room in the hive body, the bees must be given more space. To ac-

complish this, hang a frame with foundation (see page 24) or an empty comb next to the brood nest. From June on you can also hang these expansion frames directly into the brood nest. Keep adding frames until the brood chamber is full. When you add foundation, you should each time move the combs with the oldest brood to the outer edge of the brood nest. Then, when the brood has hatched, the combs can be filled with honey and, at the end of the honey season, they can be cut out (see disease prevention, page 57).

Opening up the Honey Chamber or Adding Supers

In May—in warmer regions as early as April—you should examine each colony carefully and check to see how healthy it is, whether the brood nest is well filled, and if there are any signs of disease (see page 57). In a normally developed colony, a good three-fourths of the combs are filled with brood by early May (or earlier in warmer climates), with the bees hanging below the combs in a cluster. This is the time to open up the honey chamber.

If you are working with a movable-frame hive, the following items should be ready: an empty super, a queen excluder (see drawing on page 16), a queen cage (a small cage made of wood or synthetic material; see drawings on pages 31 and 32), a queen-catching glass (see drawing on page 32), one or two frames with foundation (see page 24), and eight or nine frames with empty combs.

Above: An apiary with leaf hives. The small nucleus boxes (on the right, next to the regular hives) are used for rearing queens.

Below: A temporary hive stand that can be disassembled for transport. The entrances to the hives are marked in different colors to help returning bees find their own colony.

The Bee Year at a Glance

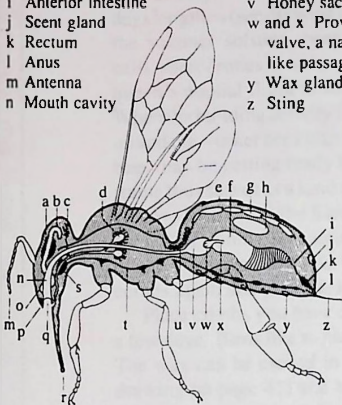
Raise new queens. 19 Prevent robbing. 20 Extract honey. 21 Supply plenty of pollen sources. 22 Start of new year. 23 and 24 Exchange queens. 25 check combs. 26 Supply winter food. 27 Last examination of the hive. Cover hive. 29 Clean feeders. 30 Take precautions against mice and 31 birds. 32 Batten down winter roofing. Last check. 34 Read bee literature. 35 Find buyers for your honey. 36 Make candles.

Klara



A Short Introduction to Bees

- | | |
|--|---|
| a Brain (upper ganglion) | o Mandibular gland |
| b Head salivary gland | p Mandibles |
| c and d Food glands in head (c) and thorax (d) | q Mouth opening |
| e Abdominal back plate | r Tongue (proboscis) |
| f Midgut or ventriculus | s Brain (lower ganglion) |
| g Heart | t Nerve cord |
| h Ovaries | u Heart spiral (nine turns) |
| i Anterior intestine | v Honey sac or stomach |
| j Scent gland | w and x Proventricular valve, a narrow, funnel-like passage |
| k Rectum | y Wax gland |
| l Anus | z Sting |
| m Antenna | |
| n Mouth cavity | |



Lengthwise vertical section of a bee. The bee's tripartite body (head, thorax, and abdomen) is enclosed by an exoskeleton consisting of chitin. Three pairs of legs and two pairs of wings are attached to the thorax. Bees breathe through tracheal tubes that open through breathing pores in the thorax, called spiracles.

discourage swarming (see page 26). If the beekeeper stands by idly, the queen will soon leave the hive with about a third of the workers (the prime swarm). The bees usually alight on a branch and hang there in a tight cluster with the queen in the middle. If the beekeeper does not catch the swarm at this point (see page 31), the bees will scout out and take off for a new permanent home in a hollow tree, a hole in the ground, or a rock crevice and will then be lost to the beekeeper for good. Almost half of the remaining bees may also move out seven days after the departure of the prime swarm, taking one

or several of the new queens with them (the after-swarm). Only the brood, some young nurse bees, and a few new queens are left in the hive. These latter will fight each other to the death until only one remains. After five days the virgin queen is sexually mature and takes off on her nuptial flight.

Drones that are ready to mate leave their hive in early afternoon usually between 2 and 3 o'clock. They fly around near their hives or gather in drone congregating areas where the weather conditions are favorable and where the drones stay aloft 15–40 feet (5–12 m) above the ground.

The mating always takes place in the air. In the act of copulation, the drone's genitalia, which are normally located inside the tip of the abdomen, are extruded by turning inside out and enter the queen's vagina pouch. The spermatozoa are discharged into the queen's vagina and gradually move from there to a sperm-holding reservoir called the spermatheca. The drone expires in the course of copulation. A queen may mate with five to eight drones during her five to six weeks of sexual receptivity. In the process she accumulates millions of spermatozoa, enough to last a lifetime of egg laying.

Sometimes the workers replace an old queen with a new one without the colony's swarming. The old queen either dies or is killed by a virgin queen or by the workers. This process, which is advantageous for the apiarist because the colony is rejuvenated without any effort on his or her part, is called superseding.

Once the young queen has mated and started a good brood nest, the drones no longer serve a useful function. They consume food without contributing to the life of the hive, and the worker bees begin to expel them from the hive or kill them.

Worker bees born in August or later winter over and don't die until the next spring. From November on no more brood is raised, and the entire colony collects in a tight cluster around the queen. The bees feed on the honey they have gathered and stored for winter, converting carbohydrates into body heat. The temperature at the center of the cluster stays between 68 and 77°F (20–25°C) and drops to be-

Fight

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Introducing a Queen into a Brood Nucleus

Introducing a queen into a brood nucleus is also a good way to forestall swarming. What you need for this are a queen in a hatching cage, an empty hive body (for movable-frame hives) or a nucleus box (for leaf hives), a food comb (that is, a comb that is largely filled with honey but has no brood) from another colony, an empty comb, and a frame with foundation.

Before noon on a good foraging day, remove two or three brood combs without the queen from a strong colony and combine these combs with the food comb, the frame with foundation, and the empty comb that you have sprayed with a little water. Place all these combs in the empty hive body or nucleus box. In the evening, hang the queen cage with the queen in it between two brood combs. Wait 24 hours, and then replace the plug of the queen cage with one of bee candy. The bees will eat the candy and thus release the queen. If you are working with a nucleus box, the nucleus must be moved to a hive after three or four weeks.

Replacing Queens in Old Colonies

If you want to replace the old queen in a colony, you must be certain that the bees are not in a swarming mood. A queen introduced at such a moment would instantly be killed by the bees. Reasons for replacing an old queen are:

- A queen should never be kept more than three years because a colony with an older queen is likely to lose strength. The time to replace an old queen is August or September.
- If the brood nest shows gaps or remains small, it is usually because the queen is missing a fore or hind leg and can no longer hold on properly to the edges of the cells when laying eggs. In this case, requeening is the only solution.

- If the bees sting more than usual even with proper handling, the genetic makeup of the queen is probably to blame. Here, too, requeening can help. There are several methods of replacing queens.

Requeening a Colony That is Left Queenless for Nine Days

Remove the old queen along with two or three brood combs from a hive to form a nucleus (see page 30). The queenless bees left in the hive will build queen cells, which you break out after nine days. ~~The bees will get restless three or four hours later because in the course of the nine days all the cells were sealed and there is now no longer any possibility of rearing new queens.~~ Place your new queen in the nucleus box after plugging the opening of her cage with bee candy (see left).

In the fall you can dispose of the old queen by squashing her against the frame with your thumb. The brood combs of the nucleus can be added to weak colonies.

When you requeen a colony that has been queenless for 9 days, the queen is usually accepted without problems, but there is a period of 10–12 days during which no new brood is produced.

Quick Requeening

The two methods described below can be used only before and after swarming season.

Lock the old queen in a queen cage, which you then hang between two brood combs. The next day you remove the old queen and substitute a new one but leave the cage in place. After another day you replace the plug of the queen cage with bee candy.

If you want to requeen in one day, you must follow another procedure for which you need a small wooden frame with plastic or wire screening (available from bee supply houses).

Remove the old queen from the colony. Brush the bees from a light-colored comb with hatching larvae, and set the new queen on it. Press the screen frame over the queen and into the wax deep enough

*Also replace the old queen, feed
queen, & then the comb will be all right*

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diameter and 3 feet long: see drawing on page 21). To provide a good grip, the upper third of the stirrer should be rounded.

If you have several buckets of honey to stir, you can use an electric drill equipped with an adapter (available from bee supply firms) and a honey stirrer made of metal. The adapter allows you to gear down the drill's speed to the much slower speed required for stirring honey.

Forest honey and honey from evergreen trees don't start crystallizing until much later, often not for months or even years after harvest. These kinds of honey therefore don't need to be stirred.

Packaging and Storing Honey

You can package honey for sale in large buckets or assorted retail-sized glass, tin, or plastic jars. For consumer-size packages (under 4 pounds or 1 gallon), the label should include the beekeeper's name, the declaration of net quantity of contents in ounces (with identification of weight of fluid measure), followed by the weight in pounds if the contents exceed 1 pound or 1 pint, and the beekeeper's control number.

If the honey has crystallized during storage, it must be liquefied before packaging. Heat the honey, but not above 104°F(40°C) because the quality of the honey suffers if it is overheated. You can melt the honey either in a thermostat-controlled heating cabinet (homemade or available for about \$200 to \$300 from beekeepers' supply firms) or with an electric immersion heater, also equipped

with a thermostat (cost about \$300). The immersion heater can be placed directly on the solidified honey. Since jars and buckets are usually of uniform weight, you need to weigh only one jar and enter the tare in the scale before you fill and weigh all the jars of that size.

The packaged honey should be stored in a cool, dry room at about 60°F(15°C) until it is sold (see *Different Kinds of Honey*, page 52).

Honey for the Bees' Use and Interim Feeding

July is often a hard month for bees. In areas with early honey flow the food sources tend to become sparser at this time, and in areas with late honey flow the honeydew (see page 9) from fir and spruce doesn't start flowing until mid-July at the earliest.

If the bees cannot find more food than they need for their immediate use, no honey is stored in the honeycombs, but the queen keeps laying and the colony stays healthy. When you weigh your hives, check to see if there is sufficient food. The hives will show neither a gain nor a loss of weight if the bees gather just what they need to survive.

If there is no natural food supply (loss of weight!), you must start interim feeding. Before you do, however, you must remove or close off the supers or honey chambers because:

- Supers or honey chambers are not needed since nature is no longer supplying food.
- Some of the substitute food you offer may be stored in the honey chambers and adulterate the honey that may yet be produced.
- If the hoped-for late honey flow fails to materialize—because of inclement weather—the fall brood nest can be started right now.

Until the honey starts flowing again, give each colony half a pint of sugar water (one part sugar to one part water) every other day or 2–4 pounds of bee candy every two weeks.

Above, left: Bee larvae, about four days old, surrounded by fluid food. Right: A nine-day-old, fully developed larva being fed by a nurse bee.

Below, left: A fully developed worker bee is hatching after 21 days. She is chewing through the cell cap and crawling out of her cell. Right: A queen hatching. On her left front leg one can clearly see the hooks that she will later use to hang onto the cell edges when she lowers her abdomen into the cells to lay eggs.

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You can also feed diluted honey (half a pint every other day, honey and water mixed in equal parts), but use only honey from your own bees. If you use honey from other sources, the danger of introducing disease (foulbrood) is too great. You must also supply a pollen substitute (brewer's yeast or soy flour). This is particularly important for bees foraging in forests, where enough summer and fall blossoms are often not available for the bees (2 pounds of pollen substitute lasts for three to four weeks).

Since the limited availability of food offered by the beekeeper resembles conditions when the honey flow is too sparse to permit storing honey for future use, the bees tend to respond by raising new brood. Interim feeding can thus be regarded as a stimulus to increase population. If the natural food sources start flowing again, supers or honey chambers must be reopened (see page 26).

At times when natural food sources dry up, there is danger of robbing. Bees from other colonies or from neighboring apiaries may clean out all the honey from your hives. This is why you should take the following precautions:

- Don't leave honey or food combs exposed.
- Don't take too much time checking the colonies, and don't leave the hives open long.
- Don't spill any syrup; if some does spill, wipe it up thoroughly, down to the last tiny drop.
- Reduce the hive entrance by two-thirds; in nucleus boxes leave open only a small slit ($\frac{3}{8} \times \frac{3}{4}$ inch, 1×2 cm). The guard bees must be able to defend the entire entrance.
- Don't feed liquid food until the evening when the bees have stopped flying.

Management of Weak Colonies

Don't try to winter over a weak colony; it is bound to die before spring. If you have two weak colonies, one with a good and one with a poor queen

(too old or damaged, or that is likely to produce bees that sting, see page 34), combine the two colonies in August. Find the undesirable queen and dispose of her (see page 34). In a movable-frame hive, place the hive body with the queenless bees either on top or underneath the colony with a queen. In a leaf-frame, hang the combs with the queenless bees next to the bees with a queen.

If you have two weak colonies with poor queens, kill both the queens (see page 34) and add the brood combs to a mediocre colony that has a good queen.

Rearranging the Combs

In the fall the bees occupy only those combs on which several broods have been reared. This is why you must rearrange the combs in July or August. Remove all the light-colored combs that don't have brood in them as well as any foundations without drawn combs.

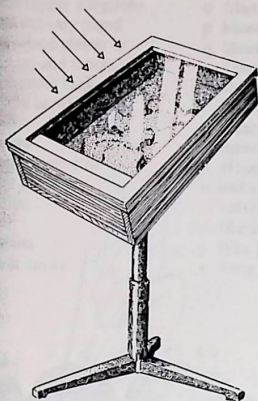
Hold old combs that have had brood in them several times against the sun or a bright light and see if any light shows through. Each emerging bee leaves a thin film of cocoon behind in the cell, and if there are enough of these cocoon layers that the light is no longer visible, the cells are too small for new brood. Cut dark combs (combs that block the light) out of the frames and melt them in a solar wax melter or exchange them for foundation. Light combs that are still diaphanous should be stored together with foundations until spring in hive boxes or a special comb-storage cabinet.

If any drone combs are present (combs made up entirely of drone cells, see page 6), these too should be removed.

Feeding to Stimulate Brood Production and Fall Feeding

For beekeepers in areas with early honey flow it is especially important to start the winter with

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A solar wax melter that uses solar energy to melt old combs. The sun's rays, which hit the sloping glass top, heat the inside of the box to as much as 180°F (80°C), and a slate bottom stores the heat. Beeswax, which melts at about 150°F (65°C), drips into a receiving pan and hardens overnight.

strong colonies. Only strong colonies can take full advantage of the spring honey flow and collect an optimum amount of honey. In areas where the honey flow comes early one cannot count on harvesting honey after the end of July. To encourage the bees to keep rearing brood, you should start feeding them after removing the supers (see page 40). There are three possible methods: you can give them half a pint of sugar water (one part sugar to one part water) every other day, you can feed them bee candy (2 pounds every two weeks), or you can give them half a pint of diluted honey (half honey and half water) every other day. (Make sure you use honey only from your own bees!) Continue the feeding until the end of August. If there are no natural pollen sources, you must also make ready some pollen substitute (see page 25).

In areas with late honey flow, feeding to stimu-

late brood production is usually not necessary because the woods normally provide food until August. (If there is no honeydew, you should of course start feeding to stimulate brood production.)

The nectar, honeydew, and pollen that the bees collect and store from August on (from natural food sources or food provided by the beekeeper) are not enough to carry them through the winter and into the spring, and you must help them with additional feeding.

You should start the fall feeding in early September (two weeks earlier at altitudes above 1500 feet, 500 m), whether the honey flow is late or early. Note: Forest honey must be extracted before it is given to the bees.

You must assess how much food the bees will need. A common estimate of the food needs of a colony wintering over in one hive box is 17–22 pounds (8–10 kg); bees wintering over in two hive boxes need about 33 pounds (15 kg).

You can determine approximately how much the bees have already stored for the winter by using the following information:

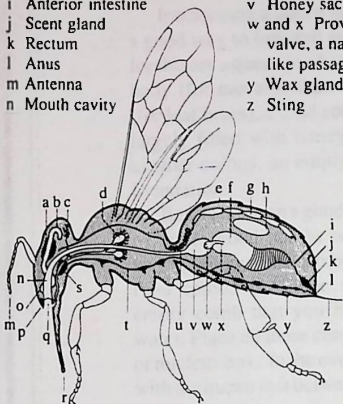
- A piece of comb measuring 4 × 4 inches (10 × 10 cm) contains about 12 ounces of food or honey.
- A comb in a Hoffman frame (usually 4½ × 16¾ inches, 11 × 42.5 cm) and with sealed cells on both sides holds about 4 pounds of food or honey.

Figure out how much food the bees are short by subtracting your estimate of how much the bees have already stored from the amount needed for survival (see above). If you use bee candy, however, you must give the bees about 10% more than the amount you calculated. The candy must be processed by the bees before it is ready for storage, an activity that requires energy, which has to be provided in the form of food.

If you have movable-frame hives, remove the cover and the plastic sheet and place an insulating cover of appropriate size and with a hole in it on top of the combs. This "bunghole" should be ¾ inches (80 mm) in diameter. The bee candy is placed on

A Short Introduction to Bees

- | | |
|--|---|
| a Brain (upper ganglion) | o Mandibular gland |
| b Head salivary gland | p Mandibles |
| c and d Food glands in head (c) and thorax (d) | q Mouth opening |
| e Abdominal back plate | r Tongue (proboscis) |
| f Midgut or ventriculus | s Brain (lower ganglion) |
| g Heart | t Nerve cord |
| h Ovaries | u Heart spiral (nine turns) |
| i Anterior intestine | v Honey sac or stomach |
| j Scent gland | w and x Proventricular valve, a narrow, funnel-like passage |
| k Rectum | y Wax gland |
| l Anus | z Sting |
| m Antenna | |
| n Mouth cavity | |



Lengthwise vertical section of a bee. The bee's tripartite body (head, thorax, and abdomen) is enclosed by an exoskeleton consisting of chitin. Three pairs of legs and two pairs of wings are attached to the thorax. Bees breathe through tracheal tubes that open through breathing pores in the thorax, called spiracles.

discourage swarming (see page 26). If the beekeeper stands by idly, the queen will soon leave the hive with about a third of the workers (the prime swarm). The bees usually alight on a branch and hang there in a tight cluster with the queen in the middle. If the beekeeper does not catch the swarm at this point (see page 31), the bees will scout out and take off for a new permanent home in a hollow tree, a hole in the ground, or a rock crevice and will then be lost to the beekeeper for good. Almost half of the remaining bees may also move out seven days after the departure of the prime swarm, taking one

or several of the new queens with them (the after-swarm). Only the brood, some young nurse bees, and a few new queens are left in the hive. These latter will fight each other to the death until only one remains. After five days the virgin queen is sexually mature and takes off on her nuptial flight.

Drones that are ready to mate leave their hive in early afternoon usually between 2 and 3 o'clock. They fly around near their hives or gather in drone congregating areas where the weather conditions are favorable and where the drones stay aloft 15–40 feet (5–12 m) above the ground.

The mating always takes place in the air. In the act of copulation, the drone's genitalia, which are normally located inside the tip of the abdomen, are extruded by turning inside out and enter the queen's vagina pouch. The spermatozoa are discharged into the queen's vagina and gradually move from there to a sperm-holding reservoir called the spermatheca. The drone expires in the course of copulation. A queen may mate with five to eight drones during her five to six weeks of sexual receptivity. In the process she accumulates millions of spermatozoa, enough to last a lifetime of egg laying.

Sometimes the workers replace an old queen with a new one without the colony's swarming. The old queen either dies or is killed by a virgin queen or by the workers. This process, which is advantageous for the apiarist because the colony is rejuvenated without any effort on his or her part, is called supersedure.

Once the young queen has mated and started a good brood nest, the drones no longer serve a useful function. They consume food without contributing to the life of the hive, and the worker bees begin to expel them from the hive or kill them.

Worker bees born in August or later winter over and don't die until the next spring. From November on no more brood is raised, and the entire colony collects in a tight cluster around the queen. The bees feed on the honey they have gathered and stored for winter, converting carbohydrates into body heat. The temperature at the center of the cluster stays between 68 and 77°F (20–25°C) and drops to be-

* this happens in the
winter but be careful.

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Introducing a Queen into a Brood Nucleus

Introducing a queen into a brood nucleus is also a good way to forestall swarming. What you need for this are a queen in a hatching cage, an empty hive body (for movable-frame hives) or a nucleus box (for leaf hives), a food comb (that is, a comb that is largely filled with honey but has no brood) from another colony, an empty comb, and a frame with foundation.

Before noon on a good foraging day, remove two or three brood combs without the queen from a strong colony and combine these combs with the food comb, the frame with foundation, and the empty comb that you have sprayed with a little water. Place all these combs in the empty hive body or nucleus box. In the evening, hang the queen cage with the queen in it between two brood combs. Wait 24 hours, and then replace the plug of the queen cage with one of bee candy. The bees will eat the candy and thus release the queen. If you are working with a nucleus box, the nucleus must be moved to a hive after three or four weeks.

Replacing Queens in Old Colonies

If you want to replace the old queen in a colony, you must be certain that the bees are not in a swarming mood. A queen introduced at such a moment would instantly be killed by the bees. Reasons for replacing an old queen are:

- A queen should never be kept more than three years because a colony with an older queen is likely to lose strength. The time to replace an old queen is August or September.
- If the brood nest shows gaps or remains small, it is usually because the queen is missing a fore or hind leg and can no longer hold on properly to the edges of the cells when laying eggs. In this case, requeening is the only solution.

- If the bees sting more than usual even with proper handling, the genetic makeup of the queen is probably to blame. Here, too, requeening can help. There are several methods of replacing queens.

Requeening a Colony That is Left Queenless for Nine Days

Remove the old queen along with two or three brood combs from a hive to form a nucleus (see page 30). The queenless bees left in the hive will build queen cells, which you break out after nine days. The bees will get restless three or four hours later because in the course of the nine days all the cells were sealed and there is now no longer any possibility of rearing new queens. Place your new queen in the nucleus box after plugging the opening of her cage with bee candy (see left).

In the fall you can dispose of the old queen by squashing her against the frame with your thumb. The brood combs of the nucleus can be added to weak colonies.

When you requeen a colony that has been queenless for 9 days, the queen is usually accepted without problems, but there is a period of 10–12 days during which no new brood is produced.

Quick Requeening

The two methods described below can be used only before and after swarming season.

Lock the old queen in a queen cage, which you then hang between two brood combs. The next day you remove the old queen and substitute a new one but leave the cage in place. After another day you replace the plug of the queen cage with bee candy.

If you want to requeen in one day, you must follow another procedure for which you need a small wooden frame with plastic or wire screening (available from bee supply houses).

Remove the old queen from the colony. Brush the bees from a light-colored comb with hatching larvae, and set the new queen on it. Press the screen frame over the queen and into the wax deep enough

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window to the brood chamber closes tightly. Drafts are harmful to bees, and the flight entrance provides enough air exchange for the hive.

Hives that are left outdoors must be covered with roofing paper that is weighed down with laths and rocks. To keep out mice, you should plug the entrance with blocks that have $\frac{1}{2}$ inch slits in them or with wire screening. Both are available from suppliers of beekeeping equipment.

In the fall and winter, birds often catch bees that venture outside the entrance. To prevent this you can put netting in front of the hives. I myself don't use netting because so far I have found no evidence of birds preying on my bees. Often only those bees that are weakened by cold and have trouble returning to the hive are picked off by the birds.

Chores for Winter

You should inspect your hives periodically during the winter. Never open up the hives. Just look to see if the roofing paper has been damaged by storms and if the mouse blocks are still in place. Any damage should be fixed. Proceed quietly, and don't make knocking noises. On these inspection tours you will see many old, dead bees. Remove them carefully, but don't disturb the colony. Place a few of the dead bees in a small box, and keep them in a cool place until you can have them checked for nosema and acarine disease (see page 53) at your state testing laboratory (ask your beekeepers' association for the address).

Winter is the best time to build new hives and frames (see page 24). You can also repair equipment that is not in use at this time of year.

This is also the time to assemble all the current year's records you have entered on cards for each hive and analyze the information. This allows you to compare the performance of the different colo-

nies. Keeping accounts (of expenses as well as income) shows you whether you have made a profit and how much.

If you keep your bees in a bee house, throw some cloths and blankets over the hives in February. The bees begin to forage for nectar and pollen (willow blossoms) in February and start a brood nest. For them to be able to maintain a brood temperature of 95°F (35°C), they need this extra insulation. Don't remove the covers until you open up supers for honey storage.

Spring Chores

As soon as the weather is warm enough in March, it is time for the first look into the hives:

Check to see if a functioning queen is present. A colony without a queen hums restlessly; fecal droppings are near the hive entrance, and there is no sign of brood. If this is what you find, the only solution is to combine the bees with a "queenright" colony, a colony with a queen (see page 34).

If you have a weak colony with a cluster only about the size of a fist and the combs are stained with droppings, the bees must be gassed. The bees are too few in number and too sick to survive, and if they were added to a stronger colony, they would endanger those bees' health. Light a piece of sulfur (available from suppliers of beekeeping equipment), replace the hive lid, and plug the entrance. The sulfuric gases kill the sick bees very quickly.

Check to make sure that the bees have enough food close to the brood nest. Full combs should be moved over to replace the empty ones near the brood nest. Don't forget to replace the insulating lid after your examination of the hive.

The next management chores are spring feeding and various measures to prevent swarming (see page 26).

* Addi seen that
D.T. gets to know
the winter D.C.
the bees were alone

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If the combs you take out of the honey chamber are only partially capped, you must test the consistency of the honey that is not yet sealed. Take a comb and either hold on to the sides of the frame with both hands, shaking it up and down vigorously, or hold the comb with one hand and knock against the frame with your other hand. If honey comes spurting out of the cells that are still unsealed, the comb must be returned to the honey chamber and you must wait a few days before you extract the honey.

Extracting the Honey

The centrifugal extraction of honey is done in a room that can be kept free of bees. In addition to the extractor you need an uncapping tray, an uncapping fork, a double honey strainer, and a honey bucket.

Wear a clean, preferably white coat and head-gear when you extract honey, and don't smoke. Honey is a food of high quality. It should go without saying that no pets are permitted in the extracting room.

First you remove the wax caps of the honey cells over the uncapping tray with the aid of the uncapping fork (see photo on page 28). Once both sides of the comb are uncapped, you place the comb into the basket of the extractor. Check to make sure that the lower edge of the comb always points toward the center of the extractor.

A honeycomb that has sealed honey cells on both sides may contain as much as 4 or 5 pounds of honey and is quite heavy. To prevent the breaking of combs, you should start the extractor basket moving slowly. The extractor can be powered by hand or by electricity. When some of the honey has been extracted, turn the combs around and extract honey from the other side. Start slowly again, and increase the speed of rotation after a few minutes. Keep spinning the combs until no more honey flows from them, and then turn them around once more and spin the other side (the one you started with) empty. This time you can start spinning fast right away.

The honey is pulled out of the cells by centrif-

gal force and spun against the walls of the extractor. It runs down the walls and collects on the conical bottom of the extractor and then flows through a cock into a double strainer. This strainer consists of two steel sieves, one coarse and the other fine. Wax particles and foreign objects are blocked, and the pure honey collects in the honey bucket.

To get rid of the last bits of wax and other small foreign items, the honey should be filtered through a cloth filter (fine cheesecloth, available from bee supply firms) while still liquid, that is, right after having been extracted.

Then let the honey settle for a day or two at room temperature. Tiny air bubbles gradually rise to the surface, where they, along with some remaining wax particles that were not filtered out, form a layer of foam that should be skimmed off with a spoon or, even better, a spatula.

Depending on its composition and the plants from which the nectar was collected, honey crystallizes slowly or more quickly. For the crystallization to be uniform, the honey should be stirred but without mixing air into it. If the honey is not stirred, the crystals that form are uneven in size. This does not affect the quality of the honey in any way, but it changes its appearance and also can cause it to become rock hard. Honey generally crystallizes from the bottom up and from the walls toward the center.

As soon as the honey starts to look opaque—because millions of tiny crystals are forming—you should stir it carefully for about five minutes once a day for several days. Use a three-sided stirrer made of beech or oak wood (about 2 inches in

Above: Passing on food. The scent and the taste of the food source are absorbed by the receiving bee, and the round or wag-tail dance provides further information concerning the location of the food source.

Below, left: Field bee with pollen pellets in the baskets of her hind legs. Right: Fanning bee. The fanning regulates the temperature inside the hive and also spreads the colony's characteristic scent to all the inmates.

** Also, in August, is making plans on preparing for winter. The first month add this*

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this hole, and an empty hive body placed over the cover with the candy. Or you can simply fold back a corner of the plastic and place the bee candy on the plastic, but this causes more loss of heat.

If you have a leaf hive, remove the combs in the honey chamber and the queen excluder. Place the cover with the bung hole directly on the combs of the brood chamber and the bee candy on the bung hole.

Or you can feed the bees a sugar solution made of three parts sugar to two parts water. The following table shows the proper mixing proportions in kilograms and liters:

Sugar (kg)	Water (liters)	Amount Produced (kg)
1	0.7	1.2
2	1.3	2.4
3	2.0	3.6
4	2.7	4.8
5	3.3	6.0

The sugar and water are mixed together, heated (but not boiled!), and stirred until the sugar is completely dissolved. Liquid food must be given to the bees in feed troughs or special feeders. The most common type of feeder for both movable-frame and leaf hives is a 5 liter jar with a cover made of a fine bronze mesh. The full jars are placed upside down on the bung hole above the brood combs. The force of the vacuum keeps the sugar water from pouring out but allows the bees to absorb it through the tiny spaces in the bronze mesh.

In addition to feeder jars there are also food troughs in drawers (holding between 5 and 6 liters) that fit exactly into the hive body on top of the brood chamber.

Leaf hives are available, with a feeding trough holding 1 liter built into the side wall.

The bees should be fed 1 liter of sugar water a day. The feeder must be washed with clean, hot water after every feeding.

Here is an example of how the feeding works:

You estimate that a colony occupying two hive bodies has stored about 5 kg of food. Assuming that the bees need about 15 kg to make it through the winter, there is a shortage of 10 kg. By mixing 9 kg of sugar with 6 liters of water, you get 10.8 kg of winter food. If you feed liquid syrup, you can give each colony 1 liter a day or 5-6 liters per week.

Feeding the bees daily is more work than less frequent feeding, but the queen will lay more eggs. If you feed Candy for Bees, or Hard Candy for Winter (see page 00), start by putting half a 15 kg package on the bung hole. Depending on how much food you expect your bees to need, you can add more as needed later. Feeding bee candy always has the effect of stimulating brood production.

Regardless of your method of feeding and whether you rely on an early or late honey flow, the feeding should always be completed by mid-September. If you live at altitudes above 1500 feet (500m), the winter feeding should be completed by the first of September.

Important note: The last time you check your hives, you must ascertain if there is enough food to last the winter. All the combs occupied by bees should have at least two-thirds of the cells capped by the end of September or beginning of October; that is, they must be filled with food. If this is not the case, supply extra food in liquid form immediately.

Last Preparations for Winter

After you have removed and cleaned the feeders, you should collect all the record cards in October. On days when the weather is above freezing and when there is only minor flying activity, you can repaint outdoor hives with an odorless paint that is safe for bees (buy the paint from a supplier of beekeeper's equipment). Make sure the covers fit tightly, and if necessary, make a tighter seal by fitting a sheet of clear plastic or a cloth of natural fiber over the hive body. If you have a leaf hive, install the insulating lid and check to make sure that the

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window to the brood chamber closes tightly. Drafts are harmful to bees, and the flight entrance provides enough air exchange for the hive.

Hives that are left outdoors must be covered with roofing paper that is weighed down with laths and rocks. To keep out mice, you should plug the entrance with blocks that have 1/2 inch slits in them or with wire screening. Both are available from suppliers of beekeeping equipment.

In the fall and winter, birds often catch bees that venture outside the entrance. To prevent this you can put netting in front of the hives. I myself don't use netting because so far I have found no evidence of birds preying on my bees. Often only those bees that are weakened by cold and have trouble returning to the hive are picked off by the birds.

Chores for Winter

Done in 195

*** You should inspect your hives periodically during the winter. Never open up the hives. Just look to see if the roofing paper has been damaged by storms and if the mouse blocks are still in place. Any damage should be fixed. Proceed quietly, and don't make knocking noises. On these inspection tours you will see many old, dead bees. Remove them carefully, but don't disturb the colony. Place a few of the dead bees in a small box, and keep them in a cool place until you can have them checked for nosema and acarine disease (see page 53) at your state testing laboratory (ask your beekeepers' association for the address).

Winter is the best time to build new hives and frames (see page 24). You can also repair equipment that is not in use at this time of year.

This is also the time to assemble all the current year's records you have entered on cards for each hive and analyze the information. This allows you to compare the performance of the different colo-

nies. Keeping accounts (of expenses as well as income) shows you whether you have made a profit and how much.

If you keep your bees in a bee house, throw some cloths and blankets over the hives in February. The bees begin to forage for nectar and pollen (willow blossoms) in February and start a brood nest. For them to be able to maintain a brood temperature of 95°F (35°C), they need this extra insulation. Don't remove the covers until you open up supers for honey storage.

Spring Chores

As soon as the weather is warm enough in March, it is time for the first look into the hives:

Check to see if a functioning queen is present. A colony without a queen hums restlessly; fecal droppings are near the hive entrance, and there is no sign of brood. If this is what you find, the only solution is to combine the bees with a "queenright" colony, a colony with a queen (see page 34).

If you have a weak colony with a cluster only about the size of a fist and the combs are stained with droppings, the bees must be gassed. The bees are too few in number and too sick to survive, and if they were added to a stronger colony, they would endanger those bees' health. Light a piece of sulfur (available from suppliers of beekeeping equipment), replace the hive lid, and plug the entrance. The sulfuric gases kill the sick bees very quickly.

*** Check to make sure that the bees have enough food close to the brood nest. Full combs should be moved over to replace the empty ones near the brood nest. Don't forget to replace the insulating lid after your examination of the hive. ***

The next management chores are spring feeding and various measures to prevent swarming (see page 26).

** Also, in 195, done + is caught back for Christmas, also*
*** Ali witnesses this-*

Care and Management

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inner debate (hls)

Chores for Winter

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Check to see if a functioning queen is present. A colony without a queen hums restlessly; fecal droppings are near the hive entrance, and there is no sign of brood. If this is what you find, the only solution is to combine the bees with a "queenright" colony, a colony with a queen (see page 34).

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Care and Management

(see below), setting up a nucleus with a queen (see next column), starting an artificial swarm (see page 33), or starting a brood nucleus (see page 34).

Relocating the Colony

If you have stacked leaf hives, this method is more difficult to implement than with hives either of the movable-frame or the leaf type that are placed next to each other. The reason is that all the brood combs of the colony that are ready to swarm must be moved to another hive. The following description is based on a system in which hives are located next to rather than on top of each other.

Move the hive with the restless bees to a spot that is at least 3 feet (1 m) away from its original location. Then take a hive without bees and put it in the vacated spot. This hive is filled with frames with foundation and empty combs (in a leaf hive only the brood chamber is filled) but with enough room left empty in the center for one comb. Now take the brood comb on which the queen sits from the colony you have moved and hang it into the center of the new hive, with all the bees and the queen attached to it. Then you empty about half the remaining bees from the old brood chamber into the new hive.

During the rest of the day, the returning field bees will join the new colony. This new colony—which is really the swarm of the old colony—will deliver just as much honey as a normal colony. The queen cells in the old colony can be used—except for two—for rearing queens (see page 31). If you don't wish to rear queens, the cells should be broken out of the comb and destroyed. When the two remaining queens hatch, the stronger one will kill the weaker one and then proceed to mate (see page 6). The old colony will recover quickly from the loss of some of its workers and its old queen because new bees keep hatching from the remaining brood combs and the queen soon starts to lay new eggs.

A Nucleus with a Queen

Another way to forestall swarming when larvae are already developing in queen cells is to form a

nucleus that includes a queen.

Ready an empty nucleus box and a queen or hatching cage (see pages 31 and 32). Find the queen, and lock her into the cage, which you attach to a brood comb with some wire or a rubber band. Hang the comb, along with the queen cage, into the nucleus box. Then take two or three brood combs from the colony that is in a swarming mood, break the queen cells out of them, and put them into the nucleus box. Shake the bees off two or three other brood combs into the nucleus box as well. Then release the queen from her cage.

If you have movable-frame hives, place a cover on the nucleus box. With a leaf hive, place the heating pad into the empty honey chamber of the new hive and block about three-fourths of the entrance by stuffing crumpled paper into it. Now take the nucleus to its new location. You must gradually add more empty combs to give the growing colony room to expand. If the colony is fed regularly (about a pint of sugar syrup daily, made up of equal parts sugar and water or 2 pounds of bee candy once a week), the nucleus will develop into a viable colony by fall.

You also have to remove the queen cells from all the brood combs in the original colony. To make sure you are not overlooking any, you must brush the bees off the comb into the hive body before you examine each comb.

After you break out the queen cells, the hive bees immediately start building new ones that must also be removed after nine days, leaving one or two. Be careful not to jolt the comb this time when you remove the queen cells because the future queen may fall off the royal jelly (see photo on page 38) and die. You should check after three weeks to see if there is a new queen in the colony and if she has started laying eggs.

If you find no sign of eggs or a queen, you have to test whether the colony is queenright. Hang a small piece of comb with eggs up to three days old (cut from the comb of another colony) or an entire comb with eggs and young larvae up to three days old into the hive. Mark the comb with a thumbtack.

September–December

- Combine weak colonies (see page 34).
- At elevations above 1500 feet (500 m), feeding should start now, whether the honey flow is early or late. At lower elevations wait until early September (see page 36).
- As long as the bees collect nectar, weigh the scale hive daily; after the last honey harvest, weekly.
- Make appropriate entries in the record cards.

What Needs to Be Done in September

The colony will have gotten smaller because the old bees that die are no longer all replaced by young ones. As soon as the nights become cool, the bees in the hive contract into a cluster.

- By mid-September you should have finished feeding the bees, whether the honey flow is early or late in your area. At elevations above 1500 feet (500 m), the colonies should be all set for winter by early September.
- Take the empty combs on the sides of the brood nest out of the hive, and store them for winter.
- Examine the colonies for the last time before winter (see page 42).
- Wintering over two colonies, one on top of the other, is advantageous.
- Keep reading the scale weekly during the feeding period; afterward only monthly.
- Make appropriate entries in the record cards.

What Needs to Be Done in October

Late-blooming plants in gardens (asters) and in fields (field mustard) offer the bees some pollen to help cover the need for protein during winter.

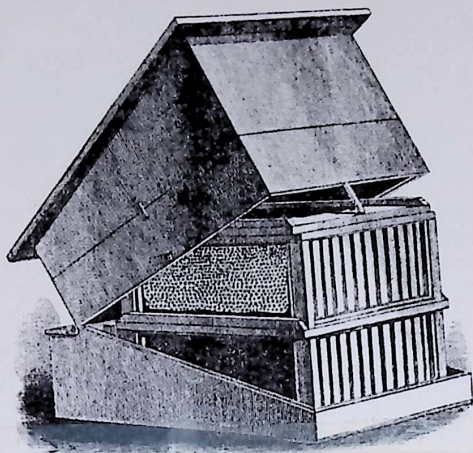
- Remove and clean the feeders.
- On frost-free days and when few of the bees are out flying, hives set up outside can be given a new coat of paint (see page 42).
- Check to make sure the hives are tight, and seal cracks if necessary (see page 42). Supply insulation, and cover the hives with roofing (see page 43).
- Take precautions against mouse invasions: Reduce the size of the entrance, or attach mouse screens (see page 43).
- Put up bird nets if you wish (see page 43).
- Weigh the hive at the end of the month.
- Make entries in the record cards, and collect the cards of all the colonies.

What Needs to Be Done in November and December

The bees have by now contracted into a tight cluster. In order not to starve or freeze to death they must keep eating the sugar syrup they have stored in the combs in the fall. The carbohydrates contained in the sugar are converted to heat.

- Check the hives once or twice a month, but be sure not to open them up (see page 43).
- Build new hives and other equipment; do whatever repair work is necessary.
- Combine and analyze the data on the record cards (see page 43).
- Expand your theoretical knowledge about bees and beekeeping. (See the list of useful books and other publications on page 65).
- Work on marketing your honey.
- Make use of the beeswax (for candles).

SWEETNESS



& LIGHT

The Mysterious History
of the Honeybee



HATTIE ELLIS



Harmony Books
NEW YORK

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"I know you still love me and that's what makes it so hard. I don't know what to do. If I let you stay--"

"I would. I would start unpacking right now."

"I know that too. But look at it this way. How could I be sure that when you were making love to me, you wouldn't be thinking about her?"

"Listen, darling, this is all too sudden and confusing and I feel like I don't know what I'm doing or why. Please, Mimi, just let me stay. I'll call her right now and tell her never to bother us again."

"I'm so tired. Let's just go to sleep. We'll talk some more tomorrow." I was exhausted myself and had no trouble going to sleep, with Mimi cradled in my arms, the way we always slept.

quiet tread, or all hell breaks loose," he says. "It's a matter of weighing the situation. If trouble starts, you bail out."

After finding a piece of sacking among the bric-a-brac on the back of the truck, Willie lights the cloth with a match and puts it in a smoker formed like a pair of miniature bellows. The smoke can help lull the bees. They think there is an emergency, eat their fill of honey, as if ready for flight, and either because a full bee is a happy bee or because they are now less able to bend and sting, they are less aggressive. Willie takes the top off the first hive. Pffffff, Pffffff, Pffffff, goes the smoke. After a short pause, he heaves off the top box. Immediately, the weight reveals the exact extent of the haul.

Honey is one and a half times heavier than water and a full box tells on your muscles. Beekeeping, in some aspects, is like fishing: some years you get next to nothing; others, you crop gold. This year everything worked; both skill and luck came together, and it is boom time. The bees were in the right place at the right time; the weather was good over the year. Willie and his family have kept bees here for more than fifty years, and he is now reaping the rewards of knowing his turf and keeping bees that are well adapted to their environment. This trip to Hangwell Law comes after a run of collecting a bumper harvest of heather honeycomb in ten days. It does not happen every year, or even often. But today, he gets 2,500 pounds of honey. Such is the drama of harvest.

The bees, in the meantime, go purposefully berserk. Zinging, small, aggressive atoms, gold in the late-afternoon sun, attack again and again from different angles, trying to find a way into the bee suit. Their persistence is unrelenting. Bees in the wild can burrow into the fur of an attacking bear, to sting the animal where it will hurt him hopping mad. In the same way, they seek the vulnerable chink in the beekeeper's second skin. A hole in the fingertip of a glove, a stray stitch on a seam will not go unpunished. You feel like

a character transposed into a video game, surrounded by flying attackers, the bee suit slightly claustrophobic, limiting your vision but not the sounds, nor the sudden sight of bees flying onto the net visor, inches from your eyes. Willie says the bees can get to people mentally. "They get you on the shake," he says. "They undermine your confidence and go dab, dab, dab." When a bee stings, a banana-like odor spreads in the air, attracting other bees to sting the same spot, like sharks coming to blood pulsing through the water.

Today, there's no real trouble. As each hive is opened, the noise grows, but Willie keeps calm, steady in the eye of the storm. Some beekeepers lose bees by carelessly crushing them under boxes as they work under the pressure of time and the bee blitz. Willie knows that bees matter more than honey. He brushes insects off each box with gentle sweeps of fern and the triumph he feels at the haul is as much about the bees as anything else: "When the opportunity presents, they are up and at it," he says, with frank admiration, as he lifts a box as heavy as a block of gold.

On the back of the truck, towers of honeycomb boxes build up, with a great cloud of bees above, moving up and down and round and round as if in a demented dance of fury. Willie, still in his bee suit, but with the hood down now, drives off. He stops after a few hundred feet and waits for a few minutes, to let some of the bees following the truckload fly back to the hives. Then he starts the engine up, drives another few hundred feet and stops again. Such thrift is the equivalent of scraping out the cake mix from the bowl: the last drops matter.

Honey is, essentially, a wild food. Willie couldn't get honey without the bees; the bees couldn't make the honey without the sun shining and the rain falling, the right amount at the right times, to bring the flowers into bloom and full of nectar. It helped, this particular year, that the winds were the mild southwesterlies rather than the usual northwests with their edge of chill. Heather is a fad-

dish flower that needs the right conditions to bloom bright. This year the purple spread to the horizons. Clouds of pollen puffed up at every step, whitening animals' muzzles. The nectar flowed and the bees massed on the flowers, drinking deep.

Willie can provide hives for the bees; he can place his hives near good plants; he can look after the bees to a certain extent. But you can hardly term a man a livestock farmer whose herd consists of seventy-five million flying, stinging, crawling, sucking, working, laying, feeding, fighting, instinctual, independent insects. Man makes use of bees, but only by respecting their nature.



WILLIE ROBSON'S FAMILY home and business is the Chain Bridge Honey Farm, 20 miles from the heather moor, on the banks of the River Tweed. At this point, the river acts as the watery border between Scotland and England. It runs broad here, with fat, smooth curves, and its force, sprung upstream from so much rain over wide moors and blank horizons, is gathered together, ready to pour into the North Sea at Berwick-on-Tweed 3 miles downstream.

The honey farm takes its name from the Chain Bridge over the Tweed, just a couple of minutes' stroll away. At the time the bridge was built, in 1820, it was the longest suspension bridge in the world. There is a heritage plaque on the Scottish side, with a cartoon of the engineer driving an overloaded carriage at the launch; a cheery Dickensian image reflecting that, in retrospect, the good times were starting to roll. Like many other parts of Northumberland and the Scottish Borders, over the centuries the land has been metaphorically crosshatched with scars from territorial conquests, celebrated in Borders ballads of robbers, or reivers, raiding land and livestock, attacks and counterattacks, all stoked up with fireside boasts. When the bridge was built, the fighting was finally over.

Now the borderless global culture invades every highway and backwater. On the red sandstone of the English side of the Chain Bridge someone has scratched: WEST SIDE, 2 PAC, referring to a notorious gangsta rapper and his territory in Los Angeles. The incongruous reference, in this quiet spot, is nicely ironic—humans playing at frontiers, just as they play CDs of guntalk. Now, alongside castles for the tourists, you just see the roofs of big, private houses poking out amid the tall trees of settled parkland, all risen with the stability of trade and commerce as their owners amassed fortunes from fishing, mining, trade, and agriculture.

There is genuine unease, however, about the future of the countryside. In the 1980s, the wealth and ways of heavy industry collapsed; now it is the turn of the land. Willie is one of the few people making an unsubsidized living from agriculture.

All the while, amid skirmishes and prosperity, the bees go where they have always gone: to the richest, longest, sweetest draft of nectar they can find, whether it is Scottish or English; agricultural oilseed rape or heather on the moorlands. When you walk by the river in early summer, a shy galaxy of wildflowers glimmers from the ground below: pinks, yellows, sky blues, mauves. Walkers shelter from the soft, cold rain under the occasional stretch of hawthorn hedge, and then continue, with the grass and flowers glittering below their feet. As I walked by the river, I watched the bees with a new interest, looking at them go to fill the honey pot, looking at the plants and wondering what sort of honey their nectar would produce.

The hawthorn used to be a fickle but exquisite source of honey, when the fields in this part of the world were parceled off between their prickly hedges. These high hedges, flowering in May and June, kept cattle in and gave the animals shelter, and they existed because the Irish shipped their stock over to be fattened by the Northumbrian farmers, who then sold them to market. No longer.

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"Yow," I said. "At the American Library Association conference in New York."

"Did I ever tell you that you saying 'yow' irritates me. Could you say 'yes' or at least 'yeah?'"

"Yes, Mimi, we met at the ALA conference in New York. My publishers arranged a reading for me. You attended it--one of the few who did."

"And you were with that snotty girl from Harvard."

"Mary, and we had agreed to split up even before the conference. And I had to get my stuff out of her apartment in Cambridge."

"And I came up and helped you and we moved you in here."

"Yes."

"Do you know why I fell in love with you--wait, I'll tell you. I thought you were the most lonely person I'd ever met. Even when you were reading, I thought that man is so lonely I can't stand it. He needs a wife, a mother-wife who will hug and kiss all that loneliness out of him. I couldn't have children--if I could, we wouldn't be having this conversation--so I adopted you. You reminded me of that boy in *The 400 Blows*. Oh, sorry, I'm just a dumb Dago broad. I shouldn't have seen a movie--I mean a film--like that."

a character transposed into a video game, surrounded by flying attackers, the bee suit slightly claustrophobic, limiting your vision but not the sounds, nor the sudden sight of bees flying onto the net visor, inches from your eyes. Willie says the bees can get to people mentally. "They get you on the shake," he says. "They undermine your confidence and go dab, dab, dab." When a bee stings, a banana-like odor spreads in the air, attracting other bees to sting the same spot, like sharks coming to blood pulsing through the water.

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"Don't be so sarcastic," I said. "I never called you a dumb Dago broad. It was a good picture, though, wasn't it, I mean despite the sad ending." I lit a cigarette with my Zippo and leaned over to light hers.

"Do you remember the honeymoon? Your father had given you the Mustang and we just took off after the wedding and headed south. I gave a reading at Queens College in Charlotte and got paid \$500 and we used that money for the whole trip. It was late September and the leaves were turning. We went down to the Great Smoky Mountain National Park--"

"And stayed at motels and fucked our brains out--"

"Yes, and that was great. We ate at those small-town diners. Remember the one in North Carolina that was supposed to be famous for its catfish?"

"I could have cooked fish better than that," Mimi said, stubbing out her cigarette. "But it was all part of the experience, and you paid for everything, and you were so proud about that."

"Damned right I was. And then we took the Blue Ridge Parkway back, taking our time, stopping at the turn-offs to look at the scenery, getting off the Parkway to stay at some dinky little motel for the night. And I didn't want the trip ever to end. I just wanted us to keep driving and driving. And remember the last night, the motel in Virginia. The black and white TV, torn linoleum on the floor, a little bed that creaked

dish flower that needs the right conditions to bloom bright. This year the purple spread to the horizons. Clouds of pollen puffed up at every step, whitening animals' muzzles. The nectar flowed and the bees massed on the flowers, drinking deep.

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so much I thought we were going to break it--"

"Yes, and next morning the horse and goat in the back yard. And you went to buy sugar cubes for them. We were petting and feeding them but the owner came out and said not to feed them anymore because we'd make them sick. They kept rubbing against each other and we recognized that love and were grateful for it. Because it was like our own. The horse was black and of course the goat was white. I have a picture of them and us somewhere. Excuse me, David, I have to pee. Close your eyes when I turn on the light"

When she came back, I had to pee myself. She had turned off the bedroom light when I got back so I had to feel my way around. She was sobbing now and when I took her in my arms, she didn't resist. She scooted down so that her head rested on my chest. "Why did it have to be her? I could have forgiven the others, but not Laura Cohen. She fucked you around twenty years ago, she killed your four-month-old baby, and you go right back to her. I don't understand. We had it so good. I don't understand...."

"I know," I said, stroking her hair. "I mean I don't know why her. And we did have it good and I don't know why I fucked around on you. I don't know anything, Mimi." We were quiet for a while. "She's got some kind of obsession on me. What I mean is I'm obsessed by her. I really don't even love her, certainly not the way I love you."

honeycombs from the boxes brought down from the heather moor. He is wearing his tweed cap, its colors reflecting the soft blues, grays, and greens of this wet, wild landscape, and tendrils of gray hair break out from under its brim. The comb's miniature golden columns are stacked one on top of the other. The room is full of the smell of honey, hanging in the air, soft and warm, alongside the sound of sticky cuts as he divides the honeycomb with a bone-handled knife. In hours of cutting and talking, not a single stray drip escapes. When a wasp comes pesking nearby, Willie dispatches it with a swift, neat backhand of his knife. "Sampras, eat your heart out," he says, in passing. He cuts off a generous corner of comb, offers it to me, and takes a bit himself. A broad, strong man, he looks, suddenly, like a bear enjoying a sweet snack. Just as suddenly, in the midst of a gloomy diatribe about the state of farming or greedy businessmen pouring money into idiot ideas, his face will light up with a sun-shaft of humor, or he will walk around the honey farm trailing out notes from his choir's repertoire: "Oh the rhythm of life is a powerful beat. . . ."

As with most small independent businesses, home and work are indivisible. Willie thinks, lives, breathes, and builds the business constantly. The honey farm, in turn, has taken on many human qualities. Despite the fact the farm is deep in the countryside, people come and go constantly, dropping by to hear the news or to see what is happening with Willie's latest scheme, telling a story as they make a purchase or arranging for an item to be picked up or sent on. People—visitors, customers, workers—are greeted as a part of the natural hospitality of the place.

Willie reckons 80 percent of the profits go back into the local economy. He employs about ten people, some of them highly skilled individuals looking for a home after the collapse of small- and medium-scale agriculture. When I visited, there was much banging and tinkering going on in some new buildings they had

put up: a new vintage transport exhibit was being created to attract visitors. Wandering around vehicle entrails and the beastlike bodies of old cars and trucks, Willie told me about a tractor recently shipped over from Australia by a beekeeper who was dying of cancer. He managed to bring his prized vehicle over personally in order to give it a home at the new museum. Chain Bridge Honey Farm draws people back, and I could imagine this man traveling halfway across the world to make a final, lasting connection with this place before he died.

Willie Robson's way of treating people fairly (both workers and customers—prices are kept reasonable) feels refreshingly ungreedy; it is almost old-fashioned in the modern world—and yet it works. The honey farm produces something good—very good—without cutting corners. Hardly anyone bothers to produce heather honeycomb these days: it is too much work. Yet there is a market for it, as the Robsons prove. Farmers, in the decades of subsidies—what Willie calls funny money—have not needed to market their produce and connect with the customer. In this time of change, they are suddenly vulnerable. Willie is in a better position. He has had to keep a careful eye on what people want, developing a range of cosmetic products, such as the heather-honey lip balm so fragrant you keep licking your soft lips and developing honey foods, such as a rich cake and a tangy grain mustard. Recently, he had been trying to persuade several farmers in the area to grow borage again. He would get good food for his bees, and they could sell the crop into the flourishing health food market; the plant makes an oil that has more gamma linolenic acid than evening primrose oil, which has taken the international health food market by storm for its reputed benefits for those with afflictions from high cholesterol to rheumatoid arthritis. The subsidy route is a dead end, he believes: "If you pay people for doing nothing, it will ultimately destroy them."

The skills of beekeeping itself originate from Willie's father.

Selby Robson lectured on beekeeping in the days when it was seen as an important part of the rural economy. He would tour around the north, listening as much as he talked, picking up the knowledge of other beekeepers and passing it on. Now that farmers are being urged to diversify, they lack the likes of Selby Robson, and others who have honed such skills for themselves from time-tested experience, among their ranks.

For Willie's part, he says that, increasingly, his knowledge comes from paying attention to nature. It is largely about respect. The morale of the colony is paramount, and any creature needs to be comfortable. You must get the bees out of drafts and make sure they have enough water. Drought comes from the nature of the subsoil. Some land needs rain every ten days, or the plants become stressed and, in turn, the bees suffer. In nature, nothing is fixed—the weather, plants, geography—all have their variations. When Willie was learning from his father, they had a fixed routine of visiting the hives. Sometimes the bees would just not be in the mood and the situation would turn nasty. Now he goes more with what the bees need and want, rather than dictating terms.

After spending some time with Willie, I began to understand what is at the heart of his philosophy. Many other beekeepers have gone down a more scientific route, which involves breeding up or bringing in new strains to promote positive genetic traits in their stock. After making a good living from beekeeping for thirty-five years, Willie has learned the hardest lesson of all: to do less, not more. He lets the bees adapt to their environment the best they can. He visits them occasionally, he checks them for disease, he makes sure the hives are in a good position, and he collects the honey. Only after years of practice, observation, and knowledge has he reached this conclusion: that the best you can do is to do as little as possible.



FIVE ROOMS of the honey farm are given over to an exhibition that covers every surface with information on the honeybee. As well as displays on the biology and ecology of bees, there are bee-related quotes ("If you want to gather honey, don't kick over the beehive"—Abraham Lincoln); bee facts about history; and snippets on bees and beliefs. The insect is featured in the Bible, with its land of milk and honey, in the Koran, and in Native American and Hindu creation myths—in the texts of almost every major religion and literature in the world.

At the end of the first room I discovered an observation hive. Aristocrats of the Enlightenment had a craze for these glass hives as they began to look at the world more closely, with an eye cleared by reason. The hive was about 4 feet wide by 3 feet high, containing a flat slab of comb. The bees went in and out through a tube in the wall. I stood before it, mesmerized. There was a faint sound, like a nonstop train going through an endless tunnel a mile below my feet. This animal engine chuffed away in a ceaseless steam of pure energy. I put my ear to the glass and both felt and heard the whirr of life: thousands and thousands of lives wound up like watches, ticking away in collective survival. I blurred my eyes. The bees formed an almost solid material, quietly, steadily seething. It was unlike anything I had seen before. Not repulsive, like the pulsing of maggots on meat. Not a crawling, or scurrying, or wriggling. It had a gentle, purposeful, cohesive movement, impressive and unstoppable in its numbers, like a crowd gathering at a large sports stadium, or a workforce funneling into a factory gate.

I thought of Willie Robson and how he and the bees lived with their surroundings; of the intimate and ultimately curious relationship that holds bees, plants, and humans in so many different, delicate webs around the world, and how these webs had existed for millennia. The products of the honeybee have always been useful to man, but beyond, far beyond, their material use, bees have

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esting finds, of a group led by Dr. Tim Demko, were approximately one hundred insects' nests. The inch-long flask-shaped cells were clustered together, and the entrance was probably through open knot holes in the wood. The formation of the cells and details of their constructions led the scientists to believe they were built by ancient ancestors of today's bees. Elsewhere on the site, they also later found nests closely resembling those of the modern sweat bees (*Halictidae*), so called for their attraction to perspiration. Chemical analysis of the Petrified Forest nests showed that the cells contained some of the organic compounds found in beeswax.

The early date of the forest could be significant. If these were, indeed, bees' nests—and the evidence certainly pointed to this, though some say you would need to find bee bodies to be certain—it would mean bees existed 207 to 220 million years ago, at least 120 million years or so before the oldest previously known bee fossil. Beyond this, the nests are older than the earliest known flower fossils. Could it be that bees existed, in some form, for ages *before* flowers?

It depends, partly, on how you define a bee. Evolution is, after all, a continuum, and these could be bee ancestors rather than bees themselves. It also depends upon when flowers first evolved, and fragile plants leave an elusive fossil trail. Charles Darwin called the origin of flowering plants "an abominable mystery," and it remains, for all the theories, ultimately mysterious.

What seems more certain is that bees probably evolved from a descendant of today's carnivorous hunting wasp. The Russian entomologist Professor S. I. Malyshev posited a theory about how this happened, and this leads to part of what makes a bee a bee: its diet. Bees are unusual among insects because the developing young have the same diet as the adult; both survive exclusively on plants. The hunting wasps still feed their grubs on protein-rich aphids that they kill with their jaws. They also eat, as bees do, the honeydew exuded

from plant-sucking aphids. Malyshev argued that these early carnivorous wasps, in the process of killing their prey to feed their young, would taste the sweetness in the aphid's body that they also found in honeydew. It would have been a short evolutionary step for the insects to feed entirely on plants, in their larval as well as their adult diet.

We do not know for certain if and how the bee first evolved from a carnivorous hunting wasp. We do not know the earliest date of the bee or the bloom. What we have are theories looped onto fragments. It makes the evolutionary detective story no less intriguing.

To get back to a concrete fact—one you can eat—Malyshev's speculations connect to another pot in my kitchen cupboard. Honeydew honey is a delectable curiosity. Strong, to the point of almost being savory, it is not made from the nectar of flowers at all. Rather, bees collect honeydew from the aphids in forests, just as the hunting wasp did all that time ago. This honey is therefore a sticky substance made from fluid ingested by two kinds of insect. But, as I spread the darkly delicious ooze on my toast, I prefer to think of honeydew as a possible clue to the evolution of the honeybee.



THE COMPLEXITY of the relationships between bees and flowers shows that they certainly coevolved to a great extent. Many flowers have highly specific structures to attract bees and other insects. The colors and shapes of flowers that so appeal to the human eye act on the bee, though in a slightly different way. The velvety red of a rose, for example, is wasted on a bee, in terms of color, because their eyes cannot distinguish differences at that end of the light spectrum. Toward the yellow, green, blue end, however, a bee's sight is acute, which may explain why such plants as thyme, rosemary, and lavender, with their blues and purples, are such famous sources of honey.

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APIS MELLIFERA, the most studied creature on the planet after man, is a summit of sophisticated engineering; an evolutionary triumph of form and function in a thousand details. This tiny creature's achievements tower above the flights of architecture and efficacy of man-made machinery. It has occupied the minds of scientists, writers, musicians, and philosophers around the globe.

The fluffiness of bees—even a bee's eyes are hairy—is seen by humans as part of a cartoon "cuteness," but the hairs that cover the honeybee's body serve many purposes. They help create an electromagnetic charge that draws pollen grains through the air, leaping toward the bee's body, where they are caught in the mesh of strands. The bristles growing between the 6,900 hexagonal plates that make up the compound lens of the bee's eye help it to gauge wind direction and flight speed. Hairs also cover the six pairs of legs. Forget bees' knees; bees' legs, on the other hand, make humans' look pedestrian. Each one ends with a claw and suction pads that enable the bee to move horizontally and vertically, to land on a petal and cling to it with just a single leg, or to hold onto other bees to form the cluster of a swarm.

The legs are hairy, and each and every bristle has its business. The forelegs have a small, hair-lined notch through which the bee cleans its antennae, keeping their sensitivity clean and bright. The



A worker bee returns to the hive with willow pollen packed into her pollen baskets.

lower, outer part of each hind leg has a concave scoop, into which the bee packs its pollen, the grains moistened with sticky, honeyed saliva so as to form small clumps. Stiff bristles of hair help anchor the collected packet of pollen, and the honeybee has evolved a sweeper system of moving pollen grains down its body to collect in these pollen baskets, which you can sometimes see when it rubs its legs together in flight. You can certainly see the pollen clumps with the naked eye, if you look carefully at the hind legs of a bee as it pauses on a flower, or even as it flies around the garden.

The color of the pollen bundles depends upon the flowers the bees have visited and is one way beekeepers can tell where their insects have been feeding. A beekeeper's pollen chart looks like a paint catalog with some surprising matches of colors and titles. Snowdrop pollen is the color of a free-range chicken's egg yolk, and red dead-nettle a sultry, vampish red; but asparagus is the orange of a 1970s plastic chair; raspberry, for some reason, is gray; gorse is mouse brown; and oriental poppy is dark blue. Between these are many shades of green, gray, orange, red, yellow, and brown.

The honeybee's wings are a transparent film, as strong as they are light. Although they look like just a single pair, each bee has two pairs, the forewings linked to the back wings by a row of minuscule

hooks that link the two together to make a hard-wearing yet flexible whole. The muscles in the insect's thorax enable the wings to beat at an astonishing two hundred times per second, and it is this rapid, energetic movement that makes the bee's buzz. This tremendous energy means the thorax could overheat, but the excess heat passes to the head, where it is dissipated and evaporated in droplets of semi-concentrated nectar, as if the bee were sweating a watery honey.

Honeybees are proverbially busy; it is even more impressive that they don't waste energy. Even a casual look at an observation hive shows a mass of activity, but just as much waiting around. Up to two-thirds of a bee's life is spent wandering around the hive doing pretty much nothing. You wouldn't call it relaxing, exactly, just not using up energy on the unnecessary.

Where there's a good load of nectar and pollen to be found, they go. The average speed of a bee in flight is 15 miles per hour. Its fuel is honey, with an average load lasting up to 37 miles. A gallon of honey petrol could take a bee seven million miles. But the bee is careful not to overload. It calculates exactly how much honey it needs to take into its honey sack in order to fly to and from the forage flowers without weighing itself down needlessly.

A beehive with its honeycomb and its bees is an embodiment of energy: energy recycled endlessly as the honey is eaten and used in the form of flight and every other facet of being alive. As interesting and impressive as bees are individually, it is as a collective force that they most fascinate. Each bee may be a tiny fraction of the hive, but each one plays its part. The collective life of the hive enables it not just to thrive but to grow, with new colonies of bees breaking off, or swarming, to create new colonies.

We tend to put a hierarchy on the three types of bee found in a hive. While there may be up to 200,000 female workers, though more commonly 50,000, there might be, at most, a few hundred drones, or male bees, and just one single queen. Her singularity and

reproductive function—she is the egg layer for the colony—crown her as the most important bee. When a nest becomes overcrowded, the colony prepares to swarm. This involves the old queen flying off with some of the workers in a great swirl of bees. Before she goes, more queens will be “started,” one of which will lead the bees remaining in the colony; others may take off with further groups or casts, depending on the needs of the colony. The queen cells, in which the new queens grow, look a bit like thick, waxy, inch-long peanut shells and hang vertically from the comb. When no more queens are needed, the next queen to hatch will destroy any that follow her. An eerie, keening noise can be heard outside the hive of the queens calling out, about to be born. They should keep quiet. The hatched queen will wait for the others to emerge and the ensuing fight is a sting-to-the-death. The queen’s sting, unlike the worker’s, can be retracted and reused, ruthlessly.

The new queen’s next major task is to mate. She leaves the dark security of the hive for her virgin flight, to be pursued by the male bees, or drones. They mate in midair and she returns to the colony, storing the sperm to use during her lifetime. From then on, the queen’s business is mainly to lay eggs—as many as two thousand in a day. She may be able to lay a million or more eggs altogether. After she has run through her supply of sperm, her end is near, and

*Queen**Drone**Worker*

The three kinds of honeybee: queen, drone, and worker.

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a long white ox hair, or a piece of grass to the bees to make them more traceable. Tracked in the evening, the bees became more easily visible as dark dots against the setting sun, or with the last light catching their shimmering wings.

The ability to follow a series of fast-flying dots is extraordinary, but the human also had, and still has, an avian ally. The greater honeyguide (with the appropriate name *Indicator indicator*) is a bird with the exceptional ability to eat wax, which other creatures find indigestible. But it needs help in getting to the bees' nest, often inaccessible within a hollow tree, the cleft of a rock, or in the ground. Honeyguides use several sweet-loving mammals, particularly the honeybadger or ratel, to gain access to the nest, but the handiest mammal of all is man. When a bushman hunter first hears the whirring *cherr, cherr, cherr* of the honeyguide, he knows there is honey to be had. The bird flies a short distance. It calls again. The man follows. It calls. He follows. At each step, the bird's call becomes more insistent and the distances shorten as the two close in on the nest. The man also calls to the bird, perhaps using a snail shell, or his own form of bird call. When it finally arrives, at the end of this long sequence of call-and-see, the bird hovers over the nest, before perching nearby, waiting for the man to finish the job. He hacks open the tree and the honey oozes out. It can take a whole day to find a nest, but just a few hours with a honeyguide. The man leaves a piece of comb containing the prized, nutritious bee brood. And the reward may not be so big as to sate the bird's appetite; otherwise, it might not lead the hunters on to the next pot of gold.

Once a tree was identified as a source of honey, the hunters might tie a piece of twine around the trunk, signaling it as taken territory. Such a honey tree might then have wooden pegs driven into the wood, to make it easier to climb up to the nest. Improvised ladders, made out of tree branches, were also propped against trees

or rocks to reach honeycomb sites. Some tribes became adept at climbing trees either by wrapping their arms and legs around the trunk and shinning up or, if the tree has a larger dimension, by slinging a length of vine (or later a belt) around the trunk like an extension of the arms, to inch their way up to the nest. Another method was to climb a parallel tree and then climb over onto an otherwise inaccessible branch. Once up, the hunters hacked into the wood and pulled out the comb. Sometimes, smoke was used to pacify the bees, just as it still is today by hive beekeepers.

The hunters and their families feasted on the honey right away, gorging on the comb as a treat. The brood comb, containing the developing bee larvae, was especially desired; the anthropologist Colin M. Turnbull, in his book on the Congo, *Wayward Servants*, describes how the Mbuti honey hunters would warm the comb gently to make the larvae wriggle as they were eaten. In much of the Western world, there is a taboo against eating insects, but many cultures see insects as a useful source of protein, and have preferences for different ways of eating them. In Zambia, for example, the unsealed brood comb is a delicacy while the sealed comb is left uneaten, perhaps because of the risk of eating nearly formed bees.

While the hunters would devour some of the comb immediately—gleefully licking their arms and fingers as their upper bodies became sticky with honey—they kept some to be shared. Dividing up food among a group lessens the risk and fear of starvation and has a profound significance for bonding. Typically, among African tribal peoples, the successful hunter is not boastful of his kill. He might at first deny to the group, on his return, that he has had any amount of success, and the fellow hunters might tease him about the smallness of his catch as they heave it back to the others left in the camp. Successful hunting and sharing food are part of survival and they are also the cornerstone of social cohesion within a group. Not sharing food verges on the taboo.

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CHAPTER THREE

ORGANIZATION AND MAGIC

While humans were hunter-gatherers, the honeybee inhabited the dark cavities of rock crevices and hollow trees; but as we began to settle, to grow crops and rear animals, new spaces were created that bees could inhabit. This probably arose by accident rather than design. The water pots and baskets made by Neolithic humans to aid their fledgling agriculture would have been perfect spaces for bees; it isn't hard to imagine roving swarms settling in ones left lying around. It is likely that humans would then raid these improvised nests, since it was easier than hunting down honeycomb in the wild. The next step would have been to create spaces specifically for bees: why not encourage them to settle where the honey could be collected more easily? This seems to be the best explanation as to how beekeeping began. The insects were still wild, just encouraged to live closer to humans.

Through the papyrus records, paintings, and sculptures that were preserved in the hot, dry climate of Egypt we know something of how the first farmers kept bees. Beekeeping was one of the many lasting achievements of the ancient Egyptians, and the pattern they set remains in many ways essentially the same today as it was five millennia ago.

Egypt is a land of two contrasting parts: the rich, fertile black soil of the alluvial plain, which you still see clinging to new pota-

toes in greengrocers, and the arid red of the surrounding desert. The green strip of vegetation that grows on the black soil is threaded on the Nile through the center of the desert and is composed of the fine, rich mud deposited by the river. Prior to the building of the High Aswan Dam, this land was brought back to life and replenished each year by floodwaters, as well as sustained throughout the year by irrigation. In a land where the rainfall can be sparse, or even nonexistent, and where the sun beats down from a cloudless sky, this river has always been the region's lifeblood. No wonder that ancient Egyptians called their land the gift of the Nile.

The fertile green strip along the Nile provided plenty of foraging for the bees. Pollen grains found in ancient honeys include those crops grown for animal fodder, such as alfalfa, clover, and chickling pea. The fruits and vegetables grown for human consumption, such as lemons and beans, provided food, too, for the honeybee, in the form of nectar and pollen. The ancient Egyptians also loved their gardens; one of their prayers was that, after death, you would sit in the shade and enjoy the fruit of trees you had planted. The garlands discovered on the mummified body of Tutankhamen (King Tut) indicate the range of plants prized by the Egyptians that also provided nectar for honey, such as cornflowers and wild celery.

Settled civilization began on riverbanks and its roots were in agriculture. The Egyptians were among the first to centralize and organize food production, including beekeeping. As well as irrigating and cultivating the soil, they bred cattle, farmed pigs, had primitive incubators for eggs to create the first poultry farming, and stored grain. There was enough food produced in this successful agricultural system to feed the workforce that built the pyramids. Life was less hand-to-mouth—more planned than before. Just as scribes counted the peasants' produce, stored it in state granaries, and distributed it back to the people, there was a specialized honey scribe to count jarfuls of honey. These early civil servants

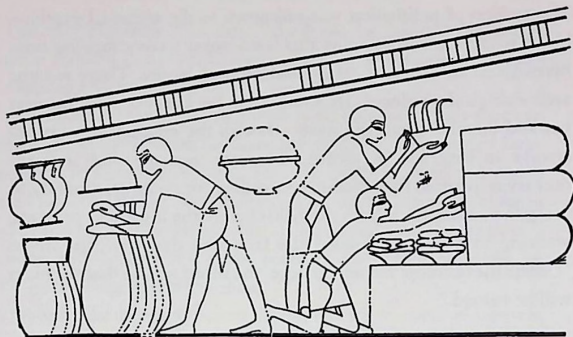
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covered with mud discs, with a hole in one end for the bees to come and go. The beekeeper opens the other end of the hive to collect the honey-filled combs. Dr. Crane also saw cow dung, a common form of fuel in the Middle East, being used to smoke bees; this could easily have been the method used in ancient Egyptian beekeeping.

Other current observations give us clues as to the methods of the ancients. An eighteenth-century traveler in Egypt described how hives were moved gradually down the Nile on boats, leaving Upper Egypt at the end of October. The hives were put on rafts and the bees went to successive fields in flower as they were moved northward toward the Mediterranean. By the start of February, this traveling workforce reached Cairo, where the honey collected on the journey was sold. Migratory beekeeping is a major source of income for today's beekeepers in many parts of the world, who take their hives around, following the crops currently in bloom, their efforts paid for by the farmers who want their crops pollinated by the bees.

The process of pollination was unknown to the ancient Egyptians, but it is not hard to imagine this boat-based society moving their hives about in order to get a good crop of honey. There is some archaeological evidence to show that beekeepers and farmers worked together from the start—though the relationship was not always an easy one. A pitiful, desperate tone pervades a third-century BC petition from beekeepers calling for donkeys, urgently, to bring their hives back from the fields before the impatient peasants, wanting to press on, flooded the land and destroyed the hives: “Unless the donkeys are sent at once, the result will be that the hives will be ruined.”



THE MECHANICS OF BEEKEEPING in ancient Egypt are not all that we know; we also know something of how honey and other bee products were used in the household, both for practical and for other, more mystical, purposes.

The diet of ancient Egypt has some striking similarities with that of today. The grain, honey, and cattle shown in the ancient pictures became the bread, beer, beef, and honey-rich cakes on their tables, as on ours. Food differed according to the rank and need of different parts of society. The messenger and standard-bearer of King Sethos I ate bread, beef, wine, sweet oil, olive oil, fat, honey, figs, fish, and vegetables, a combination that could easily suit the modern tastes of a contemporary civil servant eating a Mediterranean diet. Quarry workers at that time got a more functional, though nutritious, ration of 4½ pounds of bread, two bundles of vegetables, and a piece of roast meat.

Honey was a food of the rich—the poor sweetened their food with dates—and its high status meant it was celebrated in poetry at feasts. The daughter of Prime Minister Rekhmire had a song sung

at a party: "The little sycamore, which she hath planted with her hand, it moveth its mouth to speak. The whispering of its leaves is as sweet as refined honey."

There are honey cakes depicted in Rekhmire's tomb that can still be found in different versions today. The scribes record large quantities of honey being used for such cakes as offerings, which shows how much they were valued. The Agricultural Museum in Dokki has an ancient honey feast cake shaped into the form of a human, with a head and arms, possibly, Dr. Crane suggests, an early form of a gingerbread man.

Honey and beeswax occur in many other parts of ancient Egyptian daily life. Wax was used to hold the waves of the elaborate wigs used by both men and women. The long braided and sculpted tresses, some composed of more than 120,000 human hairs, are reminiscent of eighteenth-century wigs, or even the hair extensions of today and the sculpted forms of dreadlocks. Bee products have been found in the cosmetic boxes filled with kohl and other colorants, lotions, and beauty potions. Honey was, for example, included in a compound of powdered alabaster, powdered natron (sodium carbonate, much used in the mummification process), and salt, which was supposed to smooth wrinkles.

Honey was also used for more personal treatments. A mixture of honey, herbs, oils, and onions was applied to a woman's vagina to try to stop a miscarriage, while crocodile feces, honey, and saltpeter were used to stop conception in the first place (perhaps such a substance would work by putting you off sex altogether). Dr. Crane was told in 1993 that cotton soaked in lemon and honey was still used as a contraceptive in Egypt.

The fact that honey was added to so many of the medicines of ancient Egypt may have been a case of sweetening the pill when remedies included the likes of fingernail dirt and mouse droppings.

Ingredients like these were supposed to be repulsive to the evils inhabiting the body. Putting aside such deliberately disgusting treatments, and such hocus-pocus as curses for catarrh, we still have lessons to learn from the physician-priests of ancient Egypt, who were much admired by the ancient Greeks, usually seen as the founders of medicine. Honey was certainly put in dressings for wounds—an effective measure, as modern medicine was later to prove. When honey is mixed with body fluids, it produces hydrogen peroxide, which inhibits the growth of bacteria. For similar reasons, honey was—and still is—used for gut problems, and even for tooth decay. The remains of ancient Egyptians reveal that they had strikingly bad teeth—perhaps from having to grind down the coarse grains—and a mixture of honey and herbs would be packed into the mouth to fight infection. The modern mind may scoff at such an idea, but it was, in fact, a perfectly good remedy, and is starting to be used again today.



ANCIENT EGYPT casts a spell on us with its strange mixture of practicality and mysticism. Its priest-physicians were using a mixture of medicine and magic. Many papyrus records contain formulae that sound like plausible prescriptions, with a tone of precision and correctness, before suddenly veering off into spells—rather as if a solidly reassuring doctor's note had vaporized into sparkling ectoplasm. This mixture of knowledge and the metaphysical intrigues us today; in the same way, we admire the engineering feat of the pyramids and at the same time feel alienated—and fascinated—by their purpose as launch pads into eternity.

The mummy is the obvious physical embodiment of this cult of the afterlife. For a high-class embalming, first the entrails of the corpse were removed, preserved, and wrapped in separate packets (the brain was discarded as irrelevant). The rest of the body was

then dried by putting it in natron for forty days. It was washed, purified, and dried, the skin rubbed with honey, milk, and ointments. Because honey has preservative qualities, it also played additional parts in some burials. The corpse of Alexander the Great was said to have been covered in honey, on his own instructions, to stop its putrefying until he was buried. In *The Mummy*, the British Museum's Egyptologist Sir Wallis Budge described the discovery of a honeyed corpse. A jar of ancient honey was discovered in a grave by some treasure seekers. One was dipping his bread into the honey for a taste when he noticed a hair: "[A]s they drew it out the body of a small child appeared with all its limbs complete and in a good state of preservation; it was well dressed and had upon it numerous ornaments."

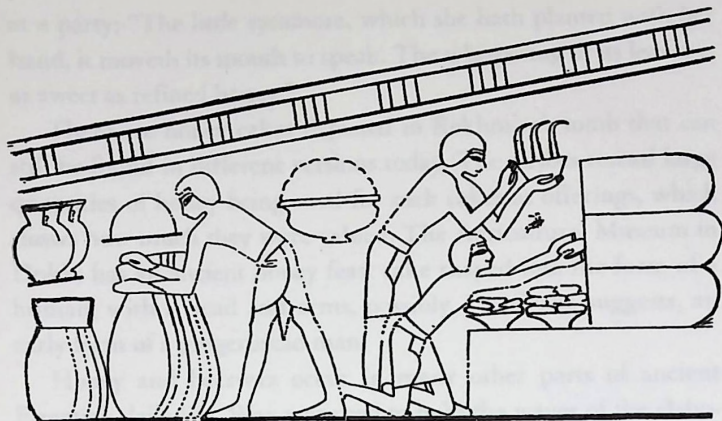
Such a ghoulish incident, like the curses on the doors of tombs in musty pyramids, is part of this frisson of ancient Egypt. Beeswax figures are similarly chilling in this effect. They were said to prefigure what you hoped would happen. One papyrus from around 2830 BC, for example, tells of the spells of a man called Aba-*aner*. From a box of magic, he produced a wax crocodile and put it into the water where his wife's lover was bathing. It came alive in the water and dragged the man down into the deep. This grisly tale shows a belief in the power of beeswax figures to move in and out of reality.

Medicine and magic both drew upon the idea of *haka*, the term the ancient Egyptians used for the power that came from creation. A potion, a prescription, a prayer: all turned toward the same source. This ultimate power could be embodied in animals and statues, and they figure in the amulets, or magic charms, that were carried about for good fortune. They could take the form of insects, sometimes breathing magic into a close observation of nature. The scarab beetle rolls a ball of dung into a hole and lays its eggs inside to give them warmth and food; the Egyptians depict the scarab as

rolling the life-giving sun across the sky each day. The ancient Egyptians believed bees originated as tears of the Sun god, Ra, merging the two crucial substances of water and sunlight in the body of the bee. The Salt Magical Papyrus records: "When Ra weeps again the water which flows from his eyes upon the ground turns into working bees. They work in flowers and trees of every kind and wax and honey come into being." As we've already seen, honey was sacred enough to be a suitable offering to the Nile gods; sacred bees were also part of the Egyptian's cult of the afterlife, with honey one of the funerary foods left in the tombs of the mummified dead, as sustenance for the next world. The Opening of the Mouth ceremony was performed on mummies so they could "eat"



Old Kingdom (top), Twelfth Dynasty, and Sixth Dynasty bees.



Painting in Rekhmire's tomb in Luxor, showing hives being smoked and honeycombs removed and packed into jars.

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trauma of war beyond its pages. The Latin name for the poem, *Georgica*, translates as "what concerns the man that works the earth," and was about such smallholders, rather than the large Roman estates that used slave labor.

Nature runs through the lines of *Georgics, Book Four*; like a stream. You see and smell the flowers that attract the bees—the wild thyme, the "rich breathing" savory, the bank green with celery, the lime blossom, willow, saffron, and lily. You recognize how the bees "hurry from the hive, all helter-skelter" (this translation is by Cecil Day-Lewis, who was himself working against the backdrop of the Second World War); the "vague and wind-warped column of cloud to your wondering eyes" of a swarm; the bucolic image of an old smallholder, happy as a king when his small, poor land can yield roses in spring, apples in autumn, and frothy honey squeezed from the combs.

The poem partly poses as instruction, and it is fascinating to read what Virgil thought of bees and how they should be kept. He encourages the beekeeper to keep his hives near water, so the bees can drink, and says the hives must be sheltered from rough winds. He emphasizes the importance of the hive's ruler, and perhaps this commanding figure is meant to suggest, on a political dimension, a leader who could bring unity to the warring factions of Rome, spinning out of control after the murder of Julius Caesar.

The poem tells the beekeeper to site the hive away from lizards, the "sinister tribe of moths," and from birds that eat bees. Some of this is all too recognizable today. As well as the moths that can devastate a colony, birds with strong beaks, such as the woodpecker, have been known to break into bees' nests in the wild, and there are twenty-five species of bee eaters, including one occasionally found in Britain, that can catch bees on the wing in their beaks and pull them over a hard surface to extract the venom before eating them. (Scientists dissecting spine-tailed swifts in the

Philippines found one bird with the remains of nearly four hundred bees, the bird's mouth and gizzards barbed with scores of detached stings.)

Virgil mentions the three kinds of bees in the hive. His probable source was Aristotle (384–321 bc), who wrote extensively about bees in his natural history writing, particularly in *Historia Animalium*. As well as noting there are different sorts of honeybees, all with different roles, Aristotle's book describes how the bees collect the juices of the flowers in their stomachs and take them back to the hive to regurgitate into the wax, and that this liquid gets thicker with time. Aristotle saw that there were hairy worker bees inside the hive and smoother ones outside (the worker bees become less fluffy with age), and that the new ruler could kill off others that emerged from other cells. He even noticed how the bees danced across the face of the comb, though he did not understand the meaning of this (we now know it is a means of communication).

Some mysteries remained. Many mused on the reproductive methods of bees. Aristotle was especially interested in where bees came from, though he never reached a satisfactory explanation, pondering whether the young were collected from flowers, olives, and reeds. The strangest belief of all, maintained for many centuries, was that honeybees generated spontaneously from the carcass of an ox. Credence in this idea of "ox-born bees" continued right up to the time when a certain Mr. Carew reported this feat of reproduction in Coventry in 1842. Virgil praises the worker bees' abstention from sexual intercourse, an escape from the mess of passion and the pain of birth. "How to get bees from an ox" appears in his *Georgics, Book Four*; almost like a recipe: in the springtime, you must take a two-year-old ox into a small house with four windows, stop up its nostrils and mouth, bludgeon it to death, and leave it in the room, along with cassia, thyme, and branches.

Virgil's description of how bees then poured out of the rotting flesh, like a throbbing attack of arrows, is so like the pulsating release of flies from the maggots feeding on carrion that this could be one natural explanation for this curious belief. The honeybee does not settle on meat; but it easily could have been confused with the drone fly that lays its eggs in decomposing carcasses. Another possibility is that bees do nest in skulls, and among other bones, in places where shelter is rare, such as the Egyptian desert. This could also be the origin of the Old Testament story of Samson (Judges 14) when he asks the riddle "out of the strong came forth sweetness"; the image of a swarm of bees and a lion remains on tins of Tate & Lyle's golden syrup.

In Virgil's *Georgics*, there is a more important interpretation than the literal truth of the ox-born bee: this is the idea that life regenerates. A swarm of bees is a beautiful, visible embodiment of reproduction; moving through the air in its dark cluster, it is a living symbol of how life moves on. In the beliefs of the ancient classical cultures, this concept was reinforced because the best swarms happen in spring—a time of the annual rebirth of the world and the continuation of life after the death of winter. Whether a swarm of bees comes from an ox or a hive, it is the start of new life, flying toward the future. Hardly surprising, then, that bees came to be portrayed as special creatures that could move between life and death, between the world and the underworld, between humans and the divine. In ancient Greece, bees flying through the cracks of rocks were thought to be souls emerging from the underworld, just as the ancient Egyptians believed the insects to be human spirits that could fly anywhere.

One of the most moving passages in *Georgics, Book Four*, describes the bees' blending of the natural and supernatural. It connects these flying particles of heaven to the way in which all of nature—including man—exists (the translation is Dryden's):



Ox-born bees in an engraving illustrating John Dryden's translation of Virgil's Georgics, Book Four.

... some have taught
That Bees have Portions of Etherial Thought:
Endu'd with Particles of Heavenly Fires:
For God the whole created Mass inspires;
Thro' Heav'n, and Earth, and Oceans depth he throws
His Influence round, and kindles as he goes.
Hence Flocks, and Herds, and men, and Beasts, and Fowls
With Breath are quick'n'd; and attract their Souls.
Hence take the Forms his Prescience did ordain,
And into him at length resolve again.
No room is left for Death, they mount the Sky,
And to their own congenial Planets fly.

Life comes, briefly, and then is reabsorbed back into the heavens and never dies. I asked Willie Robson, on the Northumberland heather moors, about the life span of a colony. The bees? They're immortal, he said.



WHO WERE THE Greek and Roman gods? In his exploration of Sicily, *The Golden Honeycomb*, Vincent Cronin described the ancient world as a twilight zone where legend and history met. The stories of mythology gave gods and goddesses human traits, raised up on Mount Olympus; but they were, for all their glory, ultimately akin to men and women, with characteristics and foibles we recognize. This was the time when humans began to civilize the Western world, to form it to our own will. Mythology was a way of projecting us onto a larger scale, with all the possibilities within the reach of our imagination—and all our mistakes, too. Greek and Roman gods certainly feel more familiar to us than the mysterious deities of ancient Egypt, worshipped from afar with fearful awe.

The Golden Honeycomb is based around Cronin's quest in the

1950s to uncover the origin of one such myth, the tale of Daedalus, the legendary master craftsman and inventor who supposedly flew to Sicily from Crete, believed by the ancients to be the origin of bees and beekeeping. On the way, Daedalus's son Icarus flew too near to the sun, and the beeswax holding his wings together melted, plunging him into the sea, where he drowned. But Daedalus made it to the island and here was said to have wrought an exquisitely realistic golden honeycomb. Did it actually exist, or was it a metaphor of some sort? Cronin travels around looking for clues. He goes to Greek ruins, such as Silenus, named after wild celery, which is a good source of nectar for bees; he reads the sweet words of poets; he writes of how nature was connected to divine forces. In Taormina he sees the spring, with its lavish surge of life and the flowers that provide so much nectar for the bees—and the reassurance that humans, too, will be able to eat again after the winter. Was this vital expression of Mediterranean nature in some way connected to the origin of the golden honeycomb?

No conclusive answer could be found; rather, Cronin's search gives him a reason to explore successive cultures, and the ways in which honey played a part in them.

Alongside oil or wine, honey was one of the libations for the dead in the classical era. Achilles put jars of oil and honey by the funeral pyre of his friend Patroclus, so the food of this life could be enjoyed in the afterlife. Honey was offered to the gods because it was a product of both earth and sky; it was believed the bees gathered the juice that had fallen from the heavens and collected in flowers, and honey was, therefore, an appropriate food with which to commune with the otherworld. Such beliefs in the sanctity of bees continued. When Cronin was writing in the 1950s, Sicilian newlyweds arriving home from the church for the bridal feast were given a loving spoonful of honey to share. Death, life, mythology, and love: honey slid into them all.



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honey as it thickens through the fanning of the insects' wings (though the "skin" is made of wax).

There was still a misunderstanding about the origin of beeswax, which was thought to be a secretion collected from plants rather than a product of the bee itself. Whatever its source, the wax itself was much used on a practical, everyday level. Wooden boards, coated with wax, were reusable writing tablets. Wax was also used by craftsmen, real and mythological, for joining objects together—unsuccessfully, in the case of Icarus's wings and more successfully, with Pan's pipes.

In the artistic field, statues were cast using the *cire perdue* or "lost wax" method. Malleable beeswax was modeled and then covered in clay; this was then heated so the wax melted, leaving a cast in one piece into which molten metal could be poured. With other methods, the cast had to be cut into pieces; with the lost-wax method, a complete mold could be made. Wax busts were also sculpted of famous people, a technique that is still used. Besides this, the flaws in dodgy classical statues could be hidden with beeswax. If a statue was *sans cere*, or without wax, the seller was an honest dealer or, as we now say, sincere.

Writing about bees and honey continued, but more in encyclopedic collections of received wisdom than in fresh observation. Fifty years after both Virgil and Varro came Columella, an army officer from Cadiz who retired outside Rome. His book on agriculture, *De re rustica*, written around AD 60, methodically runs through many aspects of the hive, from the races of bees to the extraction of beeswax. Palladius, writing in the fourth century AD, gives a month-by-month account of the honeybee; his book was translated into English in the fourteenth century. Classical authority was set to remain largely unquestioned for a thousand years—then the chief work of the Greek physician Dioscorides, *De materia medica*, written in the first century AD, was a crucial text on botany

Philippines found one bird with the remains of nearly four hundred bees, the bird's mouth and gizzards barbed with scores of detached stings.)

Virgil mentions the three kinds of bees in the hive. His probable source was Aristotle (384–321 BC), who wrote extensively about bees in his natural history writing, particularly in *Historia Animalium*. As well as noting there are different sorts of honeybees, all with different roles, Aristotle's book describes how the bees collect the juices of the flowers in their stomachs and take them back to the hive to regurgitate into the wax, and that this liquid gets thicker with time. Aristotle saw that there were hairy worker bees inside the hive and smoother ones outside (the worker bees become less fluffy with age), and that the new ruler could kill off others that emerged from other cells. He even noticed how the bees danced across the face of the comb, though he did not understand the meaning of this (we now know it is a means of communication).

Some mysteries remained. Many mused on the reproductive methods of bees. Aristotle was especially interested in where bees came from, though he never reached a satisfactory explanation, pondering whether the young were collected from flowers, olives, and reeds. The strangest belief of all, maintained for many centuries, was that honeybees generated spontaneously from the carcass of an ox. Credence in this idea of "ox-born bees" continued right up to the time when a certain Mr. Carew reported this feat of reproduction in Coventry in 1842. Virgil praises the worker bees' abstention from sexual intercourse, an escape from the mess of passion and the pain of birth. "How to get bees from an ox" appears in his *Georgics, Book Four*, almost like a recipe: in the springtime, you must take a two-year-old ox into a small house with four windows, stop up its nostrils and mouth, bludgeon it to death, and leave it in the room, along with cassia, thyme, and branches.

Virgil's description of how bees then poured out of the rotting flesh, like a throbbing attack of arrows, is so like the pulsating release of flies from the maggots feeding on carrion that this could be one natural explanation for this curious belief. The honeybee does not settle on meat; but it easily could have been confused with the drone fly that lays its eggs in decomposing carcasses. Another possibility is that bees do nest in skulls, and among other bones, in places where shelter is rare, such as the Egyptian desert. This could also be the origin of the Old Testament story of Samson (Judges 14) when he asks the riddle "out of the strong came forth sweetness"; the image of a swarm of bees and a lion remains on tins of Tate & Lyle's golden syrup.

In Virgil's *Georgics*, there is a more important interpretation than the literal truth of the ox-born bee: this is the idea that life regenerates. A swarm of bees is a beautiful, visible embodiment of reproduction; moving through the air in its dark cluster, it is a living symbol of how life moves on. In the beliefs of the ancient classical cultures, this concept was reinforced because the best swarms happen in spring—a time of the annual rebirth of the world and the continuation of life after the death of winter. Whether a swarm of bees comes from an ox or a hive, it is the start of new life, flying toward the future. Hardly surprising, then, that bees came to be portrayed as special creatures that could move between life and death, between the world and the underworld, between humans and the divine. In ancient Greece, bees flying through the cracks of rocks were thought to be souls emerging from the underworld, just as the ancient Egyptians believed the insects to be human spirits that could fly anywhere.

One of the most moving passages in *Georgics, Book Four*, describes the bees' blending of the natural and supernatural. It connects these flying particles of heaven to the way in which all of nature—including man—exists (the translation is Dryden's):

... some have taught
That Bees have Portions of Etherial Thought:
Endu'd with Particles of Heavenly Fires:
For God the whole created Mass inspires;
Thro' Heav'n, and Earth, and Oceans depth he throws
His Influence round, and kindles as he goes.
Hence Flocks, and Herds, and men, and Beasts, and Fowls
With Breath are quick'n'd; and attract their Souls.
Hence take the Forms his Prescience did ordain,
And into him at length resolve again.
No room is left for Death, they mount the Sky,
And to their own congenial Planets fly.

Life comes, briefly, and then is reabsorbed back into the heavens and never dies. I asked Willie Robson, on the Northumberland heather moors, about the life span of a colony. The bees? They're immortal, he said.



WHO WERE THE Greek and Roman gods? In his exploration of Sicily, *The Golden Honeycomb*, Vincent Cronin described the ancient world as a twilight zone where legend and history met. The stories of mythology gave gods and goddesses human traits, raised up on Mount Olympus; but they were, for all their glory, ultimately akin to men and women, with characteristics and foibles we recognize. This was the time when humans began to civilize the Western world, to form it to our own will. Mythology was a way of projecting us onto a larger scale, with all the possibilities within the reach of our imagination—and all our mistakes, too. Greek and Roman gods certainly feel more familiar to us than the mysterious deities of ancient Egypt, worshipped from afar with fearful awe.

The Golden Honeycomb is based around Cronin's quest in the

1950s to uncover the origin of one such myth, the tale of Daedalus, the legendary master craftsman and inventor who supposedly flew to Sicily from Crete, believed by the ancients to be the origin of bees and beekeeping. On the way, Daedalus's son Icarus flew too near to the sun, and the beeswax holding his wings together melted, plunging him into the sea, where he drowned. But Daedalus made it to the island and here was said to have wrought an exquisitely realistic golden honeycomb. Did it actually exist, or was it a metaphor of some sort? Cronin travels around looking for clues. He goes to Greek ruins, such as Silenus, named after wild celery, which is a good source of nectar for bees; he reads the sweet words of poets; he writes of how nature was connected to divine forces. In Taormina he sees the spring, with its lavish surge of life and the flowers that provide so much nectar for the bees—and the reassurance that humans, too, will be able to eat again after the winter. Was this vital expression of Mediterranean nature in some way connected to the origin of the golden honeycomb?

No conclusive answer could be found; rather, Cronin's search gives him a reason to explore successive cultures, and the ways in which honey played a part in them.

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CHAPTER FIVE

CANDLELIGHT AND INTOXICATION

In the woods that once covered swathes of northern Europe, men would raid the bees' nests they found within hollows in tree trunks. To the bee, a tree is not just a home; the flowers offer an enormous stash of nectar gathered together in one place. Even a single lime or chestnut, say, can release enough nectar to make at least a kilo of honey in just a short amount of time.

The insects' woodland stores then made rich pickings for medieval honey hunters. Russian bee men, for example, working the forests around Moscow, would keep an eye out for swarms in the springtime and follow them to where they settled. Sometimes they smeared honey in a box to trap a single bee, and, on its release, followed the insect back to its colony. A bee man claimed a found nest by carving his personal mark—perhaps a hare's or goat's ear—on the bark, and returned year after year to see if it contained any honey.

Wild forest honey-hunting began to give way to more organized practices. In addition to plundering natural nests, the specialist woodland hunters gouged holes to create nest spaces in which homeless bees could settle, and would make small doorways over the hollows in the trunks so they could check and collect the honey stores more readily. They also hung hollow logs in the trees, high enough for swarms to settle out of reach of the animals on the

ground. One illustration shows a cruel trap, designed to get rid of one such major competitor, the bear: the climbing animal is trapped on a platform placed near the nest and shot at by archers so it falls onto spikes on the ground below.

It might be a 12-mile round-trip to check a "bee-walk" of colonies; the more prosperous bee men went by horseback, the less so by foot. In a forest of five hundred known tree cavities, as few as ten might contain nests. Collecting honey could be as treacherous as unpredictable: perhaps one in a thousand hunters died, not to mention the number of broken limbs that came from falling out of trees when pursued by angry insects.

Accordingly, these woodland workers began to devise safer methods. Hollow sections of trunk were taken from the tree and put on the ground to make primitive wooden hives. In Poland and



*German woodland
beekeepers removing combs
from trees.*

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"So we the bees make honey, but not for ourselves": a seventeenth-century woodcut showing a skep.

wheat fields that were Scandinavian blond in the bleaching light of late August, I thought again of how the skep was still the single most evocative image of beekeeping, instantly conjuring up a cottage garden full of drowsily buzzing bees in late-afternoon sun—even if, in reality, it was now made in a commuter village and sold to customers who did not use it for beekeeping at all.



DEEP IN THE CONFUSING forests of Shakespeare's *A Midsummer Night's Dream*, Titania ordered her fairies to find wax candles to light the way for her newly beloved Bottom (act 3, scene 1):

"The honey-bags steal from the humble-bees, / And for night-tapers crop their waxen thighs, / And light them at the fiery glow-worm's eyes, / To have my love to bed and to arise."

Shakespeare shows the contemporary confusion between the pollen loads on the bees' legs and the wax they secrete from within themselves.

One of the most extraordinary skills of the honeybee is its production and use of beeswax. When the bees have no more comb in which to store honey, the nectar they have collected stays in their honey stomachs and the stored sugars assimilate into their bodies; this enables them to secrete small, transparent plates of wax through the glands on the front of the abdomen. The wax is moved by their legs to their mouth parts, where it is kneaded until it is ready for use. With this new wax, they build more comb.

The honeycomb is built by a hanging curtain of worker bees, who pass the materials up a chain to their fellow builders. The cells of the honeycomb are hexagonal because this design needs the minimum amount of wax to hold the maximum amount of honey—almost $2\frac{1}{4}$ pounds of honey in just 1 square foot of comb. The bees are so careful with their wax because it takes nearly 16 pounds of honey to produce enough comb for a colony: wax secretion is therefore a very expensive item in the hive's energy economy.

Light as a feather, the wax comb is now ready for use. It hangs in parallel, vertical sheets, a network of regular cells placed back-to-back and tipped on a slight angle so the nectar and honey do not drip out.



HONEY WAS NOT always the most valuable product of the bees; in medieval Europe, beeswax was so important that it could almost be said that honey was a by-product of the wax. In England, at the time, the wax could be worth eight times as much as honey. No wonder, when it provided the most prized means of lighting after dark. Just as the bees can manipulate the warm wax to make comb, humans can easily mold and shape molten wax. It is flammable, as

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THE CHURCH was a voracious consumer of wax candles in the Middle Ages. Monks kept bees, and rents and tithes from their substantial lands could be paid by their tenants in wax. Candles were needed in large quantities to light the large, dark spaces of churches, chapels, and cathedrals. In the eighth century, Pope Adrian I burnt a perpetual light in St. Peter's in Rome consisting of 1,370 lights in the shape of a cross: it must have been a staggering sight in the dim world of the Dark Ages.

Candles have a many-layered significance in Christian belief; not only was light seen as symbolic of the awakened soul, but beeswax was regarded as pure because of the chasteness of the worker bees. If the wax was the spotless body, the wick was the soul and its flame a symbol of divinity, or the Holy Spirit. Some took the metaphor further, to portray the drones as monks, and their autumnal expulsion from the hive as a symbol of good moral housekeeping by the punishment of the lazy. Pure beeswax candles were burned at liturgical services, and there was a belief that the souls of the dead could only be at peace when watched over by the living. Candles were burned in their memory, a custom that continues today in the slightly different form of votive candles.

Honey, too, was also part of early Christian custom. Until the seventh century, people took honey and milk just after being baptized, a rite that echoes the early diet of the infant Zeus. In another story that connects the medieval world with that of the Greeks and Romans, St. Ambrose, the fourth-century Bishop of Milan—and the patron saint of beekeepers—was visited by bees in his cradle. The insects flew up high, vanishing as if to heaven. This was said to be a sign that St. Ambrose would be both great and eloquent.

Candlemas on February 2 is the day when the candles for the year are blessed and distributed. Based around the same time as the

Roman pagan festival of purification, it is the festival of the purification of the Virgin Mary and marks the presentation of the infant Jesus at the temple, when St. Simeon, in the *Nunc Dimittis*, called Jesus "a light to lighten the gentiles." By the middle of the fifth century, candles became an explicit feature of the occasion.

The guilds, including the Wax Chandlers, would participate in big religious festivals, and doubtless provided the candles. The famous funeral procession of Henry V in 1422, an exercise in state showmanship of some proportions, was lit by fourteen hundred wax tapers along the 2-mile procession, and every fifth man held a torch.

The significant religious demand for beeswax meant it was dealt a great blow when the monasteries were closed by Henry VIII in the sixteenth century. Although there was a revival of candle use under the Roman Catholic Mary I, exemplified by the making of an enormous, 300-pound Paschal candle, such displays fell from favor in England. Oliver Cromwell later banned altar candles altogether.

Beeswax candles were an especially valued form of light; then in the eighteenth century, New England whalers discovered how to burn the oil found in the head of sperm whales, in a substance called spermaceti, which was refined into a hard, crystalline substance and made into candles that burned with a new brightness. The cheap, mass-produced paraffin candles of the nineteenth century were to further eclipse the light of the honeybee. You can, however, still find beeswax candles as a specialist product and enjoy their soft scent and beautiful shine. The Wax Chandlers Guild continues and has links with contemporary beekeepers, offering an award if an entrant especially excels in the British Beekeepers Association annual examinations.



IN MANY CULTURES around the world, honey was regarded as a magical, transforming substance, almost a potion. At the heart of

this belief was mead. As a sweet intoxicating liquor, it was the main use of honey—more so than as food or medicine. The question arises, even, whether honey was more valued for its sweet taste or for its power as an alcoholic drink.

The sugars in honey naturally ferment when mixed with water and yeasts already present, or in the air; it is therefore one of our most ancient drinks. The Greeks had many honey-based drinks, some of them, like mead, made from fermented honey and some made from honey mixed with another drink, such as the common mulsum, a mixture of wine and honey. Rhodomel was made with roses and honey; omphacomel from grape juice and honey; thalassiomel used seawater; and there was even a meal-of-a-drink called kykeon, with oil, wine, cheese, and mead, that was drunk at the harvest feast. Dionysus, or the Roman Bacchus, was probably the god of mead as well as wine. But honey drinks were also a source of good health and not just bacchanalian excess. Pollio Romulus, aged one hundred, told Julius Caesar he had kept the vigor of mind



The impact of mead on some Caucasian peasants.

and body by taking spiced mead inwardly and using oil on his outer body, an alcoholic variant on Democritus's prescription for long life: taking honey on the inside and oil on the outside.

Mead predates wine, perhaps by many thousands of years; but when the grape arrived, it eventually began to replace mead in southern countries. Mead continued as a fine tradition in northern climes. Pliny wrote of the British Celts that "these islanders consume great quantities of honey-brew." Mead was a drink of status, of royal courts, actual and literary. The Queen bears the mead that is given to Beowulf, and King Arthur downed gobletfuls of the stuff. Mead is much mentioned in Welsh poetry and laws. A free township had to pay its dues to the king by giving him a vat of mead big enough for the monarch and a companion to bathe in.

Great ceremonial communal drinking bowls were made of wood and precious metals, and known as mazers, from the word for one of the original materials, maple. One example of such a vessel is the Rochester Mazer, made in 1532, which is in the British Museum in London: the wide, shallow bowl would have been held with two hands and passed between drinkers. (Admiring this renowned object, now sequestered in its glass museum case, I allowed myself the scurrilous thought that there might have been a term, in the ebullient vein of northern European drinking traditions, "to get mazered.")

Beyond the British Isles, mead was the drink of gods and heroes. In Teutonic mythology, warriors reaching Valhalla quaffed sparkling mead offered by divine maidens. Odin stole the magic mead of the gods, made love to its guardian giant's daughter, drank the brew in three mouthfuls, and fled in the form of an eagle.

Some of the intoxicating stories connected to mead have come down to us, almost inevitably, with a lurching exaggeration. In the tenth century, Olga, widow of the Prince of Kiev, was said to have invited the murderous mourners to her husband's funeral, instruct-



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CHAPTER SIX

ENLIGHTENMENT

The Reverend Charles Butler signaled a new phase in man's understanding of the honeybee. He used his own observations to challenge medieval beliefs, therefore pushing back centuries of received wisdom. An era in which scientific thought became based on the direct study of the natural world was about to begin.

Butler was the vicar of Wootton St. Lawrence, near Basingstoke in Hampshire, in the early 1600s. As well as being a scholar, teacher, and inventor of a form of phonetic spelling, he wrote about logic, music, and theology, was an advocate for the legality of marriage between cousins, and was the great-great-grandfather of the eighteenth-century Hampshire naturalist Gilbert White. He is best known today as one in a line of humane, engagingly helpful authors on the subject of the honeybee; his book *The Feminine Monarchie* is still read by beekeepers with affection.

The Feminine Monarchie, first published in 1609, was well received at court, and the third edition (1634) was even dedicated to Queen Henrietta Maria, the start of a fashion for presenting such books to the royal "queen bee." Butler starts with a note of admiration for the bee's moral rightness and practicality, depicting the relationship between bee and beekeeper as one of good, clean living. If the beekeeper approaches the hive drunk, puffing, blowing, hasty, and violent, he will be stung; if he behaves prop-

erly, all will be well: "[T]hou must be chaste, cleanly, sweet, sober, quiet and familiar; so will they love thee, and know thee from all others."

The righteous praise for such steadfast qualities is leavened by Butler's varied and idiosyncratic enthusiasms for his insects. The sound of a hive starting to swarm is well known to beekeepers. Butler, a music scholar, scored it in the first edition, later turning the notes into a madrigal with four parts. Another section of his book deals with such matters as sealing wax, drinks, and a syrup of violets and honey that "tempereth and purgeth hot and sharp humours, expels melancholy and effects—headache, waking, dreams, heaviness of heart," like a seventeenth-century liquid form of aromatherapy. It was Butler who recorded the flavorings of Queen Elizabeth I's favorite spiced mead: rosemary, bay leaves, sweet briar, and thyme.

Charles Butler's most significant advance was to trust his own eyes on the workings of the hive, rather than the words of classical authors. He notes, for example, that drones were clearly part of the reproductive means of the hive, although exactly how, he did not know. He also observes the "shivering" bees that seemed to presage swarming. We now know this is one way bees communicate within the hive.

Much of the book is immediately recognizable. Nature, after all, barely changes, just our knowledge of it. Butler describes the poisoned spears of stings that you must quickly flick out to stop the pain being "greater and longer"; the late swarms, known as blackberry swarms, which start their new colony too late to store enough honey to survive the winter; the passing of the year through the zodiac and its different flowers. Gemini brings us honeysuckle and bean blossom. Cancer brings the thyme that "yeldeth most and best honie." Then come knapweed and blackberry, and ivy during

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fetched more than ten times the price English honey could command. The sugar plantations in Barbados were becoming economically significant, but Hartlib showed a bias toward English produce; he also pondered the possibility of extracting sweetness from home-grown apples.

So much for the theory. This group of seventeenth-century intellectuals did have practical beekeeping experience—for example, John Evelyn recommended in *Sylva*, published in 1664, particular trees that were good for bees, such as the oak, the black cherry, the poplar, the willow, and the buckthorn with its “honey-breathing blossom”—but how successful, ultimately, were their hives? These new boxed hives were not universally popular. One user wrote to Hartlib in 1658 saying it made no difference to the amount of honey collected, and that plain country traditions such as skep beekeeping produced more profit for less trouble. Perhaps these enlightened beekeepers set too much store by the rationality of the bee. Instead of crawling into the hive and going up to the top and building downward, the bees started their comb in the bottom box. The holes between the boxes did not allow a large number of insects to move easily into the upper layers. Furthermore, the elaborate, hexagonal wooden hive was too expensive and difficult to construct to be economical for commercial beekeepers.

For all their thoughts, inventions, and curiosity, these enlightened Englishmen were only at the beginning of the discovery of the bee. It was another two centuries before the problem that preoccupied them—how to remove the honey cleanly, without killing the bees—was finally resolved. Regarding the scientific study of bees, the early observation hives had just small panels of glass, offering only a partial view of the colony. Other scientists were to take matters much further.



ON THE CONTINENT, a young Dutch scientist devoted months to focusing entirely on the honeybee. By using observation hives and peering through the glass eye of a microscope, he went further than anyone else had in understanding the insect's mysteries. Jan Swammerdam was born in 1637. By the time he was thirty-two, he had written his *Historia Generalis Insectorum*. It was one of three books published within two years that marked the beginnings of entomology—the others were Marcello Malpighi's study of the silkworm and Francesco Redi's book on insects. The young Dutch scientist went on to become one of the pioneering students of the honeybee.

Swammerdam grew up in Amsterdam. His father was a noted collector, who kept a renowned cabinet of curiosities on display at his home. New objects, from Chinese porcelain to fossils, would arrive through the city's port, at the center of world trade. Visitors also came on the ships, making their way to the house to study and admire the collection.

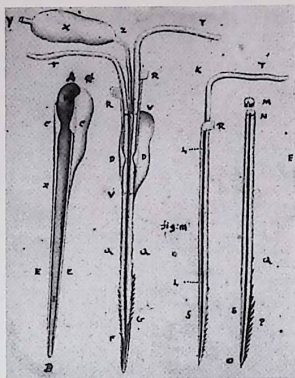
The young Swammerdam began to create a natural history collection, picking up insects and their eggs, food, and even their excrement on expeditions both in Amsterdam and in the towns and countryside beyond. He searched the air, land, water, meadows, cornfields, sand dunes, rivers, wells, trees, caves, ruins, and even privies in order to find his quarry. His findings were also put on display; by the age of twenty-four he had no fewer than twelve hundred items to show, a number that would eventually more than double.

There were now two collectors, of different generations, in the same family, sharing the same house. This must have created tensions. The relationship between father and son was to prove difficult on many levels. Conflict manifested itself, at first, in Jan Swammerdam's choice of profession. His father, a pharmacist, wanted his son to go into the church. Jan Swammerdam, although

could emerge from its larval anatomy. The prince offered a large sum to the Dutch scientist if he would bring the collection to his court. Swammerdam, a devout Protestant, declined the Catholic's offer.

Swammerdam was by now deeply immersed in his insect explorations. His drawings of the honeybee were made from 1669 to 1673. For months of extraordinary devotion, he would rise with the light, starting at 6 a.m. to work for as long as possible. He worked with the sun beating down, peering at the bees through glass hives and his microscope. By noon, his straining eyes would start to fail. After that, he worked well into the night recording his observations and drawing until he could continue no longer. Despite these labors, Swammerdam still wished he had a year of never-ending light to work harder still. By the end of these studies of bees, the summit of his life's work, Swammerdam's body and mind were battered; some think he never recovered.

Swammerdam's drawings show the exquisite dexterity of his dissections. He used instruments so tiny that they had to be sharpened under the microscope. His favorite tools were tiny scissors with which he could separate out and cut minute parts of the bee's anatomy without tearing them. He would put a bristle into a bee's gut and inflate it by blowing down a tiny glass tube so he could inject a colored fluid and see the anatomical structure more clearly. The insects were punctured with a needle to drain their fluids, dried, and anointed with resin and oil to preserve them. When Swammerdam started his observations of an insect, he would first look at it through a weaker lens and move progressively closer and closer by turning to stronger and stronger lenses. Once he became familiar with the animal's general form, he could put each new detail in context as he perceived it. Using this approach, he was able to discover the ovaries of the queen bee, anatomically proving her role as egg layer.



*Swammerdam's anatomical drawing
of the honeybee's sting.*

By this stage, the pressures of family life were impinging on Swammerdam's devotion to discovery. His father wanted him to earn a living as a doctor rather than wasting his time drawing insects. Financially dependent on his father, Swammerdam had to turn down an offer from his old friend Thévenot to live and study with him in France. His options at home were limited. He retired to the country, but there was surrounded by the insects of his studies. Thoughts swarmed in from every direction. Swammerdam also became plagued by a dilemma of vocation. He saw a conflict between his studies and his love of God. Should he study God alone, or God's works? At times, he had reconciled his studies and religion, writing in a letter to Thévenot: "Sir, I present you the omnipotent finger of God in the anatomy of the louse." But for now he turned away from the natural world and toward its maker.

He tried to sell his natural history collection and began a correspondence with Antoinette Bourignon, a guru known as The Light of the World. She had been left part of the island of Nordstrand, near Schleswig, and lived there surrounded by acolytes. When

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Swammerdam wrote to Bourignon for advice about his conflicts between belief and science, her reply allowed him to finish his study on bees but was nonetheless stern. Give up "the amusements of Satan," she wrote, and concentrate on Jesus. Swammerdam left his unpublished bee studies behind, as if carelessly, no longer believing they were the way to God, and traveled to join Mlle. Bourignon's community in September 1675.

The trip was not a success. There were problems both within the group and with the community outside. For a while, Swammerdam acted as secretary and translator for Antoinette Bourignon, but nine months later returned to Amsterdam to a less-than-conciliatory father. Still dependent, the son had to live with the father once again, until the latter gave up his house and went to live with his daughter, leaving Swammerdam even more isolated.

In 1678, Swammerdam's father died. Although his financial problems were eased, his sister took more than her share of their father's estate and his physical condition deteriorated further. By the end of 1679, he was very ill. Thévenot offered to send medicine to help his fever, and Swammerdam asked desperately for a palliative for his edema. But it was too late. The obsessional Dutch scientist died in his forty-third year, destroyed by fever and mental exhaustion: incessant study, anxiety, and illness had worn him out. He died like a worker bee, falling in the field, all energy spent. At a posthumous public auction, the cabinets of both father and son were sold together, though in lots, not as complete collections.

But on his deathbed, Swammerdam returned to his work on the honeybee. Bees displayed God's wisdom and power in a mathematical manner, he said; their minute exquisiteness made the glory of God all the greater. In his will, he asked that his work be published, in Dutch as well as Latin, so it would be more accessible. Even his final resolution was not without complications. Swammerdam had left the ownership of his unpublished engrav-

ings of bees to Thévenot; but he sent the engravings themselves to a publisher, who refused to relinquish them until forced to do so by legal action. The drawings were not published until 1737, more than sixty years after they were made, in a book whose title, *Biblia Naturae*, or *Bible of Nature*, combined Swammerdam's devotion to God and his creations. It became his most celebrated work.

Swammerdam's legacy was to pioneer microscopic work on the honeybee, and this helped to sweep away a blind belief in classical learning. In 1880, a plaque was put on Swammerdam's house bearing the words: "His study of nature remains an example for all times." Observational inquiry, rather than the uncritical repetition of erudition, was the scientific path he helped establish.

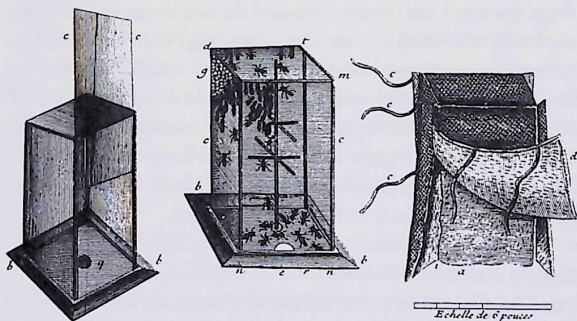


IN THE EIGHTEENTH CENTURY, observation hives became popularized by the French scientist René Réaumur (1683–1757), who in his *Mémoires pour servir à l'histoire des insectes* reproduced drawings showing his own glass hive. Such objects became something of an exhibit and were shown in public for a small fee as men and women studied bees for moral, technical, and philosophical enlightenment.

It was another kind of observation hive, one that opened like the pages of a book, known as a leaf hive, that was to yield the greatest secrets of the bee to date; the hive had twelve frames, 12 inches high, each containing a single comb. The frames were joined together at the back, hinged as if on the spine of a book so that they could be opened out and examined on both sides. A small piece of comb was put in the top of each frame to help the bees get started. The hive was then closed for three days to encourage them to build further. After this, the frames could be opened like pages and "read" by the observer: it proved to be the best method yet of looking closely at bees.

Most remarkable of all, the leaf hive's Swiss inventor and reader, François Huber, was blind. Huber began to lose his sight when he was fifteen. Despite this, he still managed to marry the girl he loved, who stuck with him against her father's wishes, and to continue his passion for nature. Huber was helped in his work by his servant, François Burnens, who read natural history texts, including those of Swammerdam, to his master, and in the process became absorbed in the subject himself. "This is not the first example of a man who, without education, without wealth, and in the most unfavourable circumstances, was called by nature alone to become a naturalist," wrote Huber.

Using the leaf observation hive, Burnens began to follow Huber's instructions to conduct simple experiments on honeybees. At first the two men carried out experiments that had been performed by others, such as Réaumur. They sought first to validate his findings; and then, by repeating the tests several times, to check their own methods and results. As this work progressed, a covert trial was being carried out by master on servant. Burnens conducted the simple experiments with skill and intelligence. He then went on to more complex ones, and his passion for science grew. At



Réaumur's glass observation hives.

the same time, Huber's belief in his servant's powers became stronger and stronger. It got to the point that the blind naturalist had total trust in Burnens: "I hesitated no longer to give him my entire confidence, feeling sure to see well when seeing through his eyes," he wrote.

By this stage, the relationship had evolved from master and servant to that of colleagues. Testing their theories with repeated experiments—the basis of the scientific method—the two men advanced together. Huber described their work in his book *New Observations on Bees*, printed in 1792. These two volumes are easy to understand today, even for the layperson, because the prose is the sum of two people talking to each other.

Huber and Burnens made many discoveries, but the mystery that absorbed them most was the mating of the queen. Swammerdam had proved through his anatomical dissections that the queen was both female and the mother of the hive. But how was she fertilized? The Dutch scientist believed the drone gave out a strong smell and that this was connected to how the queen was fertilized, through some sort of transference. An English naturalist, de Braw, had previously argued that male bees fertilized eggs externally, like fishes or frogs. Réaumur had already dismissed the first theory by reasoning. As for the second idea, Huber knew that eggs were hatched when drones were no longer in the colony, over the winter. They needed, however, to prove that fertilized eggs were laid without drones present in the hive. Burnens got rid of all the drones, and for four days checked through a glass tube at the hive's entrance that none returned. When eggs continued to hatch, they knew that the eggs the queen laid must already be fertilized within her.

Where and how, then, was the queen fertilized? The two men thought it must be connected to the time the drones left the hive for a midday flight. The key to the mystery was to see what happened when the queen also went out at this time.

On June 29, 1788, Huber and Burnens stationed themselves before the hive at eleven o'clock, when the sun had warmed the air. They watched some drones fly out, and then the young queen come to the entrance. "We saw her promenading on the stand of the hive for a few instants, brushing her belly with her posterior legs: neither the bees nor the males that emerged from the hive appeared to bestow any attention upon her," wrote Huber, the fresh exactness of his reportage relaying how Burnens must have described the scene to him.

The queen took flight, moving in horizontal circles 12 or 15 feet above the hive. Then she disappeared for seven minutes. Upon her return, Burnens picked up the queen, examined her abdomen, and found no signs that she had mated. After fifteen minutes back in the hive, the queen emerged again, took off, and flew out of sight. Twenty-seven minutes later, she returned. "We found her then in a very different state from that in which she was after her first excursion," Huber recorded. "The posterior part of her body was filled with a whitish substance, thick and hard, the interior edges of her vulva were covered with it; the vulva itself was partly open and we could readily see that its interior was filled with the same substance."

This, Huber and Burnens reasoned, was the "fecundating liquid" they had seen in the seminal vesicles of the drones. When they opened the hive two days later, the queen's belly was enlarged and she had laid nearly a hundred eggs in the worker cells of the comb. They repeated their vigil several times, with the same results. They had proved that the queen had been fertilized on what we now call the virgin flight.

In the introduction to the first of two volumes of *New Observations on Bees*, Huber pays homage to his faithful servant. The extent of Burnens's work shows a devotion to the subject, as well as to his master; he was clearly compelled by the pursuit of



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It had already been discovered that worker bees as well as the queen could lay eggs. But were they just small queens mistaken for workers, or were there really laying workers? And if so, what sort of bees did they produce? On August 5, 1788, Burnens and Huber found eggs and larvae of drones in two hives that had been without queens for some time. Standing intently in front of the hive, Burnens tried to spot bees laying, to see if it was workers or a small queen doing so. Burnens spent eleven days, with scarcely a break, taking every bee out of the hive individually and checking to see if it were a queen or a worker. He performed the task with what Huber calls inconceivable dexterity, taking "the strokes of the stings" as they came. When he actually saw a worker laying, Burnens seized her and discovered she had ovaries. They also found that such laying workers produced only drones. This, we now know, is because the eggs were unfertilized; an unfertilized queen will also lay only drone eggs, and the colony will die out.

For fifteen years, Burnens and Huber worked together on bees. The year after the first volume of *New Observations on Bees* was printed, they had no fewer than sixty-three hives to work on. By the time the second volume of the book was published, nineteen years

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It had already been discovered that worker bees as well as the queen could lay eggs. But were they just small queens mistaken for workers, or were there really laying workers? And if so, what sort of bees did they produce? On August 5, 1788, Burnens and Huber found eggs and larvae of drones in two hives that had been without queens for some time. Standing intently in front of the hive, Burnens tried to spot bees laying, to see if it was workers or a small queen doing so. Burnens spent eleven days, with scarcely a break, taking every bee out of the hive individually and checking to see if it were a queen or a worker. He performed the task with what Huber calls inconceivable dexterity, taking "the strokes of the stings" as they came. When he actually saw a worker laying, Burnens seized her and discovered she had ovaries. They also found that such laying workers produced only drones. This, we now know, is because the eggs were unfertilized; an unfertilized queen will also lay only drone eggs, and the colony will die out.

For fifteen years, Burnens and Huber worked together on bees. The year after the first volume of *New Observations on Bees* was printed, they had no fewer than sixty-three hives to work on. By the time the second volume of the book was published, nineteen years

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SCIENTISTS, ARISTOCRATS, FARMERS, and philosophers of the Enlightenment: all admired the insects for their rational, productive ways. Bees and their colonies were adopted as a symbol for the perfect society. The gender of the ruler bee, for example, seemed to change according to who was on the throne. In the court of Charles the Second, the royal beekeeper Moses Rusden argued that the ruling bee in the hive was a king. The frontispiece of his book *A Further Discovery of Bees* (1679) shows a crowned bee, and he states that the "king bee" has the deadliest and most dexterous sting of the hive. Yet Charles Butler had already made it clear that he thought the bee was a queen by the very title of his book *The Feminine Monarchie*.

Bees were recruited as a satirical symbol of a society in an anonymous sixpenny pamphlet, first published in England in 1705, called *The Grumbling Hive: or, Knaves Turn'd Honest*. This was the start of what is now known as *The Fable of the Bees*, one of the most notorious poems of the eighteenth century.

The poem was written by a Dutch physician, Bernard de Mandeville, who had moved to London and worked as a specialist

in nervous diseases. The work is a satire based loosely on the concept of the animal fable. De Mandeville had cut his literary teeth by translating fables, including those of La Fontaine. Fables, like allegories, allowed the writer to address human subjects at an oblique angle. In *The Fable of the Bees*, de Mandeville pictures human society as a hive. Instead of being occupied by the most sociable and cooperative of creatures, the bee, the hive is filled with its opposite, the antisocial human.

The gist of the poem's argument is revealed by its subtitle, "Private Vices, Publick Benefits." Vanity, luxury, pride, envy, and prodigality may be examples of man's failings, but they also, de Mandeville mischievously points out, create wealth and provide jobs. Crime keeps multitudes at work: lawyers, jailers, turnkeys, sergeants, bailiffs, locksmiths. There is a disastrous reversal of fortune when the bees turn honest: the hive is ruined. Those who had made money through the corrupt habits of society had now lost their living. "[M]ost writers are always teaching men what they should be, and hardly ever trouble their heads with telling them what they really are," writes de Mandeville.

The poem was republished in 1714 in a longer edition. In 1723, it was expanded again, and the following year published in its final form amid considerable controversy, with a new succession of elucidations and rebuttals included in the text. The growth of the work, from pamphlet poem to a book of close argument and counterargument, shows the ferment of debate that words produced at this time. Such books and pamphlets were relatively new forms at a time when censorship of the written word had been loosened and the minds of the age were pushing at the boundaries of debate.

The poem reads, as does the work of de Mandeville's contemporary Jonathan Swift, like a refreshing squirt of lemon to the intellect, challenging the reader with the sharp sting of its argument. Dr. Samuel Johnson, an English author, said it "opened my views into

real life very much." The religious leader John Wesley wrote in his diary: "Til now I imagined there had never appeared in the world such a book as the works of Macheavel. But de Mandeville goes far beyond it." He was consequently seen by some as nothing less than an anti-Christ, and the controversy surrounding *The Fable* continued for the rest of the century. Five years after its publication, ten books had come out attacking it. There were sermons preached against the poem, and letters to the press denouncing its content. The Grand Jury of Middlesex put the book forward as a public nuisance. The controversy spread as it was translated into French and German. In France the book was ordered to be burned by the common hangman. Wherever the fable was read, the hive of society buzzed as if attacked by an intruder.



BEES AND HIVES were also brought to an aristocratic audience through showmanship. Thomas Wildman (1734–1781) has been called the Barnum of Beekeepers for his show-stopping displays, which he took to the English court and beyond. In his insect spectacles, Wildman was carried through London on a chair covered in bees; he enacted a battle between bees and three mastiffs; he got the bees to fly from one place to another, as if he were a conductor leading tens of thousands of flying half notes; and he trotted on a horse, followed by swarms that settled on him as he rode.

These exuberant exhibitions were founded on a more serious knowledge of how bees worked. Wildman's methods for beekeeping were laid out in his book *A Treatise on the Management of Bees* (1768). The book begins with a list of five hundred subscribers, showing how Wildman popularized the honeybee from King George III and his wife, Queen Charlotte, to whom the book is dedicated, to members of the Royal Society, dukes, and tradesmen. At the heart of his work was the same quest that still engaged the

mind of many beekeepers: how to manage the bees without killing them. "Were we to kill the hen for her egg, the cow for her milk, or the sheep for the fleece it bears," he writes, "everyone would instantly see how much we should act contrary to our own interests: and yet this is practised every year, in our inhuman and impolitic slaughter of the bees."

Thomas Wildman was born in Devon, one of England's great beekeeping counties. Although he made and sold wooden hives, his main method of beekeeping was to use four or more flat-topped skeps piled on top of each other for one colony. He could take off the top skep and extract the honey, rather as a super is used in a modern system, rotating and removing the skeps in the tower as needed. He used some of the honey to make mead, which he preferred dry, fermenting the sweetness right out to get "a fine, racy flavour."

Wildman sold his bee expertise not just through his shows and book but by going around the country visiting people to advise them on their apiaries. He thought that the bees should be "near the mansion-house, on account of the convenience of watching them."

Wildman's nephew Daniel was operating at the same time in London, and was a professional bee-equipment maker with a shop at 326 Holborn. He kept bees on top of his house and, in order to see how far his bees were flying to forage, he marked some with flour and discovered that they were going right up to Hampstead Heath. Daniel Wildman, a good businessman like his uncle, also wrote a beekeeping manual, entitled *A compleat guide for the management of bees*, which came out in 1773 and went into many editions, including a French translation. He traveled around the continent giving exhibitions, and there are records of his nightly exhibitions of bees at the Jubilee Gardens, Islington, from June 20, 1772. An interest in bees had clearly spread from the court and countryside to the general urban public.

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receiving just a single sting—in his bottom as he bent over to cut out the comb.

This trip turned out to be beginner's luck, however. Euell Gibbons used his homemade bee kit again, with some success; but he would often lose the trail or the bees. Patience, he summarized, is what the bee hunter most needs—and, clearly, blue carpenter's chalk, old honeycomb, and an aluminum cake cover can come in handy.



BY THE EARLY nineteenth century, the honeybee in America had spread as far as it could from its original landing points. When the insects encountered the Appalachians and Allegheny mountains, their easy progress was thwarted. But they continued by other means, carried along with human pioneers: as the new Americans went westward to find freedom and fortune, the honeybee went too.

Some of the insects flew on with the followers of the Church of Jesus Christ of Latter-day Saints, commonly known as Mormons. Their faith's founder, Joseph Smith, said that as a farm boy in upstate New York he was directed to inscribed golden plates by the angel Moroni, and in a series of revelations translated their words. The text was published in 1830 as *The Book of Mormon*, which describes ancient Israelite tribes who came over to America, centuries before Christ, and underwent experiences similar to those found in the Old Testament. In language reminiscent of the King James Bible, the book describes how bees were part of the bounty brought to this new land: "And they did also carry with them deseret, which, by interpretation, is a honey bee; and thus they did carry with them swarms of bees, and all manner of that which was upon the face of the land, seeds of every kind."

Deseret—as the honeybee was referred to in *The Book of Mormon*—was important to Joseph Smith in other ways. He had a keen eye for how symbolism could bring and bind people together.

The bees' ordered society was an example of cooperation and productivity; Mormon businesses were all cooperatives—unusual in the free-for-all of the frontier. The reproductive life of the hive, with its ruler mated by several drones, perhaps also reinforced the Mormons' practice of polygamy—a custom that was a major reason for the sect's unpopularity in its early days. Joseph Smith was eventually lynched by a mob, such was the animosity toward the group. It was said his grave was protected by hives of bees, put there to prevent grave robbers from digging up and desecrating his body.

In order to build their society in a place free from persecution, some 66,000 Mormons set out on their epic journey toward the Salt Lake Basin, following their new leader, Brigham Young. The Mormons arrived in 1847 in what was to become Utah and Salt Lake City. Honeybees were first transported there in the back of a covered wagon the following year, and by 1851, several hives were said to be responding well to local conditions. The land was won from the Mexicans in 1848, and at this point the Mormons called the territory Deseret, after the honeybee. The 1850 territorial seal is based on a beehive, as a symbol of organization, unity, and productivity. However, when the territory became the forty-fifth state in 1896, after the Mormons had renounced polygamy, the name Utah was picked, instead, after the Ute Native Americans of the area.

The Mormons' honeybee symbolism continued in their choice of house for the leader. The building has a roof based on the shape of a skep, and was called the Beehive. Brigham Young, the first governor of the territory of Deseret, lived here from 1854 until his death in 1877. It was restored in 1961 and can now be visited by the public. Deseret Telegraph Company connected all the Mormon settlements to the Beehive house; communication was again reinforced by the symbolism of the honeybee, which is able to tell its fellow insects about nectar sources and other business of the hive.



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the motion of the ship would not disturb the bees. For the same reason, another hive was to be kept on a set of gimbles, the device that keeps a ship's compass on the level despite the motion of the sea. Furthermore, Cotton wanted an observation hive in his cabin. These bees would be active, and he would feed them with honey.

It is uncertain how, in fact, the bees were transported and, indeed, whether they arrived dead or alive. The Devon beekeeper Thomas Woodbury, writing in 1858, says Cotton's hives had been thrown overboard—"to the indescribable grief and disappointment of their amiable and enthusiastic owner"—by superstitious sailors who thought the insects were to blame for storms and bad luck on the latter part of the voyage. Cotton's diaries do not describe this event, which is surprising since he recorded other parts of his trip in gleeful detail. (He tells, for example, of the sharks who came to bite at the salt pork the sailors were towing over the bows so as to wash off some of its brine: he felt a frisson of danger, since he had recently taken a refreshing dip, assured that sharks did not swim so far south.) Did the sailors toss the hives into the sea, or not? Peter Barrett, the Australian beekeeper who has written two meticulously researched volumes about the introduction of the honeybee to Australasia, *The Immigrant Bees*, as well as a volume specifically on Cotton, has unearthed reported evidence supporting both outcomes.

What *is* certain is that once he arrived in New Zealand, Cotton was supplied with some bees from Australia. Honeybees were first taken to New South Wales in 1822. Previously, the Aborigines had collected honey, but this was from stingless bees. They would track down a nest by fastening a speck of white down to the back of an insect with a dot of gum, and follow it to the colony. They called the new bee "the white-fellow's sugar bag." (Another, tangential, historical detail illustrates the times: in 1829, convict number 680 was a woman from Gloucester—transported for the offense of stealing bees' honey.)

There were no native bees of any kind in New Zealand, but the honeybee had already been imported by the time Cotton landed. *Apis mellifera* was first brought to the North Island in 1839 by Miss Mary Anna Bumby, from Thirsk in North Yorkshire, who came over with her bees to become housekeeper to her missionary brother. She put her two straw skeps of bees in the mission churchyard, out of the way of curious Maori.

As well as leading a physically active life in New Zealand—swimming, riding, sailing, and walking—Cotton kept his beloved bees and supplied honey to the college. He had such a connection with these insects that he was said to be able to walk around with one in his pocket. As regards his theories of beekeeping, he disapproved entirely of the method of collecting honey by killing the bees, and writes on the subject with characteristic passion: "NEVER KILL YOUR BEES . . . every one of you must feel some sorrow when you *murder* by thousands in the autumn those who have worked hard for you all the summer, and are ready to do so again next year."

Honeybees fly through the rest of Cotton's lively diaries and the letters he wrote to his sisters in England. These missives contain many colorful anecdotes of New World life, put in the envelopes alongside parrot feathers and illustrations of Maori tattoos. Cotton taught the Maori to keep bees, introducing them to honey by dipping his finger into a plateful and offering them a taste. "The universal expression of admiration," he records, "is *He mea uka waqaharahara* 'a very exceeding sweet thing,' the last word, the highest superlative, pronounced with great energy."

But although Cotton was the life and soul of the settler community, his animation had a darker side. "Cheery and lively but an anxiety, from time to time, truly," was the heartfelt summation of Sarah Selwyn, the wife of Cotton's bishop. He had, she said, a want of ballast to steady his eccentricities. Despite his goodness and

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CHAPTER EIGHT

FOLKLORE AND SCIENCE

If you wanted to be fanciful for a moment, you could compare a colony of bees to the questing human mind. Our wandering thoughts fly off in a thousand directions; then these winged notions return to the hive of the head to make honey. The sweet and strange stories of bee folklore contain nectar from some of the wilder flowers of the field; yet the large quantity of such stories and beliefs also reflects our longstanding preoccupation with these mysterious insects. These tales often contain an element of sound advice, too.

The same superstitions cropped up time after time in the eighteenth and nineteenth centuries. All over Europe, it was deemed bad luck to buy a colony; rather, they should be acquired by bartering. In 1720, Thomas Lupton's *Thousand Notable Things* includes the comment: "If you have no Stocks of Bees, but must buy them, I advise you first, not to give Money for them, but some other Commodity; for though there can be nothing in it but a superstitious Observation, yet things often dishearten People that are apt to credit such Reports." Country folk exchanged goods such as wheat, barley, and oats for their bees, and in mid-nineteenth-century Hampshire, a colony was worth a small pig. Beliefs about payment for bees continued, in various forms, into the twentieth century. In the first decade of the 1900s, in Sussex, it was reputedly acceptable to use money—but only gold; in Devon as late as the 1930s, bee-

keepers were warned against being given bees rather than buying or bartering for them; and in 1948, in Surrey, one woman urged: "If you buy bees, you *must* give silver for them." Perhaps all this care about payment derives from peasant thriftiness; in France, in the Vosges, it was considered bad luck—and presumably, bad judgment—to pay too *much* for bees.

Beliefs about bees often reflect the way they were seen as moral creatures; any disruption in the household would provoke a reaction in the colony. Bad language and quarreling would offend the bees: such behavior could result in a stinging punishment from the reproofing insects. Bedfordshire beekeepers would sing psalms before their hives if the bees were not thriving. In France, it was believed that a sting was a message from a relative languishing in Purgatory, a sharp reminder of the wages of sin. On a secular level—though no less fantastically—Central European peasants had a custom of giving their bees written contracts, promising to look after them throughout the year, hoping in turn to be repaid by productivity.

Swarming bees were seen as an omen, presaging some important event. If they landed on a dead branch or a hedge stake, a death could be imminent; if they flew into a house, a stranger would arrive; if they landed on a roof, good luck was on the way (perhaps in the form of a local source of honey, if only some brave person took the chance of collecting it).

Bees were part of the family, so important events such as marriage and death had—of course—to be reported to them, a ritual known as "telling the bees." This was first recorded in England in the seventeenth century and became more common from around 1800. The various customs included tapping the hive with a key, whispering the news to the insects, and leaving an appropriate gift—a piece of wedding cake or funeral biscuits dipped in wine—at the hive's entrance. If the bees were not kept informed of events,



"Telling the bees."

they might fly away. This superstition has a modicum of sense: when a beekeeper died, his skills went with him; how the insects were treated would perhaps indicate their future fortunes.

It was also the custom to turn hives away from the beekeeper's coffin as it was carried out of the house. In their *Dictionary of Superstitions*, Iona Opie and Moira Tatem relate one late-eighteenth-century Devon funeral when chaos ensued because the bees were treated incorrectly: "[A]s the Corpse was placed in the Hearse, and the horsemen . . . were drawn up in order for the procession of the Funeral, a person called out, 'turn the Bees,' when a Servant who had no knowledge of such a Custom, instead of turning the Hives about, lifted them up, and laid them down on their sides. The Bees, thus hastily invaded, instantly attacked and fastened on the Horses and their Riders. It was in vain they galloped off, the Bees as precipitately followed [and] a general Confusion took place, attended with loss of Hats, Wigs, &c."

Alongside the custom of "telling the bees," the hives might be draped in black crepe, or with a piece of black wool, following a

death in the family. A newspaper article in 1925 related how one Worcestershire woman would dress up—including gloves—to inform the bees of important family news. After a death, she wore widow's black; for a wedding, "she donned her gayest dress and carried white ribbon"; for a birth, the ribbon would be pink or blue.

In an echo of ancient beliefs, some saw the bees as the embodiment of human souls. *Lincolnshire Notes and Queries* (1851) tells the story of two traveling servants from the start of that century: "[They] laid down by the road-side to rest, and one fell asleep. The other, seeing a bee settle on a neighbouring wall and go into a little hole, put the end of his staff in the hole, and so imprisoned the bee. Wishing to pursue his journey, he endeavoured to awaken his companion but was unable to do so, till, resuming his stick, the bee flew to the sleeping man and went into his ear. His companion then awoke him, remarking how soundly he had been asleep and asked what he had been dreaming of—'Oh!' said he, 'I dreamt that you shut me up in a dark cave, and I could not awake until you let me out.'"



AGAINST THE BACKDROP of such whimsy came the rising rationality of the eighteenth and nineteenth centuries, with scientists advocating proof over blind belief. Pioneering scientists, particularly the Swedish naturalist Carolus Linnaeus (1707–1778), began to classify insects as a separate branch of natural history; with such thinking came the rise of the entomologist. Nonetheless, insects were still widely seen as a curious subject for scientific study. When the Reverend William Kirby, a Suffolk vicar, listed three hundred species in his 1802 monograph on English bees, he clearly faced some derision. While the botanist is admired for studying mosses and lichen, he wrote the physical smallness of these creatures meant that "an Entomologist is synonymous with every thing futile and childish"—in effect, they were boys chasing bugs. In his

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Chapter 18

I had to hold up two twenties to convince a driver to go to Brooklyn. The address was in a bad neighborhood, he said, and I'd probably get mugged. I thought about telling him I'd been there before, but he might already have thought about how dressed up I was and why I was carrying luggage to a warehouse in Brooklyn. Watch out for the coloreds, Sir, he said, handing me the luggage. I was tempted to give him only twenty, but I didn't want him to remember me. So I tipped him five.

The Brooklyn Moving and Storage Company was a huge warehouse located on a brick street.. I stood in front of it, wondering if I should go directly up to Liz's office when a tall black guy in greasy coveralls came over and said, Let me have that. He led me to the side garage and pulled down the sliding door. I hoped he wouldn't get grease on my new luggage. As I climbed the stairs and looked up, there was Carlos Delgado, hands on hips, looking like the pimp he probably had been. I could tell he enjoyed standing over me, but finally he went into the small office, motioning for me to follow him. He sat back in Liz's

keepers were warned against being given bees rather than buying or bartering for them; and in 1948, in Surrey, one woman urged: "If you buy bees, you *must* give silver for them." Perhaps all this care about payment derives from peasant thriftiness; in France, in the Vosges, it was considered bad luck—and presumably, bad judgment—to pay too *much* for bees.

Beliefs about bees often reflect the way they were seen as moral creatures; any disruption in the household would provoke a reaction in the colony. Bad language and quarreling would offend the bees: such behavior could result in a stinging punishment from the reproving insects. Bedfordshire beekeepers would sing psalms before their hives if the bees were not thriving. In France, it was believed that a sting was a message from a relative languishing in Purgatory, a sharp reminder of the wages of sin. On a secular level—though no less fantastically—Central European peasants had a custom of giving their bees written contracts, promising to look after them throughout the year, hoping in turn to be repaid by productivity.

Swarming bees were seen as an omen, presaging some important event. If they landed on a dead branch or a hedge stake, a death could be imminent; if they flew into a house, a stranger would arrive; if they landed on a roof, good luck was on the way (perhaps in the form of a local source of honey, if only some brave person took the chance of collecting it).

Bees were part of the family, so important events such as marriage and death had—of course—to be reported to them, a ritual known as "telling the bees." This was first recorded in England in the seventeenth century and became more common from around 1800. The various customs included tapping the hive with a key, whispering the news to the insects, and leaving an appropriate gift—a piece of wedding cake or funeral biscuits dipped in wine—at the hive's entrance. If the bees were not kept informed of events,

"She's ready to go," he said. "If those rednecks do their job, we're home free. There's a spare in the trunk and enough tools to change a tire, although you shouldn't have to do that. The ones on there now are new. The Georgia license plate is under the back floor mat and there's a screwdriver in the glove compartment."

As I adjusted the seat, Carlos walked over and put an avuncular hand on my shoulder. "Bring the product back," he hissed, "or I'll fucking well kill you." I gave him a hard stare but said nothing. As I was backing out, Desmond motioned for me to stop. He handed me a piece of paper.

"Here's where you get the oil changed. Nowhere else." It was a Mobil station in Atlanta. I put it in the glove compartment and backed out into the street, swung the big Caddie around and headed for Flatbush Avenue.

It felt good to be on my own, away from Liz, Carlos and even Laura. I had hitchhiked all over the country during summer vacations from college. Now I was in charge, with a car I was proud to drive, about a thousand dollars in cash, an American Express card, luggage filled with expensive clothes, and a job to do I thought was only mildly dangerous. I looked back at the city while crossing the George Washington Bridge. It was the best place to live in the world--if you had money.

I drove steadily on the New Jersey Turnpike, never going over 60.



"Telling the bees."

they might fly away. This superstition has a modicum of sense: when a beekeeper died, his skills went with him; how the insects were treated would perhaps indicate their future fortunes.

It was also the custom to turn hives away from the beekeeper's coffin as it was carried out of the house. In their *Dictionary of Superstitions*, Iona Opie and Moira Tatem relate one late-eighteenth-century Devon funeral when chaos ensued because the bees were treated incorrectly: "[A]s the Corpse was placed in the Hearse, and the horsemen . . . were drawn up in order for the procession of the Funeral, a person called out, 'turn the Bees,' when a Servant who had no knowledge of such a Custom, instead of turning the Hives about, lifted them up, and laid them down on their sides. The Bees, thus hastily invaded, instantly attacked and fastened on the Horses and their Riders. It was in vain they galloped off, the Bees as precipitately followed [and] a general Confusion took place, attended with loss of Hats, Wigs, &c."

Alongside the custom of "telling the bees," the hives might be draped in black crepe, or with a piece of black wool, following a

I made a pit stop near the Pennsylvania Turnpike and debated with myself whether to stop in the Philadelphia area or go on along the Interstate to D.C. It was only a little after one so I drove on to Washington, where I took a one-bedroom suite at the Ritz Carlton hotel in Georgetown. After hanging up my two suits and some shirts, I was hungry and had a restaurant in mind that I'd always wanted to try, Ruth Chris Steak House near DuPont circle. While I was having a martini, I thought about Mimi, thought about calling her--but what could I say? I'm in town for the night and would like to see you. That would be stupid. Better to leave her alone. But I would send her a check for \$5,000. when I got back. That was just about what she had spent on me during our six years together. And maybe after that, I would hear from her. The New York Strip was superb, but I ate it without much enthusiasm

I was the only single diner in the room and it made me feel odd, and lonely. I would call Laura when I got back to the hotel. I wished I hadn't stopped in Washington. It brought back too many memories of Mimi and me. I wondered if she had a serious boyfriend now.

"Is anything wrong," Laura said.

"No, I'm fine. I'm in D.C. and feeling lonely."

"You're not going to see her, are you?"

"No, of course not. Why would I do that--or try to? Besides, she probably has another boyfriend by now."

death in the family. A newspaper article in 1925 related how one Worcestershire woman would dress up—including gloves—to inform the bees of important family news. After a death, she wore widow's black; for a wedding, "she donned her gayest dress and carried white ribbon"; for a birth, the ribbon would be pink or blue.

In an echo of ancient beliefs, some saw the bees as the embodiment of human souls. *Lincolnshire Notes and Queries* (1851) tells the story of two traveling servants from the start of that century: "[They] laid down by the road-side to rest, and one fell asleep. The other, seeing a bee settle on a neighbouring wall and go into a little hole, put the end of his staff in the hole, and so imprisoned the bee. Wishing to pursue his journey, he endeavoured to awaken his companion but was unable to do so, till, resuming his stick, the bee flew to the sleeping man and went into his ear. His companion then awoke him, remarking how soundly he had been asleep and asked what he had been dreaming of—'Oh!' said he, 'I dreamt that you shut me up in a dark cave, and I could not awake until you let me out.'"



AGAINST THE BACKDROP of such whimsy came the rising rationality of the eighteenth and nineteenth centuries, with scientists advocating proof over blind belief. Pioneering scientists, particularly the Swedish naturalist Carolus Linnaeus (1707–1778), began to classify insects as a separate branch of natural history; with such thinking came the rise of the entomologist. Nonetheless, insects were still widely seen as a curious subject for scientific study. When the Reverend William Kirby, a Suffolk vicar, listed three hundred species in his 1802 monograph on English bees, he clearly faced some derision. While the botanist is admired for studying mosses and lichen, he wrote the physical smallness of these creatures meant that "an Entomologist is synonymous with every thing futile and childish"—in effect, they were boys chasing bugs. In his

chair, as though he was an executive about to bawl out a heirling.

"This wasn't my idea," Carlos said. "I don't trust you."

"You know what a pitchfork is, Delgado?"

"What pitchfork?"

"The one I want you to stick up your ass.

"Don't get smart with me, shitface. I'll come around there and smash your face in."

"Fuck you, Delgado. Liz is my boss."

"You don't know the half of it," he said. "You don't know shit." I crossed my legs and stared at him. His expression changed from a scowl to what he probably thought was a charming smile. He had two gold teeth on either side of that smile. "Hey--what's your name, David?--I was just testing you out, David. You got balls, I got balls, we'll get along fine. See, we're both part of the same organization."

"Good," I said. "Liz will like that."

"That's all too true, my man. Come on, the car's probably ready." I went ahead while he locked the office door. The black guy, Desmond, was lowering a maroon Cadillac to the tracks, a welding torch in his hand.

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But by the time of the Victorians, insects were avidly collected. Specialist groups sprung up, most notably the Entomological Society of London, of which Charles Darwin was a lifelong member. During the summer months, working-class men would find rare species and sell them to enthusiasts. The natural history writer David Elliston has suggested this rise in interest was perhaps a symbol of the new urban middle classes' need for nature; trapped in their new towns and cities, these fledgling city dwellers needed a memory of freedom and flight.

Writers on bees tended to divide into those who were absorbed by the science and those who were commercial beekeepers, who were often down-to-earth people making a living in a rural economy. Both sides had much to learn from each other in this age of improvement: beekeepers found applications for the scientific theories; and those exploring the science—frequently clergymen—were beekeepers themselves and therefore practical in bent, if not explicitly commercial. This crossover between the science and practice was a key aspect of the nineteenth century, especially after the 1850s, when production shifted up a gear and beekeeping moved from cottage industry to factory production. The honeybee became business—and in the United States, big business.

At the start of the nineteenth century, the challenge was to promote a more rational form of beekeeping. A Nottingham skeppist, Robert Huish, published his forthright views on bees, gathered from his experience of keeping up to a hundred hives, in the journal *Gardener, Florist and Apiculturist*. He scorned superstitions such as the idea that a colony bought with money would not thrive.

"Excepting the Spanish," he wrote, "I know of no nation which entertains such superstitious prejudices, in regard to bees, as the English."

In hindsight, of course, it is easy to see this debunking author's own mistakes. Huish thought the idea that bees mated in the air quite absurd, and believed that wax was collected from plants, like pollen and nectar, rather than made by the bee. He thought bees tended by women were bad tempered, and blamed the poor state of the bees he saw in one Sussex village on the gender of their keepers. But whatever his misconceptions, Huish was genuinely trying to get rid of some of the more wide-and-wayward ideas.

The push was on to convince more cottagers to keep bees. The English radical William Cobbett tried to educate the common man, woman, and child to live productively at a frugal level, to make, by skill and graft, a decent life and living that could help the family make the slow, steady ascent up the social scale. Cobbett was a propagandist for the practical, and his *Cottage Economy* (1822) adds the muscles of exhortation to the bones of instruction. The honeybee fitted Cobbett's purposes admirably. He saw an educational and moral purpose in maintaining livestock such as bees; but above all it offered the cottager the chance, for no cost other than his own labor, to make something from nothing. "He must be a stupid countryman indeed who cannot make a bee-hive; and a lazy one indeed if he will not, if he can," he wrote. "In short there is nothing but care demanded and there are very few situations in the country, especially in the south of England, where our labouring man may not have half a dozen stalls of bees to take every year."

To kill or not to kill the bees? This question continued to vex beekeepers. We know William Cotton's vehement opposition to the practice; before he departed for New Zealand, he specifically addressed cottagers with this advice. Cobbett, however, thought sparing the bees when the honey was collected was mere whimsy;

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"I still wish you hadn't stopped near her."

"How's the dog."

"He's fine. He walks at my heel now. Did you teach him that?"

"Yes. That's the way a dog should walk."

"Poor Jake," Laura said. "He's been brainwashed. You're so rigid, David."

"No, I'm not. I like things to be a certain way, the way they should be."

"You must be the most frustrated person on the planet then."

"That's true," I said, laughing with her. "I love you and miss you. I'll call again tomorrow night."

"O.K.," she said. "Love you, too."

I felt better after calling Laura, and went to bed fairly early, taking only one Xanax. I woke up at dawn and powered the car along Interstate 66 to Route 29, where I cut south, a much more scenic route than staying on I-95. I tired of changing tapes from twelve-string guitar blues to classical. I fiddled with the dial until I found a country station on the radio and listened to it until the triteness of the lyrics and commercials got to me. So I drove on in silence for a while. Route 29 was actually a parkway, with two lanes on either side divided by a grass strip. The trees

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nattering little dreams that bothered me, though I couldn't remember them. I checked out at dawn and took a county road out of Lynchburg, then a track deep into the woods, where I changed license plates. I was sure no one saw me. It was Wednesday now and I'd better make time to Atlanta. I hit I-85 at Greensboro, North Carolina, was through Charlotte by noon, Greenville, South Carolina a couple of hours later, and the outskirts of Atlanta by early evening, where I checked into a Holiday Inn.

I forgot about having the oil changed until after I had eaten at a nearby diner and was getting ready for bed. I asked the desk clerk how to get to the Mobil station and he drew a map for me, telling me to follow it exactly because Atlanta was an easy town to get lost in. The Mobil horse was still lighted when I found the right gas station. I pulled in by the pumps and a young skinny black guy came hopping out of the office.

"Hey, dude, you supposed to be here by eight o'clock. I been waiting two hours for your sorry ass."

"I forgot about it," I said. "My apologies."

"You what, you *forgot* about it. Get out of the fucking car and let me change the oil and get the fuck out of here. Now I have to make an excuse to the boss tomorrow morning, tell him I was working on my own car, or some such shit. You done caused me a world of grief."

"There's no need to get excited," I said. "I said I'm sorry."

individual bees would in any case perish from age, and the less strong colonies would die over winter. Another apiarist author, Richard Smith, also scorned the idea of not killing bees, warning that a patch could be overstocked with bees, just as pasture could with cattle.

Another controversy hinged on the skep versus the wooden hive. Many early-nineteenth-century beekeepers preferred straw hives to wooden boxes. They thought straw provided better insulation and more protection from drought and rain; they were also cheaper than wooden hives, so better suited to the cottager. The best hives, said Cobbett, were made from rye straw, topped with thatch to keep out the rain. Each swarm at the outset should be housed in a new hive, because used ones could harbor moths and other problems and diseases.

One British author with advanced ideas on this subject was Dr. Edward Bevan. His delightful 1827 book, *The Honeybee, its Natural History, Physiology, and Management* (the second edition was dedicated to the current "queen bee," Victoria), successfully combined the practical with the historical and scientific. He kept only half a dozen hives, mostly for observation, but he saw how bees could be both a profitable part of cottage economy and a source of "pleasing and rational" amusement for the man of leisure. The bee, he said, "tends to enlarge and harmonize the mind, and to elevate it into worthy conceptions of Nature and its Author." His own writing transports you with the bees toward plants; he writes evocatively, for example, of the loud humming in the ivy-mantled tower of an old castle.

In the debate about straw skeps versus wooden hives, Dr. Bevan came down on the side of wood. The system of building up layers of boxes, or "storyfying," so that the honey could be removed without taking away all the bees, worked better in wooden hives. "I think wooden boxes have a great superiority over straw hives; they are more firm and steady, better suited for observing the operations

were still barren of leaves but I saw fields turning green the farther south I got. I passed the Virginia Center, an artists colony where I had stayed several times, and thought about stopping there to show off the car and my new-found prosperity, then thought better of that thought and drove on to Lynchburg where I stayed at a Best Western motel in a room that smelled like about fifty other motels I'd stayed in during my poets-in-the-schools travels, a stale odor of rug cleaner and room deodorizer impossible to describe but unmistakable as you stepped through the door.

Laura wasn't home when I called, so I left a message, telling her I'd call from Atlanta tomorrow night. I changed into the blue three-piece suit and drove out to the Crown Sterling restaurant, where a group of us from the Virginia Center, had eaten once before. The kid serving me, wearing a bow tie and a faux tux jacket, introduced himself as Charles, and asked if I would like a cocktail before dinner. I said no, but had a beer with the salad and lobster tail, hurrying through the meal because I could feel a panic attack coming on and I hadn't brought my pill holder of Xanax with me. By the time I'd finished the lobster, the aroma of grilled steaks from the open cooking area was nauseating, and the wood paneling and fireplaces seemed to be closing in on me. I was shaking by the time I got back to the motel. I took two 2 mg. Xanax and the attack passed in about fifteen minutes.

I slept fitfully that night, not having nightmares but what I called

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of the bees through the glass windows in the backs and sides, and less liable to harbour moths, spiders, and other insects," he wrote.

Within a few years, the manufactured wooden hive began to replace the homemade straw skep, and this led to large increases in honey yields. The drive to produce more honey, through the application of science, was to be the story of the beekeeping century.



THE WORLD SHRANK in the nineteenth century. New inventions in America soon made their way to the Old World, and other innovations hurried back across the Atlantic. Industrialization brought affordable goods to the people; mass-produced books filled homes and libraries, spreading knowledge like pollen. Entomology grew as a subject in the United States, just as it did in Europe. Thomas Jefferson, in his *Notes on the State of Virginia*, had called on Americans to become acquainted with the flora and fauna of their country, a challenge taken up by insect hunters when they went into the field armed with nets and collecting baskets.

In Philadelphia, a young boy named Lorenzo Langstroth, born in 1810, grew up so fascinated by insects that he wore out the knees of his trousers studying ants on the ground. He put down crumbs, pieces of meat, and dead flies to attract insects so he could watch them at close quarters, and roved around one of the city's parks observing the metamorphoses of cicadas. A teacher chastised the six-year-old for devoting too much time to trapping flies in paper cages; when she tore up one such homemade prison, releasing its captives, the boy cried himself to sleep in the dark cupboard where she had sent him as a punishment.

Langstroth left behind bugs to study at Yale, graduating with distinction in 1831; he was later ordained and took on a ministry in Andover, Massachusetts. It was only in his late twenties that his childhood passion for insects was reignited. In the summer of 1838,

he encountered a large glass sphere full of honey on a table in a friend's parlor (such jars were attached to some hives for the bees to build their combs in them). This beautiful sight led Langstroth upstairs to the attic room where his friend's bees were kept; "the enthusiasms of my boyish days seemed, like a pent-up fire, to burst out into full flame," he later recalled. Immediately—on his way home—he bought two colonies of bees.

Langstroth began to study bees in earnest. He remembered sitting on his father's knee as he listened to him read Virgil's *Georgics, Book Four*; now he absorbed the works of other such classic writers as Swammerdam and Huber, and also became a devotee of the British Dr. Edward Bevan. In 1848, Langstroth moved back to Philadelphia and started up a larger-scale apiary. It was here that he was to make a discovery that would revolutionize beekeeping all over the world.

Most American bees were kept in simple, hollowed-out logs or plain box hives. All such designs shared the skep's fatal flaw: to remove the honeycomb, you had to cut it away from the surrounding walls. The bees would fill any space between the comb and hive wall, either with more comb or, in the case of narrower gaps, with propolis, the sticky resin gathered from trees.

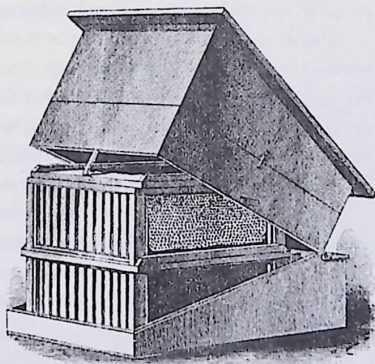
American bees had at that time been stricken by the wax moth, whose larvae destroy the honeybee's comb and brood. Probably brought over from Europe at the start of the century, the moth had devastated many hives; in 1808, it was estimated that four-fifths of the colonies in the Boston area had been abandoned because of it. This was another issue that a better hive could address.

It was Langstroth's refinement of the basic box hive that was to confront both problems. His influence was to extend far beyond the United States: some three-quarters of the world's hives today incorporate the discovery he was about to make. His simple deduction would change everything.

Langstroth had experimented on hives with frames of comb

attached to top bars that slotted into the hive's body. He left a slight gap between the bars and the hive cover, making the combs theoretically easier to move; but the bees insisted on attaching the frames of comb to the sides of the hive. On October 30, 1851, Langstroth suddenly realized that this gap had to surround the entire frame. He saw that the bees instinctively left a corridor, between and around the combs, that only *just* allowed two bees to pass each other; they filled in anything larger, as bees hate both drafts and wasted space. This corridor, around $\frac{3}{8}$ inch wide, has come to be known as the bee space. If he left this exact distance around the frames of comb, they could be removed easily—both to harvest the honey and to examine the comb for diseases such as the wax moth. Langstroth's discovery was a "eureka" moment; at that instant, he wanted to run down the streets like Archimedes.

Tantalizingly, it was too late in the beekeeping season to put the new principle into practice. All the same, Langstroth applied for a patent for his new hive in January 1852, quit his job at a school for young ladies, and made one hundred hives incorporating the bee



Langstroth's moveable-frame hive: a revolution in beekeeping.

space. This was the first moveable-frame hive: the piece of equipment that is the basis of modern beekeeping.

Langstroth's patent defined the bee space, giving him—at least in theory—rights over every hive in which his modification was used. The discovery had major commercial potential. Improvements to the old box hives, through greater control over the combs, would result in healthier colonies and higher yields. "You have made not just a discovery but a revolution," a friend told him.

It was at this time of high excitement that Langstroth's mental health collapsed. He had long suffered, intermittently, from severe depression—"head trouble," as he called it. Now his problem struck again, in force. Leaving his wife and children in Philadelphia, he took refuge with his brother-in-law. Here, he managed to write his classic book *The Hive and the Honey-Bee* (1853), but was much debilitated. Trying to describe his severe sufferings, Langstroth quoted the seventeenth-century cleric and poet George Herbert:

*My thoughts are all a case of knives
Wounding my heart
With scatter'd smart.*

In a particularly painful manifestation of his illness, what formerly gave him the most pleasure—his bees—instead caused the most pain, stinging his mind with "scatter'd smart." He would sit on the other side of the house from the hives, hide his bee books, and even, when escaping into other literature, find the capital letter *B* painful because it reminded him of the insect. Relief from such profound melancholy was only to be found in the impersonal field of the chessboard: he would lie awake at night, moving his mind through chess problems.

Instead of bringing Langstroth riches, the patented invention brought strife and misery: this was a classic example of an

unworldly inventor coming into conflict with hard-faced businessmen. An idea as good as this was bound to spread like wildfire—and it did, irrespective of the rights of its inventor.

At first Langstroth, suffering from his "head trouble" and having little business acumen, tried to get others to capitalize on the invention on his behalf. Meanwhile, others with a sharper approach just took the idea and ran, often making hives of slightly different designs, but still incorporating the concept of the bee space. Langstroth teamed up with a businessman named R. C. Otis, who bought the patent right for the moveable-frame hive in the western states and territories. In defense of the patent right, Otis and Langstroth geared up for a lawsuit against an alleged infringer, Homer King. This New York-based businessman had contracted in 1867 to pay a royalty to Langstroth; he reneged on this three years later, saying he had changed the design and no longer needed to pay. The battle lines were drawn for a court case.

Meanwhile, American beekeeping was burgeoning, and organizations began to proliferate. In 1870, the first national convention of beekeepers, the North American Bee Association, met in Michigan, with Langstroth as president. The following year, the Northeastern Beekeepers' Association grew into a rival national group, the American Beekeepers' Association—and its members also elected Langstroth as their president. The group's leader, Homer King, doubtless trying to put on a good show in front of the beekeeping community, then proposed that a fund of \$5,000 be raised to support the bee-space inventor who had been unable to capitalize on his discovery (due, of course, to the maneuvers of men like himself). What was more, promised King, he would lead the fund-raising with a donation of \$50. Langstroth's colleague Otis stood up and denounced King, saying the bee master deserved justice, not charity—and he'd give \$500 to start a fighting fund. King replied he'd give the inventor \$1,000—and draw the check immediately! Otis

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FURTHER BEEKEEPING innovations followed thick and fast in the second half of the nineteenth century. In 1865, Major Franz von Hruschka, an Austrian living near Venice, gave his son a piece of honeycomb in a basket. The boy swung the basket around his head—a reckless gesture of playfulness—and his father noticed how honey was thrown out of the comb by centrifugal force. This principle was used to create extractors that removed the honey

of the bees through the glass windows in the backs and sides, and less liable to harbour moths, spiders, and other insects," he wrote.

Within a few years, the manufactured wooden hive began to replace the homemade straw skep, and this led to large increases in honey yields. The drive to produce more honey, through the application of science, was to be the story of the beekeeping century.



THE WORLD SHRANK in the nineteenth century. New inventions in America soon made their way to the Old World, and other innovations hurried back across the Atlantic. Industrialization brought affordable goods to the people; mass-produced books filled homes and libraries, spreading knowledge like pollen. Entomology grew as a subject in the United States, just as it did in Europe. Thomas Jefferson, in his *Notes on the State of Virginia*, had called on Americans to become acquainted with the flora and fauna of their country, a challenge taken up by insect hunters when they went into the field armed with nets and collecting baskets.

In Philadelphia, a young boy named Lorenzo Langstroth, born in 1810, grew up so fascinated by insects that he wore out the knees of his trousers studying ants on the ground. He put down crumbs, pieces of meat, and dead flies to attract insects so he could watch them at close quarters, and roved around one of the city's parks observing the metamorphoses of cicadas. A teacher chastised the six-year-old for devoting too much time to trapping flies in paper cages; when she tore up one such homemade prison, releasing its captives, the boy cried himself to sleep in the dark cupboard where she had sent him as a punishment.

Langstroth left behind bugs to study at Yale, graduating with distinction in 1831; he was later ordained and took on a ministry in Andover, Massachusetts. It was only in his late twenties that his childhood passion for insects was reignited. In the summer of 1838,

"Don't tell me what to get excited about, cracker." At least his uniform was clean so he wouldn't get grease all over the front seat. While taking his place at the wheel, he deliberately hooked me with a sharp elbow. I reacted by hitting him with my middle knuckle right at the base of his skull. He slumped over the wheel and hit the horn with his head. I pulled him upright so the horn stopped. He wasn't out but he was stunned. "You motherfucker. That was a sucker punch." Damn. I should have just let it go. Now Liz would hear about it, and I'd made one more enemy.

I watched as he stumbled over the garage door, pulled the cable to open it, and start back towards me. I thought he might be carrying a tire iron, but he dumped himself in the driver's seat and made the tires squeal as he backed up. I had come to think of the Caddie as my car and thought about pulling him out and giving him another karate lesson for abusing it, but that would have fucked things up more, both with him and Liz. I should have known that anyone associated with the organization was an asshole. I also knew that the only reason he didn't put up more of a fight was that he was afraid of fucking up the deal. As I was leaving about a half-hour later, I could hear him yelling something about stomping my ass next time.

I took I-75 out of Atlanta the next morning almost to the Florida Panhandle border in the southeast corner of Georgia. A state road led to my destination, not much more than a crossroads about ten miles from a

he encountered a large glass sphere full of honey on a table in a friend's parlor (such jars were attached to some hives for the bees to build their combs in them). This beautiful sight led Langstroth upstairs to the attic room where his friend's bees were kept; "the enthusiasms of my boyish days seemed, like a pent-up fire, to burst out into full flame," he later recalled. Immediately—on his way home—he bought two colonies of bees.

Langstroth began to study bees in earnest. He remembered sitting on his father's knee as he listened to him read Virgil's *Georgics*, *Book Four*; now he absorbed the works of other such classic writers as Swammerdam and Huber, and also became a devotee of the British Dr. Edward Bevan. In 1848, Langstroth moved back to Philadelphia and started up a larger-scale apiary. It was here that he was to make a discovery that would revolutionize beekeeping all over the world.

Most American bees were kept in simple, hollowed-out logs or plain box hives. All such designs shared the skep's fatal flaw: to remove the honeycomb, you had to cut it away from the surrounding walls. The bees would fill any space between the comb and hive wall, either with more comb or, in the case of narrower gaps, with propolis, the sticky resin gathered from trees.

American bees had at that time been stricken by the wax moth, whose larvae destroy the honeybee's comb and brood. Probably brought over from Europe at the start of the century, the moth had devastated many hives; in 1808, it was estimated that four-fifths of the colonies in the Boston area had been abandoned because of it. This was another issue that a better hive could address.

It was Langstroth's refinement of the basic box hive that was to confront both problems. His influence was to extend far beyond the United States: some three-quarters of the world's hives today incorporate the discovery he was about to make. His simple deduction would change everything.

Langstroth had experimented on hives with frames of comb

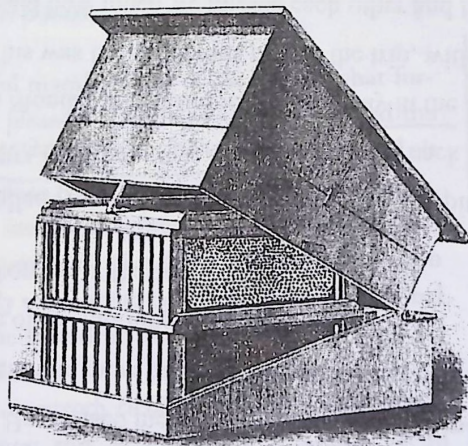
county seat. The airfield consisted of one short runway and a small hangar, with an orange windsock fluttering from a pole in one corner. I checked out the entrance, an open gate in the sagging storm fence, then drove on to the town, where I had a lunch of chicken fried steak, fried green tomatoes and okra, followed by peach cobbler.

It was only two and I had no idea what to do with myself between now and tonight, so I checked into a tacky motel and watched black and white TV, getting more nervous as the afternoon wore on. I knew I stuck out in my three-piece suit and hoped I would be taken for a traveling salesman. There had been a group of local businessmen in the diner dressed in suits, and the motel clerk had hardly looked at me as I filled out the check-in card and paid him twenty-one dollars and change in cash. At about five I took a 10 mg. Xanax and lay down, meaning only to take a short nap, but when I woke up my watch said 10.10. I hadn't brought my luggage in so I left the key in the door and eased the big car back on the two-lane blacktop to the airfield.

I had been instructed to park at one end of the runway, but I didn't know which end, so I settled for nearest one. When I turned the key and switched off the headlights, it was country-dark and still. I could hear my own heavy breathing and the Caddie's motor ticking down. I sat there in the darkness, smoking one cigarette after another until another car pulled in, its headlights in the mirror blinding me for a moment, and headed for the other end of the runway. Cops. I hadn't liked or trusted them since a

attached to top bars that slotted into the hive's body. He left a slight gap between the bars and the hive cover, making the combs theoretically easier to move; but the bees insisted on attaching the frames of comb to the sides of the hive. On October 30, 1851, Langstroth suddenly realized that this gap had to surround the entire frame. He saw that the bees instinctively left a corridor, between and around the combs, that only *just* allowed two bees to pass each other; they filled in anything larger, as bees hate both drafts and wasted space. This corridor, around $\frac{3}{8}$ inch wide, has come to be known as the bee space. If he left this exact distance around the frames of comb, they could be removed easily—both to harvest the honey and to examine the comb for diseases such as the wax moth. Langstroth's discovery was a "eureka" moment; at that instant, he wanted to run down the streets like Archimedes.

Tantalizingly, it was too late in the beekeeping season to put the new principle into practice. All the same, Langstroth applied for a patent for his new hive in January 1852, quit his job at a school for young ladies, and made one hundred hives incorporating the bee



Langstroth's moveable-frame hive: a revolution in beekeeping.

have been three when Duane shook me none too gently by the shoulder and said I was ready to roll. He advised me to go back to the motel and stay there until morning. A car like mine might be considered suspicious on a county road at this time of the morning and he couldn't be responsible for what might happen in the county adjacent to I-75.

The next morning I called Nina collect from a pay phone at a pit stop along I-75. I told her everything was fine, I was on my way back and I would see her and Jake on Monday. She cautioned me to stay in the right lane and go only 55. This was the dangerous part of the trip, with all that product in the car. We said how much we missed each other and how strange it was to sleep alone.

It was only Friday and I could have been back in Brooklyn by Sunday evening, but Liz had said Monday, so I decided to visit an old friend of mine, Bill Schultz, who lived way up in the north Georgia mountains near Rabun Gap. It took a couple of hours to get up there, but I was in no hurry. The scenery turned more lush after Tallulah Falls as I climbed steadily into the Blue Ridge Mountains. I stopped in Clayton to gas up and call Bill for directions to his place. He seemed surprised but glad to hear from me, and said to come on up. His hand-hewn log cabin was about five miles up a gravel road.

As I stepped from the car, a friendly hound trotted out from beneath the porch to nose around as Bill and his wife Velma stepped down to greet me. "Gaw-le," Bill said. "Here's old David Kernahan in a

space. This was the first moveable-frame hive: the piece of equipment that is the basis of modern beekeeping.

Langstroth's patent defined the bee space, giving him—at least in theory—rights over every hive in which his modification was used. The discovery had major commercial potential. Improvements to the old box hives, through greater control over the combs, would result in healthier colonies and higher yields. "You have made not just a discovery but a revolution," a friend told him.

It was at this time of high excitement that Langstroth's mental health collapsed. He had long suffered, intermittently, from severe depression—"head trouble," as he called it. Now his problem struck again, in force. Leaving his wife and children in Philadelphia, he took refuge with his brother-in-law. Here, he managed to write his classic book *The Hive and the Honey-Bee* (1853), but was much debilitated. Trying to describe his severe sufferings, Langstroth quoted the seventeenth-century cleric and poet George Herbert:

*My thoughts are all a case of knives
Wounding my heart
With scatter'd smart.*

In a particularly painful manifestation of his illness, what formerly gave him the most pleasure—his bees—instead caused the most pain, stinging his mind with "scatter'd smart." He would sit on the other side of the house from the hives, hide his bee books, and even, when escaping into other literature, find the capital letter *B* painful because it reminded him of the insect. Relief from such profound melancholy was only to be found in the impersonal field of the chessboard: he would lie awake at night, moving his mind through chess problems.

Instead of bringing Langstroth riches, the patented invention brought strife and misery: this was a classic example of an

sergeant whipped me with a wide black belt for running off from the orphanage when I was eleven. My stomach twisted into another convolution as I thought about having to work with them and trust them. A moment of pure panic made my forehead break out into a sweat. Just then I heard the drone of a plane and turned on the motor and headlights. The cruiser's lights on the other end switched on and off three times, then left its brights on. The plane came in at a sharp angle, but the pilot must have been used to landing in the bush because he glided to a stop about fifty feet from me. The cruiser swung around and backed in at the rear of the plane. I eased forward and then back to a position parallel to theirs. The pilot had already jumped down and opened the cargo door. The cocaine was packed in cartons containing bags of waxy brown paper. The sheriff and his deputies set to work, handing the cartons to one another in a kind of bucket line. They filled the trunk of my car first, then the cruiser's, then the back seats of both cars after I'd moved my luggage to the front seat.

The Indian-looking pilot was uneasy, pacing around and speaking rapid Spanish to himself, of which I caught only a word now and then. As soon as the plane was unloaded, he slammed shut the cargo door, hopped into the pilot's seat, turned the plane around and roared off, using only his own headlights. He probably had extra fuel tanks and stopped at some place in Mexico before heading back to Columbia.

"The stupid bastard," one of the cops said. "We could have gone

unworldly inventor coming into conflict with hard-faced businessmen. An idea as good as this was bound to spread like wildfire—and it did, irrespective of the rights of its inventor.

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big old Cadillac dressed like an undertaker on his way to a hospice." I hadn't met Velma before, but she had a nice smile, plain unadorned face and a slight limp. One of the first things he said was you'll have to stay the night. Just then Leon the dog let out a yowl that would have startled any racoon within miles, brushing our legs as if he wanted to get in on all this friendliness. I patted his black and white splotched neck and got a slobbery kiss and a nose in the crotch in return. "That dog loves everybody," Bill explained as we climbed the steps to the house. I had forgotten that he was a head taller than me, about six feet four, and still lean as the basketball player he had been in college. Everything in their cabin looked hand-made, quilted, spun. There was a sleeping alcove for guests, Velma said, as she turned around a rocking chair in front of a fieldstone fireplace, in which there were still embers. A large spinning wheel that looked like a primitive harp stood in a corner, and brightly colored rugs had been placed here and there--probably hand-hooked by Velma. Bill straddled a chair and looked straight at me, while Velma sat by the kitchen table.

"How in the heck are you, son? You look prosperous."

"Fine, Bill, I'm a traveling man now."

"I gathered that. But how do you feel about your life?" He leaned forward, the ardor of a true believer intense in his light blue eyes. "I believe in Jesus Christ now. I had prostate cancer and Christ saved me and I saved myself by coming to him. Velma and I go to church three

called for King to be prosecuted. The row made it into the newspapers, which gleefully reported this testy quarrel between bee men.

As is often the case, the row began with a standoff and ended with a whimper. After the deaths of his wife and his backer Otis, Langstroth, still in poor health, felt unable to press the lawsuit; it was dropped, and King and many others continued to make their new hives without paying him a cent. In his *History of American Beekeeping* (1938), Frank Pellett remarks that it would have been better for Langstroth if he had simply given his idea to the world, instead of trying to defend his patent.

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up there and lighted the runway for him."

"Aw, Duane," another said. "Them Spics is all alike. Panicky when the shit hits the fan."

The three of them looked at me now. My suit was rumpled and I straightened my tie before becoming aware of what I was doing. I buttoned the jacket and stepped forward with my hand out. "David," I said. "David Kernahan." My hand was ignored.

"Duane," the sheriff said. "And these are my two deputies, Jack and Homer. You follow us." Their belts creaked as they walked around to the cruiser. They led me to a two-car garage at the crossroads village where Jack, evidently the owner, put on a pair of coveralls, motioned for me to get out of the car, put it on the lift and began using a cutting torch to free the \$50,000. under the right front fender. Duane looked the money over, remarked that Liz was never short, and nodded to Jack to begin packing the coke. I didn't want to know how they arranged 110 pounds of the drug under each high-riding fender, so I sat down in the small adjoining office. My thinking was that if I didn't know how the cocaine had gotten into the fenders of the car, I couldn't be held liable. Completely illogical--I knew that. And I felt that the lawmen didn't want me to know how they hid it. That it was a trade secret between them and Desmond.

I read tattered copies of Sports Illustrated until I dozed off. It must



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times a week. We live simply and the Lord takes care of us." His low tone of voice was soothing, like that of a preacher bringing a convert to the altar. This was the same guy I had discussed Kant, Schopenhauer and other philosophers with at all-night bull and beer sessions in college. If we weren't out and out atheists, we were certainly agnostics.

"We could bring you to the Lord right now, David" Velma said. "Just kneel down and pray with us." This "witnessing" was making me uncomfortable, and I decided certainly not to stay the night and in fact to take off in an hour or so. Velma made coffee and brought a mug over to me, and I changed the subject by talking to Bill about old classmates, wondering who ended up where and in what circumstances. After finishing the coffee, I lied by telling them I had to be in Asheville by four.

"Business, business," Bill said. He could tell I was irritated by their desire to convert me then and there. As I was leaving, Velma hugged me and said the Lord be with you, and David and I shook hands and he said don't be a stranger, but both of us knew we'd probably never see each other again. As I drove off, I envied their faith in an absolute God, and also wondered how they got by, how they made money.

I was in Asheville by four and decided to treat myself to a really posh place, the Inn on Biltmore Estate, where I took a one-bedroom suite with a whirlpool. The desk clerk explained they normally didn't take transients, but this weekend wasn't booked up, so they would be glad to

problems, as first he'd hoped. Harbison found that Langstroth's patented hive was too small and flat to suit the conditions in California with its magnificent nectar flow. His own major advance was to invent a hive that produced small squares of honeycomb that could be taken straight out of the hive and sold to the public. These 2-pound combs were packed in pails and sold as a package of pure goodness. There began the "honeycomb era." A major load of Californian honey—ten railcars packed full of combs—arrived in New York City from San Diego in 1876, causing an enormous stir.

During the 1870s and 1880s, San Diego County was a region of sage and buckwheat—both excellent honey plants. This was pioneer land; one of the best areas for small apiaries was the backcountry, inland from the coast up to the Volcan, Cuyamaca, and Laguna mountains. Here, smallholders would subsist on a homestead with vegetables and livestock, including a row of beehives.

A gloomy comment came from Harbison, who said pioneer settlement and clearing was destroying the bee industry by damaging its forage plants. A debate ran in the bee press about which plants you could grow to boost nectar supply. There was still plenty to go around, however. More and more citrus and other fruit trees were being planted each year, for example, providing excellent food for the bees. By 1884, Californian apiarists achieved an annual production weighing more than two million pounds. Curiously, given that honeybees help pollinate trees, there was some conflict between fruit growers and beekeepers; Harbison wrote a letter to the *American Bee Journal* in 1893 saying he had lost some 350 hives to arson in just one year due to this. But despite such tussles, California became the leading honey-producing state in the United States.



IN THE LATTER HALF of the nineteenth century, there emerged something of a cult following for what became known as the Italian bee. *Apis mellifera ligustica* is still much admired today for its attractive yellow coloring, productivity, and docility. During the Napoleonic Wars a Captain von Baldenstein served in northern Italy, where he admired these pretty, useful bees. He returned to live in his castle in the Tessin Valley, an area of Switzerland that borders Italy, and later sent men to fetch some of the insects; the bees arrived in September 1843. Johann Dzierzon brought them to Vienna ten years later, and his writings continued to spread enthusiasm for the Italian bee around Europe and over in America.

An early attempt, in 1855, to bring Italian bees across the Atlantic failed because a ship's officer stole some honey and the bees starved. Samuel Wagner, of the *American Bee Journal*, with support from Langstroth, again imported some in 1859, but there were questions about their genetic purity.

There were attempts to get the U.S. government to support the project, with forecasts of spectacular dividends from this fabled honey producer. Then a botanist, S. B. Parsons, undertook the journey himself. He bought some bees from H. C. Hermann, a German beekeeper whose book *The Italian alp-bee, or, the gold mine of husbandry* (1859) had done much to popularize the variety. The bees were packed in cigar boxes filled with honeycomb; in all, twenty colonies were sent off to the States.

Parsons had packaged the bees into three batches; a third for the U.S. government, a third for the beekeeper P. J. Mahan, and a third for himself. On April 18, 1860, when the *Arago* steamer docked in New York, their Italian queens were finally unloaded in the United States—alive, but only just. The combs had loosened in their boxes, and many of the insects were crushed. None survived in the government's batch; none in Mahan's; of all the bees that set out, at a cost of \$1,200, only two Italian queens had made it. Once landed,

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accommodate me. The first thing I did was to get into the whirlpool. The trio of cops had smelled of sweat and another odor which I identified with locker rooms and dirty jock straps. I felt much better with Laura's silk robe around me before changing into the blazer outfit again and taking a stroll around the estate grounds with their formal gardens, the multi-colored flowers just breaking into bloom. I had a half-bottle of Chateau La Tour with my dinner of chef's salad and porterhouse steak. I went outside to smoke the second of Marty's cigars, walking some distance off into the darkness where I could see the star-filled sky. I pointed the cigar at Sirius and thought there must be other beings out there in all that heat and cold and dark and light. The species on earth couldn't be only living things in the whole universe. It would be interesting, I thought, to live 5,000 years from now when that might be known.

But I had more earthbound considerations to think about. I called Laura and told her how much I wished she could be with me and that it would be a great place for a vacation. We could go horseback riding and river rafting, the food was superb and the scenery spectacular. She said she'd think about it, but the important thing now was to get back to Brooklyn. I slept well that night, taking only one Xanax, and woke up at dawn.

this pair still faced a precarious future. A W. Cart of Coleraine, Massachusetts, took one queen and an Austrian beekeeper, Bodmer, the other. The Austrian failed with his queen; luckily, Cart had more success. He created a large apiary of Italians for Parsons, and these were the genesis of the Italian bee industry in the States. A total of 111 of these queens were taken to California, most arriving in good condition.



ITALIAN QUEENS arrived in England before the United States, imported by Thomas Woodbury (1818–1870). Woodbury was one of the most important British beekeepers of the modern “scientific” era. He studied the great bee writers and, after becoming fascinated by the possibility of other races of *Apis mellifera*, imported one thousand Italian bees from H. C. Hermann. They arrived by train in a box: you can imagine his excitement when, back home near Exeter, he shook the bees out, hunting for the queen. He placed her carefully in a wineglass and carried her to a skep where she was put among other bees. A fortnight later, when he spotted workers carrying plenty of pollen into the hive to feed new brood, Woodbury knew that the colony and its new queen were thriving.

Woodbury was quick to adopt the principle of the bee space and is credited as being the first person in Britain to use moveable frames, in 1860. He also developed his own hive, incorporating Langstroth’s innovation. With a typical inventiveness, he was planning a hive suitable for the giant eastern bee *Apis dorsata*, when he died, suddenly, at the age of fifty-two.

Another interesting aspect of Woodbury’s life was that he corresponded with Charles Darwin. After formulating his earth-shaking theory of evolution, Darwin continued to live in the quiet seclusion of Down House in Kent, carrying on an extensive correspondence and taking daily walks in his garden where he would

peer into the flower beds, minutely observing the behavior of insects. He now consulted pigeon fanciers and beekeepers such as Woodbury about native species. He was most intrigued when Woodbury sent him a sample of the new comb foundation in the 1860s, and also wrote about how bees tend to visit one sort of flower at a time, remarking how important this is to the cross-fertilization of plants of the same species. "Humble [Bumble] and hive-bees are good botanists," he commented, "for they know that varieties may differ widely in the colour of their flowers and yet belong to the same species."



SCIENTIFIC ADVANCES and the development of beekeeping groups led to the growth of a specialist press in Britain as in America. The *British Bee Journal*, launched in 1874, came out monthly, then weekly, and settled down as a fortnightly paper. Events such as the first bee and honey exhibition at Crystal Palace in 1874 helped to spread ideas and inventions. This was set up by the newly formed British Beekeepers' Association, which aimed for "the encouragement, improvement and advancement of bee-culture in the United Kingdom, particularly as a means of bettering the condition of cottagers."

Since the start of the century, beekeeping had become an increasingly useful part of the rural economy. In 1870, a professional gardener named A. Pettigrew wrote his *Handy Book of Bees* (1870), with an attractively plain-speaking tone—not unlike William Cobbett's in the 1820s, but with an even more businesslike perspective. Pettigrew's father had been a laboring man and beekeeper in Lanarkshire. His sons helped look after the bees, and when the future bee author became an apprentice, then journeyman-gardener in Middlesex, he would keep his own bees in addition to managing his employers' bees. Money was an important

incentive: "Stings do not seem half so painful," he wrote, "to the man whose annual proceeds of bee-keeping amount to £10, or £20, or £50." He also praised the occupation for its productive, moral nature and recommended that swarms be given as gifts to deserving servants: "Who has not seen hundreds of working men blessed and charmed beyond description in attending to their bees and cow?" he asked. "Such men are superior to the low vulgarities of the public-house, and superior in every sense to those who waste their time and strength in drinking." He hadn't much time for Italian bees, asserting that a gullible susceptibility to the new was the greatest weakness of an Englishman, and he also found straw skeps infinitely preferable to the newfangled wooden hives.

But Langstroth's advances and a generally more scientific approach to beekeeping were spreading. At the end of the century, a Sussex beekeeper, Samuel Simmins, wrote a book promoting beekeeping as a profitable pursuit. His prediction of the market shows how perspectives had shifted toward industrialization. He talked of how bees, through pollination, helped along fruit being grown for jam, one of many foods that were now mass-produced. Simmins saw that, with the aid of modern extractors, liquid honey was the future now, not comb: "Honey in the comb will ever remain a luxury," he wrote, "but that in the liquid form is destined ere long to be found in general use in almost every family." It was a prediction that has proven true to this day.

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Chapter 19

I changed license plates just over the Virginia border and the trip back was uneventful, but by the time I got back to Brooklyn on Monday morning, I was exhausted, both from the long drive and nervous tension. Desmond had been waiting for me, he said, and Liz was in the office. As I climbed the stairs to the office, I had to make room for Carlos who was hurrying down. "You ain't gettin' paid till everything checks out." Desmond had the car already on the lift and a welding torch sparked in his hand. Carlos, trying to supervise the job but only getting in the way, stepped back, brushing the lapels of his sharkskin suit jacket. Liz, in a stunning powder-blue Chanel suit, stood on the landing, watching the whole operation. Desmond began loading what I guessed were four-kilo bags on a warehouse cart. Carlos took a pen knife and licked the product off the blade. "Yeah, baby," he yelled up to Liz, "it's the same stuff. It ain't been cut. I'm taking my twenty keys now." Liz just shook her head and motioned for me to follow her into the office.

"You did fine," she said. "Except for the fight with Jo-Jo. Try to make it up with him next time." She pushed a United Airlines bag

incentive: "Stings do not seem half so painful," he wrote, "to the man whose annual proceeds of bee-keeping amount to £10, or £20, or £50." He also praised the occupation for its productive, moral nature and recommended that swarms be given as gifts to deserving servants: "Who has not seen hundreds of working men blessed and charmed beyond description in attending to their bees and cow?" he asked. "Such men are superior to the low vulgarities of the public-house, and superior in every sense to those who waste their time and strength in drinking." He hadn't much time for Italian bees, asserting that a gullible susceptibility to the new was the greatest weakness of an Englishman, and he also found straw skeps infinitely preferable to the newfangled wooden hives.

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towards me. "Here \$42,500 in cash and a payroll check for nearly five. That makes us even."

"And I get to make the run next month?"

"Right," she said. "And that's all you'll do. Except for Marty."

"I'm tired."

"Go home. I'll get a taxi for you. Stand downstairs, just inside the door. And stay in touch."

Desmond had put my luggage down by the door, and in about ten minutes a Checker cab pulled up. The driver got out and helped me put the luggage in the trunk. He took the Manhattan Bridge back and about halfway across it, I noticed that he hadn't pulled the meter handle.

"How about the meter?" I said. "Or do you have a set rate?"

"This is a company car, kiddo. No charge. You have breakfast? Because if you haven't I know a very good place. At a stoplight he turned and offered me his hand. "Gus," he said. "Nick Gustavson." I wanted to get home but I figured being a friend of Gus might come in handy sometime. The place where we stopped, the NoHo Star, was only two blocks from where I lived. Odd that I hadn't known about it. Gus was another of Liz's anonymous-looking men, average height, weight, but he had what my grandmother called a wandering eye, a condition where one brown eye looked at you while the other may have been looking at the

CHAPTER NINE

CREATIVE BEE

At the start of the twentieth century, *The Life of the Bee* by the symbolist playwright and essayist Maurice Maeterlinck became a bestseller. This Belgian, who went on to win the Nobel Prize for Literature, wrote his account of the honeybee in an explicitly literary style, which appealed to the general public and not just a beekeeper readership. My copy is a small, moss green hardback, embossed with gold flowers, with fin de siècle tendrils swooping elegantly across the endpapers and spine. The book accompanied me on trains, park benches, and bus seats, slipping in and out of my coat pocket for a month or so. This was the edition's seventeenth printing; I became intrigued by what drew so many people to bees at that time.

The volume had belonged to my great-aunt Isobel and sat on her bookshelves alongside W. B. Yeats, Tennyson, and Rupert Brooke. Bees were a motif in the work of all these poets. Yeats dreamed of a "bee-loud glade" on the Isle of Innisfree; Tennyson dreamt of "the moan of doves in immemorial elms, / And murmuring of innumerable bees." "And is there honey still for tea?" asked Rupert Brooke, a line ever-glowing with nostalgia. Bees represented an old-fashioned idyll as factories churned and cities spread.

Maeterlinck's book starts on a similar note, with the storybook account of his first meeting with an apiarist. This old man lived in

the Dutch countryside, a place of little trees marshaled along canal banks, of polished clocks and the musical voice of the perfumed, sunlit bee garden. He had retreated from human affairs, and kept twelve straw skeps painted pink, yellow, and blue to attract the bees. In this beautiful place, Maeterlinck writes, "the hives lent a new meaning to the flowers and the silence, the balm of the air and the rays of the sun."

At times Maeterlinck's descriptions of bees are anthropomorphic. He ponders on the virgin queen's flight, wondering if she is a "voluptuary" who enjoys mating in the air. The big-eyed mating drone is a doomed romantic hero whose unique kiss will lead to his death. The duels between the virgin queens, stinging fights to the death, are vicious as only a dramatist could make them.

But while Maeterlinck waxed lyrical, he also had a background in the craft: he had been a beekeeper for twenty years and kept an observation hive in his study in Paris. His book follows the life of the bee through the life of the year, from spring awakening, to swarming, to the building of a new colony and its filling with honey. He watches events unfold with a sense of awe. Fighting queens will hold back if it looks as if they are about to sting each other to death, leaving the nest leaderless: the central mystery of the hive, for him, was the way the individual bee works for the good of the colony.

Why did they do this? In the pre-Darwinian world, it would have been seen as due to God's divine design. But *The Life of the Bee* is disturbed by the shock waves of Darwin; this was now a world in which humans could be descended from apes. Maeterlinck is tentative about the theory of evolution, perhaps because he saw its implications. His language is still religious in timbre; the mystical life force he sees in a hive of bees is similar to the Holy Spirit. Yet meaning has slipped from "God" to "Life": a mysterious force of nature. The meaning of life, for the bees, is survival. "The God of the bees is the future," he concluded.

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Farm problem.

First few pages
37-39 are
unneeded
repeated in
p 40 etc. +
shown by
unneeded
Start on 40.

Having grown up in a sparsely populated neighborhood surrounded by pasture, there was only one other boy to play sports with. For everything we played -- football, baseball, basketball or track -- the competition was always one on one. Occasionally, playing baseball, in the heat of competition we would lose the ball and have to find something else to replace it. A tennis ball worked pretty good, but it usually ended up getting hit further away into a pasture never to be seen again. So that left us with only one other option, black walnuts. One good whack with the bat and it was gone, out of the park. Mark McGuire would have been envious since I'm pretty sure I hit way over 70 home runs in every season. When one was hit so hard it disappeared, just grab another one, there were always plenty on the ground. We would then end the game by cracking a few with our bat and eating them.

So, when are black walnuts ready to be harvested? They reach a mature stage when the hull can be dented with your thumb or they start falling from the tree. However, it is important to hull the walnuts soon after harvest because the hull will leach a stain through the nut and into the meat if not removed. The stain will not only discolor the meat but also give it an off flavor.

Walnuts can be hulled by running the walnuts through a corn sheller or pounding each nut through a hole in a board. The hole must be big enough for the nut but smaller than the hull. The hulled nuts should then be washed off. This can be done by spreading and spraying them with water. They can also be placed in a tub of water. If placed in a tub, the good nuts should sink. Those that float normally are not wellfilled with kernels.

Next, the nuts should be dried. Place them in layers no more than three deep in a cool, shady, and dry place such as a garage or tool shed. Drying normally takes two weeks.

Black walnuts (*Juglans nigra*) are members of the *Juglandaceae* or 'walnut family'. They are trees of moderate growth rate that can reach, eventually, up to 50 metres in height. They have long pinnately compound leaves. The whole row of leaflets may be up to a half metre in length, like the leaves of an ailanthus. These leaves have a distinctly tarry texture, and they are bitter tasting. Twigs are large budded, stout, and have a spiralled leaf arrangement. The handsome bark is dark and deeply furrowed. The wood is durable and very dark. The monoecious trees are both male and female. The male flowers are long catkins. The red-purple plumed female flowers have a single ovule. This ovule develops into a large rough shelled nut with a thick greasy husk.

Black walnuts are best known for their thick shelled nuts. These walnuts are hard to crack, but their 'meat' is very delicious. These nuts are relished by squirrels, which cache great numbers of them in the ground. A portion of these buried treasures are 'forgotten', misplaced, or deemed surplus, by their rodent vectors, hence squirrels aid in the propagation of walnuts in the wild. To a limited extent black walnuts have been cultivated commercially as nut-trees. Although, they are not so commonly cultivated for their nuts as are European walnuts (*Juglans regia*). European walnuts have thinner shells which are more easily cracked.

Juglans is both an Eurasian and American genus. The greatest number of species occur in the Americas, especially in South America. It is probable that the *Juglans* genus originated in South America. Many species of walnut live in the Andes Mountains, and whole forests in associations in Central America can be dominated by various *Juglans* and oak species. *J. australis* of the southern Andes and *J. neotropica* of the northern Andes are examples of New World walnuts. These species have fairly large nuts, but mostly they are valued as lumber trees, and the nut-husks are used for making dye.

Black walnuts are natives of the Carolinian forests from southern Ontario to Texas. These walnuts grow in moist bottomlands and the older primeval forests of the east. Unlike the similar butternut (*J. cinerea*), black walnuts are fairly disease tolerant and can live, if planted, in soils dryer than their natural habitat. Black walnut is sometimes planted as an urban ornamental. Usually the city milieu most favourable are spacious yards, with plenty of surrounding tree cover. The large husked nuts fall mostly in the autumn, but squirrels knock some down in mid-summer. These nuts (4-5 cm wide) are large enough to hurt if they fall on one's head. Furthermore, the wood of walnuts is durable, but old dead branches have a tendency to break and fall. The trees also seem to have some proneness to lightning strikes. The roots of walnuts exude a substance called **juglone**. Juglone is an example of an *allelopathic* agent. This allelopath inhibits the growth of other plants. Consequently, turf grass, flowers and other plants do not thrive when planted under walnut trees. Because of the large nuts, weak wood, and the juglone, walnuts do pose some problems as ornamental trees. Black walnuts are not a good choice for small yards, near traffic lanes, near walkways or near gardens.



FactSheet

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Ohio State University Extension Fact Sheet

Horticulture and Crop Science

2021 Coffey Rd., Columbus, Ohio 43210-1086

Growing Beets in the Home Garden

HYG-1604-93

Pamela J. Bennett

Beets are popular in the home garden because they are relatively easy to grow and practically the whole plant can be eaten. Beets can be grown for their root qualities which include different shapes and sizes as well as red, yellow or white colors. The tops or greens, when young, are excellent in salads and when the plant is older, can be cooked. The greens are even more nutritious than the roots.

Climatic Requirements

Beets prefer a cooler climate although they are tolerant of heat. Temperatures of 60 to 65 F and bright sunny days are ideal for beet plant growth and development. They can withstand cold weather short of severe freezing, making them a good long-season crop.

Soils

Beets prefer loose, well-drained soils but will tolerate a wide range. Remove stones and debris since this will hinder growth. In high clay soils, add organic matter to improve soil structure and to help avoid crusting after rainfall. Beets also make an excellent raised bed crop since soils are generally less compacted and there is less foot traffic. Beets are also sensitive to soil acidity. A low soil pH results in stunted growth. They prefer a pH of 6.2 to 6.8 and will tolerate 6.0 to 7.5.

Fertilizers

Fertilizers and lime are best applied using soil test results as a guide. Arrangements for soil testing can be made through your local Extension office. A fertilizer with the analysis of 5-10-10 can be applied at the time of seeding and again when the plants are about three inches high.

Establishing the Planting

<http://ohioline.osu.edu/hyg-fact/1000/1604.html>

1/23/2004

Plant the seeds in a well-prepared seedbed as soon as the soil can be worked in the spring. Sow the seeds 1/2-inch deep and in rows 12 to 18 inches or more apart depending on the method of cultivation.

Space the seeds, which are actually fruits containing several seeds, one inch apart in the rows. When the seedlings are one to two inches tall, thin to about one plant per inch. As they grow, thin to about three to four inches between plants.

Succession planting can be done at three week intervals throughout the season. Avoid seeding during daytime temperatures of 80 degrees F, wait until it is cooler. Most varieties will mature within 55 to 70 days and can be planted until late summer.

Culture

After plants are well established, the application of a mulch will conserve soil moisture, prevent soil compaction and help suppress weed growth. Any mechanical cultivation should be very shallow in order to avoid damage to the beet roots.

In order to obtain the highest quality, beets must make continuous growth. Soil moisture and plant nutrient element supply must be adequately maintained to prevent checking of the growth. Supplemental watering may be necessary during dry spells.

Weeds, insects and diseases must be controlled in the planting. Principal insect and disease problems of beets are flea beetles, leaf miners, aphids and Cercospora leaf spot. Regular inspection of the crop can help deter a major pest infestation. Check with your local Extension office for current control recommendations when you notice a problem.

Harvesting and Storage

Beets can be harvested at any time in their growth cycle. Greens are best when four to six inches tall. Beet roots are generally most tender after growing for 40 to 50 days. The best size is between 1-1/2 to 2 inches in diameter. As beets get larger, they tend to become more fibrous. When harvested, leave at least one inch of foliage on the root to avoid bleeding during cooking.

Beets are suited to long-term storage if kept at temperatures near freezing and with high humidity to prevent wilting.

Varieties

Choice of cultivar depends on your tastes. Excellent varieties for Ohio home gardens include Early Wonder, Detroit Dark Red and Little Ball for red beets. More recent introductions include Pacemaker III, Red Ace Hybrid, Warrior and Avenger. Burpee Golden and Albino White are alternatives for a different color of beets. Below are some varieties and their characteristics.

- Burpee Golden - Round type with a unique yellow-orange color.
- Pacemaker III - Uniform, smooth a tender round beet, cercospora leaf spot tolerant, high quality tops.
- Red Ace hybrid - Exceptional weather tolerance, cercospora leaf spot tolerant, early maturity.

- Little Mini Ball - Sliver-dollar sized round roots.
- Detroit Dark Red - Excellent canning, pickling quality, tender & sweet, good boiling greens.

Additional Extension publications that may be useful include:

- Bulletin 287 - *Home Vegetable Gardening*
- Bulletin 736 - *Vegetables for Ohio Gardens*.

The author gratefully acknowledges James D. Utzinger, William M. Brooks, and E. C. Wittmeyer, on whose fact sheet this is based.

This fact sheet was reviewed by Marianne Riofrio, Dr. Robert Precheur and E.C. Wittmeyer.

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Bee Periods

- 1-19
- A { ¹⁹⁵ April - decides to wait a year.
Transition bees.
- B { July - building 2 poplar hives 3-tier hives
- C { August Sept. - visits to other ~~hives~~ ^{apiculturists}
Sept 16-28
- D { ¹⁹⁶ Oct - ~~can~~ - visit to apicult. - Bee cleanout
on snow -
- E '96 Feb - April - stools up on kees to edit it
- F August - flight is also in
- G Sept - fall from tree
- H Oct Decision to sell
- I 197 no sale until spring

Growing Potatoes in the Home Garden

HYG-1619-92

E.C. Wittmeyer
Marianne Riofrio
Mark Bennett

Potatoes can be grown successfully in Ohio gardens, but they require more care and attention than most other vegetables. The potato has specific soil requirements, and thorough insect and disease control is necessary. A good yield would be 150 to 175 pounds of usable potatoes from 100 feet of row. Practices are suggested here to aid in obtaining a high yield of quality potatoes.

Soil Requirements

A well-drained, fine sandy loam soil, high in organic matter is preferred. If heavy clay or clay loam soils are used, drainage problems should be corrected and organic matter content improved by growing cover crops or adding aged manure or compost. Be cautioned, however, that manure may increase the incidence of potato scab (see below).

Seedbed Preparation

If a cover crop (rye or wheat are excellent choices) was planted the previous fall, it should be turned under before it exceeds 12 inches in height by tilling 8 to 10 inches deep, depending on the depth of the topsoil. After tilling, level the surface slightly so that furrows can be made. It is best to wait at least a week after tilling in the cover crop before planting the seed pieces.

Soil pH and Fertilizer Practices

Because scab disease (brown corky tissue on surface of tubers) may be a problem in alkaline or "sweet" soils, the pH should be 5.0 to 5.5. Liberal amounts of fertilizer are required for large yields of potatoes. Ideally, the fertilizer should be placed in continuous bands two to three inches to each side and slightly below the seed piece. However, many gardeners will broadcast the fertilizer before tilling or spading. Fertilizer rates should be based on results of a soil test; a typical rate would be two and a half to three pounds of 8-16-16, 10-20-20, or equivalent per 100 square feet. When plants are four to six inches tall, band two to three pounds of fertilizer per 100 feet of row about 6 to 10 inches from the row, if growth is not satisfactory and if foliage is yellowish-green.

Variety Selection

Irish Cobbler is an excellent early maturing variety for the home garden, but seed is scarce. It should be planted early, from late March to mid-May, depending on the section of the state. Norland is an early, red-skinned variety, various strains of which are readily available. Another red-skinned variety is Pontiac, a late-maturing, high-yielding potato of fair cooking quality, but often misshapen. Superior is a white-skinned variety, maturing later than Irish Cobbler, but earlier than two other recommended varieties, Katahdin and Kennebec. These two are desirable when gardeners want to store potatoes.

Whichever variety is selected, use certified disease-free seed. Such seed is grown under rigid rules and

carefully inspected by state authorities. The potato seed is not a true seed, but modified stem tissue known as a tuber. The true seed of the potato occurs in the small, inedible orange fruit the plant produces during mid-season.

Some feed and garden stores sell B-size seed-small tubers weighing 1-1/2 to 2 ounces. These tubers should not be cut before planting. If 4 to 6 ounce or larger tubers are used, cut them so that each piece is block shaped, contains at least one good eye or bud, and weighs about 1-1/2 ounces. Plant immediately after cutting.

Planting

Plant the seed in shallow trenches 3-1/2 to 4-1/2 inches deep and cover with an inch or two of soil. The seed pieces should be spaced 9 to 12 inches apart in rows 28 to 34 inches apart. Nine to 12 pounds of seed will be needed for each 100 feet of row when 1-1/2 to 2 ounce seed pieces are planted 12 inches apart.

Cultivation and Weed Control

Due to the small area involved and the variety of potentially sensitive crops grown in the garden, chemical weed control is not recommended. Control weeds by shallow and frequent cultivation. Deep cultivation may cut potato roots and slow growth. When plants are 6 to 8 inches tall, begin to mound soil around the bases of the plants to start forming a ridge or hill. By the time the plants are 15 to 18 inches tall (at last cultivation), the ridge or hill should be 4 to 5 inches high. "Hilling up" is necessary to prevent greening of shallow tubers.

Insect and Disease Control

Most feed and garden stores sell approved insecticides and fungicides for use on potatoes. The spraying or dusting program should start as soon as the plants emerge and continue according to the product label until late summer or a few weeks before harvest. Flea beetles, leafhoppers, aphids and Colorado potato beetles are the major insects affecting leaves and stems. Early Blight and Late Blight are the major foliar diseases.

Garden area previously in sod may harbor wireworms, white grubs and other soil insects. These insects should be controlled before planting. Contact your local Cooperative Extension office for current control recommendations.

Harvesting and Storage

For highest yields and best storage, potatoes should not be dug until two weeks after vines have naturally died down. This allows the skins to set and reduces skin peeling, bruising and rot in storage.

When harvesting at temperatures above 80 degrees F, potatoes should be picked up immediately and put in a dark place. Potatoes exposed to sun and high temperatures will turn green and may rot.

Most homes do not have a suitable place to store potatoes for more than four to six weeks. To store potatoes for several months, the tubers should be cured in a dark place at 60 to 65 degrees F and a humidity of 85 percent or higher for 10 days. After the tubers are cured, keep them in a cool (40 to 45 degrees F), dark place with high humidity. Under these conditions most varieties will not sprout for two

to three months.

The authors gratefully acknowledge James D. Utzinger for the 1983 fact sheet on which this is based.

My wonderful organic soil company (Bibb's) sells 6 varieties of "seed potatoes" and all are marked "EASY" on germination—meaning when you plant 'em, the odds SOMETHING will start growing are excellent and the very majority of the seeds WILL produce a plant.

SEEDS

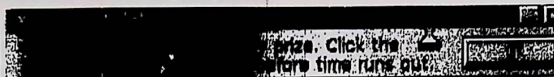
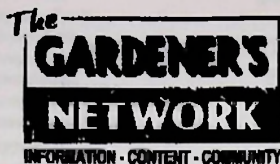
Bibb's sells 2 varieties of seed seeds, both marked EASY for germination. One matures 30 days after planting, the other in 35 days.

POTATOES

My wonderful organic seed company (Richters) sells 6 varieties of "seed potatoes" and all are marked "EASY" on germination—meaning when you plant 'em, the odds SOMETHING will start growing are excellent and the vast majority of the seeds WILL produce a plant.

BEETS

Richters sells 2 variety of beet seeds, both marked EASY for germination. One matures 50 days after planting, the other in 55 days.



The dragon Beets !!

Beets



How many of you out there like beets? Okay, so Beets may not be the most popular vegetable on the planet. But those who like Beets, really love them. And, home gardeners quickly discover that Beets are easy to grow. They reach maturity quickly, and take up little space.

Almost all varieties are a deep rich red. There is one white variety on the market. Beets are commonly known to bleed, or leak, their deep red juice. This juice can cause stains, so be careful where you set them.

Did you know? Beets are one of eight vegetables that makes V8 taste great.

Varieties:

- There are several varieties of beets. Most are round in shape, with deep red color.
- A few varieties are deep red and cylindrical, making them easier to slice into uniform slices.
- There is also an uncommon white beet.

Holiday Insights

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Time to Shop:

Gardening:

Annual Seeds
Perennials Seeds

Planting:

Plant Beet seeds thinly, 1/2 inch deep. After germination, thin to 2 to 3 inches apart. Rows should be spaced 1 1/2 feet apart.

Growing:

Apply a general purpose fertilizer while sowing, and again two to three weeks later. Beets should be kept weed free. It is easy for weeds to

Herb Seeds
Organic Seeds
Flower Bulbs
Composters
Greenhouses
Hammocks
Houseplants
Supplies
Pond "Stuff"
Statues/Elves
Back Yard/Deck

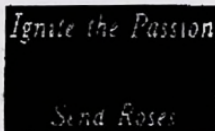
Seasonal:

Halloween
Thanksgiving
Carving Stuff
Lights
House Flags
Candles
Decorations
Kitchenware
Thermometers

TGN's Florist

Bird Stuff:

Bird Feeders
Bird House
Seeds 'N Suet
Squirrel Stuff
Martin House



Amazon.com

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overshadow the shorter beet leaves.

Tip: Keep the soil lightly watered. Too little water will result in a tough leathery crop.

Days to Maturity:

Approximately 55 to 60 days for most varieties.

Insects and Pests:

Aphids and beetles will occasionally infest the plants. Treatment with insecticide is effective.

Mice and squirrels and a few other pests will sometimes nibble on your crop.

Disease:

Mildew and leaf spots are an occasional problem. Treat with fungicides

Harvesting:

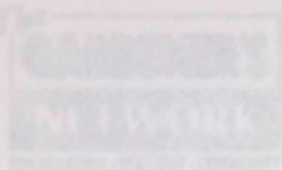
Begin to harvest beets when they are two inches in diameter, thinning ^{the} row as you go. Beets are tender when young. A big round beet will look really impressive, but will certainly not taste impressive, as they will get tough quickly.

Hardiness:

Beets are sensitive to frost. But they are a root crop. Should Jack Frost an unexpected visit, the beets are still harvestable.

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Amazing! The versatile and Luscious Potato. Simply or elegant as they are, potatoes are delicious, and a staple of the dinner table. As well as being a staple, potatoes are also a source of many nutrients. With its thick, starchy flesh, the potato is one of the most versatile vegetables we eat. It can be used in a wide variety of ways, from a simple boiled potato to a gourmet potato dish. The potato is also a source of many nutrients, including potassium, vitamin C, and fiber.

Despite its humble appeal, it is surprising that many home gardeners do not grow potatoes. There are three main reasons for this. First, many gardeners do not have enough space to grow potatoes. Second, many gardeners do not have the time or knowledge to grow potatoes. Third, many gardeners do not have the right soil for growing potatoes. However, with a little planning and effort, anyone can grow potatoes successfully.

Do you know your potato? Find out the Family Facts of the Spud!

Types:

- **Maine Potatoes** for their quality as "Bakers"
- **White Potatoes** - This is the most common and most popular potato. It is used for everything from mashed potatoes to french fries.
- **Red Potatoes** - A less common variety, but with great taste.
- **Gold Potatoes** - Don't forget these. They are one of the best tasting potatoes, which are popular in the north and west.

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Potatoes



Ah!! The versatile and Lovable Potato. Spuds or tubers as they are affectionately nicknamed, are a regular at the dinner table as well as breakfast. Plain by itself, it does not have a strong, overpowering flavor; the numerous ways we cook and serve it and the wide variety of spices herbs and sauces added to or put on it, makes for a tremendous number of delicious tastes.

Despite its mealtime appeal, it is surprising that more home gardeners do not grow potatoes. Two or three hills do not take up an overly large amount of space. And, it does not require a lot of maintenance. While you can plant seed potatoes, the home gardener can use any potato that has been lying around the kitchen long enough to develop "eyes".

Do you know your roots? Find out the Family Roots of the Spud

Types:

- Idaho- Famous for their quality as "Bakers"
- White Potatoes- This is the basic and most popular potato. It is used for everything from mashed to french fries.
- Red Potatoes- A less common variety, but with great taste!
- Salt Potatoes- Don't forget these. They are small white potatoes which are popular at fall cookouts and clambakes.

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Did you know? Potatoes were not part of the first Thanksgiving. Irish
<http://www.gardenersnet.com/vegetable/potato.htm>
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Holiday Insights

Greeting Cards

* Time to Shop *

Gardening:

Annual Seeds
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Herb Seeds
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Supplies
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Statues/Elves
Back Yard/Deck

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Seasonal:

House Flags
Candles
Decorations
Kitchenware
Lights
Clocks
Thermometers

Bird Stuff:

Bird Feeders
Bird House
Seeds 'N Suet
Squirrel Stuff
Martin House

immigrants had not yet brought them to North America.

More Potato trivia: Potato chips were first made by Chef George Cru Saratoga Springs, NY on August 24, 1853.

Growing:

Potatoes grow best in soft "muck" soil. Wherever mucklands can be found you will find onion or potato farming. Potatoes will grow in many other soils, but potato root development is enhanced by adding lots of compost and loose material into the soil. When preparing your soil add compost, straw and other amendments down three to six inches into your soil.

"Seed" is a potato that has developed an "eye". Seed stock can be obtained in garden stores or seed catalogs, or in your kitchen cupboard. If there are any in your kitchen, ask around to friends and family.

Potatoes can be planted as early as two weeks before the last frost in your area. They are susceptible to frost, but take a couple weeks to root and emerge from the soil.

The most common form of planting is in "hills". Prepare and loosen the soil where you will make the hill. Place two or three potato eyes on the ground. Cover or "hill" three to four inches of soil on top of the seed. Water thoroughly. Space center of hills a foot apart.

A second and less common method is to use furrows. Dig a trench six to eight inches deep. Fill 1/2 the depth of the trench with a mixture of compost, mulch, straw and garden soil. Sow the eyes in the trench every four to six inches. Cover three to four inches with loose garden soil and mulch.

Fertilize every two to four weeks. Fertilizers high in nitrogen will result in leafy, green plant at the expense of root development. A good fertilizer sweet potatoes and yams contain low levels of N and high levels of phosphorus. 6-24-24, or 8-24-24, are good fertilizers for sweet potatoes.

As the plants grow, mound additional soil around the plants every week. Do not let the tubers or potatoes be exposed to sunlight. You can cover the soil around the plants with compost, mulch or even black plastic.

Harvest:

Several weeks after the plant has developed, very carefully, dig down a foot to see if the potatoes have developed large enough tubers to harvest. Be careful not to sever the main root from the plant to the new potato. Replace soil or mulch around the plant. Once they have become large enough for consumption, you can harvest as much as you need for your individual meals. After the plants have died off, dig out and around entire plant. Be careful to dig out far enough that you do not slice into

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potatoes while harvesting.

You need not hasten to dig out your potatoes after the plant has died. It will remain perfectly safe and healthy for a couple of weeks. Insects and pests however, will continue to be a problem, so despite their remaining fresh, you will have no respite from insects, moles or mice munching up the harvest.

He worries & loses to unhelpful,
Days to Maturity: Early varieties 70 to 90 days, mid season varieties 120 days, late varieties 120 to 140 days. *Plant in July late winter*

Important Note: Potatoes that have been exposed to sunlight will develop a green skin which contains toxins that will make you sick. Discard any potatoes that are green.

Insects: Potatoes are susceptible to a number of pest. Among the most common are potato maggots.

Disease: Potato suffer from some of the same blight and mildew problem as tomatoes. Fungicides will help with fungus diseases. If the plant becomes too bushy, air circulation will be impaired and increase the chances of disease. Do not hesitate to thin a bushy plant to increase air circulation.

Hardiness: Potatoes are quite susceptible to frost. While you can plant them in the ground prior to the last frost, make sure your timing is such they do not sprout prior to the last frost date. Late season varieties are susceptible to fall frost, even a mild one. While the plant will die back, potato underneath the soil is safe from harm of frost or even freezes.

Other Resources:

- The National Potato Council A non-profit potato organization
- The Irish Potato Famine Learn about this famous event in History

Potato "Lite":

- Spuds Trivia

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importance of crop rotation & cover crops. Very interesting

SUSTAINABLE POTATO PRODUCTION

Scientists and farmers agree that it is economically feasible to grow potatoes successfully in a healthy way that improves the land's long-term productivity. The U.S. Department of Agriculture's Sustainable Agriculture Research and Education Program conducted an analysis of four pairs of **organic** and conventional potato farms in Washington. The results showed that variable costs on the **organic** farms averaged 12 percent less than on the conventional ones, with essentially the same yields. Since **organic** growers have relatively low input costs, they can survive a bad growing season with lower investment risks than conventional farmers. There are many options available for farmers who grow potatoes sustainably.

The most important step in growing potatoes organically is to carefully plan a crop rotation scheme that allows a few years between potato crops on the same land. A good rotation includes crops that are not hosts to common potato pests, as well as green manures that add nutrients and **organic** matter to the soil. Green manures are crops that are grown over the winter or for an entire year, and are then incorporated into the soil. Some crops can be harvested for seed or hay and the plant residues that remain are used as a green manure. When an effective cropping sequence is in place, pesticides and chemical fertilizers are not necessary.

wheat, clover, the wrong bird for potatoes

Wheat, corn, and barley, which are commonly grown in rotations with potatoes, are hosts for the Columbia root-knot nematode *Meloidogyne chitwoodi*, a serious potato pest that blemishes tubers and renders them unmarketable. Nematodes are primarily controlled by fumigating soil with 1,3-dichloropropene (1,3-D) or metam sodium. Because these fumigants impact nontarget organisms, they disrupt many beneficial soil ecological processes, such as nutrient cycling and biological control. Root-knot nematodes can be suppressed by growing crops in rotation with potatoes which are not hosts for nematodes. Plant pathologists at Oregon and Washington State Universities list asparagus, cowpea, http://www.eap.mcgill.ca/MagRack/JPR/JPR_25.htm

1/14/04

fodder radish, lima bean, Scotch spearmint, sudangrass, popcorn, super sweet corn as nonhost crops
3,4 In any crop rotation, proper weed control is important since many weeds are suitable pest hosts.

There are some green manures that result in remarkably good nematode control when they are incorporated into the soil. Rapeseed, sudangrass, white mustard, and rye not only control nematodes, but they have also been shown to suppress weeds and diseases such as the soilborne fungus *Verticillium dahliae*, which causes potato early dying. 5,6,7 These plants are allelopathic. That is, they release a compounds into the soil which are toxic to certain other plants and animals. Most researchers have found that rapeseed is the most consistent at controlling nematodes and weeds and increasing potato yields.3» Rapeseed contains glucosinolates, which break down to isothiocyanates, compounds that are toxic to these soil organisms.

All green manures have benefits to the soil that extend beyond the chemicals they may release. Cover crops can reduce erosion from rain or wind, especially in the winter or early spring. When green manures are incorporated into the soil, they build up the **organic** matter content, which improves water retention, reduces compaction, and makes the soil a healthy habitat for beneficial organisms. Pests have to compete with the beneficial organisms in the soil, so their populations are unlikely to rise to damaging levels.

Legumes are important green manures for any **organic** farms. They have a symbiotic relationship with bacteria that can fix nitrogen into a form that plants can use. When legumes are incorporated into the soil prior to a potato crop, the nitrogen is made available to the potatoes. It is released more gradually than chemical fertilizers, so potatoes benefit throughout the growing season and the nitrogen does not leach into the groundwater. Austrian peas and Nitro alfalfa are used most commonly by **organic** potato farmers. Researchers found that Nitro alfalfa or Austrian peas provided 40 to 100 percent of the nitrogen needed by a subsequent potato crop, depending on how wet the intervening winter and spring were.¹ The nutrients provided by legume green manures can be supplemented by animal manures or kelp. To accomplish this, some farmers raise cattle or chickens and use the manure they produce.

When crop rotation~s and green manures are used and pesticides are eliminated, the resulting farm encourages beneficial organisms and becomes more diverse, much like a natural ecosystem. Consequently, **organic** farmers do not usually have large enough problems with pests or diseases to cause crop damage. One example of a rotation scheme comes from Steve Walser, who runs a 320-acre farm in Eastern Washington. He uses a 3-year rotation, following potatoes with squash or sweet corn. The year before potatoes is devoted to green manures, beginning with sudangrass, followed by Austrian peas over the winter. He also uses compost and animal manure.⁹ This is a shorter rotation than many farmers use, but it works for Steve. The right rotation scheme will be different for every farmer, depending on local conditions and markets. **Organic** farmers do have to keep up with the weeds that grow in their healthy soils, and they do so using mechanical methods rather than herbicides. Mechanical weeding is most important when the young potato plants are emerging, since as they get bigger they become strong enough to compete with weeds. Some hand weeding among the large plants may be necessary. When the potatoes are mature, conventional farmers use dessicants to kill the potato plants and cause the tuber skins to toughen. **Organic** farmers simply let the plants die on their own with the help of the first frost, or they use a flailing machine to rip up the plants. By using mechanical methods and a little hard work, dessicants can be replaced.

Teresa Huntsinger

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Getting Started

Many bees are truly wondrous creatures, and keeping them can be a thoroughly rewarding and enjoyable hobby. Getting started though is not always easy. The path may be simple and straightforward, or it may be strewn with difficulties. To ease your way and to make your introduction to the world of our honey bee as enjoyable as possible, consider doing the following. First an experienced, successful beekeeper who is willing to help you, look over his or her shoulder when ever possible, and ask lots of questions. Remember, however, that years of experience do not guarantee a beekeeper's competence or success. It may actually be one year of experience many times over. Select your mentor with care. There are a number of good books available about beekeeping. Read two or three of the more recent ones. Acquire one or two of the better ones for your own library. Read them and reread them. In selecting your books, realize that beekeeping is probably the same worldwide. There are some national and regional differences, however, in both equipment and methodology. Beginners will do well to stay with books written for their own area. For example, for instance, might not be as relevant by a book written in California or England. Start with new equipment or standard designs and variations. Used equipment or homemade equipment both have the potential to bring problems that the novice may not be prepared to recognize or handle. Do not experiment in the first year. Learn and use each method. Then you'll have a basis for comparison if you return or experiment in future years. Do not buy a so-called beekeeper's kit. You know the one for each piece of equipment. You may find that you are better off with a suggested list of equipment, which may be more expensive. They are the standard, the ones you can find in any country. Those acquired from other beekeepers, or those of other race or strain available.

getting started in beekeeping

Cooperative Extension University of Massachusetts

Getting Started

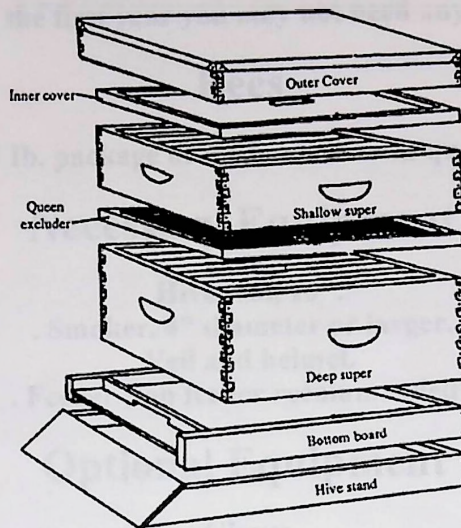
Honey bees are truly wondrous creatures, and keeping them can be a thoroughly rewarding and enjoyable hobby. Getting started though is not always easy. The path may be simple and straightforward, or it may be strewn with difficulties. To ease your way and to make your introduction to the world of the honey bee as enjoyable as possible, consider doing the following: . Find an experienced, successful beekeeper who is willing to help you. Look over his or her shoulder whenever possible, and ask lots of questions. Recognize, however, that years of experience do not guarantee a beekeeper's competence or success. It may actually be one year of experience many times over. Select your mentor with care. . There are a number of good books available about beekeeping. Read two or three of the more recent ones. Acquire one or two of the better ones for your own library. Read them and reread them. In selecting your books, realize that beekeeping is generally the same worldwide. There are some national and regional differences, however, in both equipment and methodology.

Beginners will do well to stay with books written for their own area. A New Englander, for instance, might not be best served by a book written in California or England. . Start with new equipment of standard design and dimensions. Used equipment or homemade equipment both have the potential to bring problems that the novice may not be equipped to recognize or handle. . Do not experiment the first year. Learn and use basic methods. Then you'll have a basis for comparison if you choose to experiment in future years. . Do not buy a so-called beginner's outfit until you know the use for each piece of equipment and are sure that you want it. You may find that you are better off making your own selection. A suggested list of equipment follows this section. . Start with Italian bees. They are the standard, the most common, and readily available in this country. Those acquired from a competent breeder are as gentle as any other race or strain available. In future years you can experiment, and

again, have a basis for comparison. .Start with a package of bees rather than with a nucleus hive (a-nuc) or an established hive. Once past the initial awe and apprehension, the novice can easily handle and install a package. By its nature a properly bred package is non-aggressive. It is a unit that a beginner can handle and relate to immediately. You will grow in confidence and competence as the colony grows in size. .Start early enough in the season, but not too early. Late April through early May is appropriate for most of New England, and packages are readily available during this period. .Recognize that you may not get a surplus of honey the first year, especially from package bees. The first year is a learning time for the beekeeper and a building time for the bees. .Join your local beekeepers' association. These groups welcome and encourage beginners. You will find kindred souls there. Beekeeping is much more difficult to learn in isolation, and beekeeper associations are a prime source of information about books and other publications, classes and workshops, and beekeeping events in the area. Many associations hold annual bee schools for beginners. You can usually get information on your local association from the county extension office. .Subscribe to a beekeeping magazine. They are full of valuable information for beginners.

Basic Equipment

A look through any beekeeping catalog will show an array of equipment and supplies that can be over-whelming to a potential beekeeper. However, the amount of equipment that is actually required during the first year is relatively small. Experience will guide you in subsequent years. In New England most beekeepers use two full-depth hive bodies as their basic unit, with supers (superstructure) added and removed as appropriate during the active season. The following list includes everything needed to maintain one colony for the entire first season.



Elements of a beehive

Complete Two-story Hive

- . Bottom board with entrance reducer.
 - . Hive bodies (2), full depth, $9\frac{1}{2}$ "
- . Frames (20), full depth, $9\frac{1}{8}$ ", with wedge top bar and two piece or split bottom bar.
 - . Foundation (20), full depth, 8«, wire reinforced.
- . Support pins (4 per frame) or frame wire and eyelets.
 - . Inner cover, ventilated.
 - . Outer cover, telescoping.

Honey Supers

- . Super, shallow, $5\frac{1}{16}$ " or mid-depth, $6\frac{1}{8}$ ".
 - . Frames, (10), shallow, $5\frac{3}{8}$ " or mid-depth, $6\frac{1}{4}$ ".
 - . Foundation, wired, shallow, $4\frac{3}{4}$ " or mid-depth, $5\frac{5}{8}$ ".
 - . Support pins (4 per frame), or frame wire and eyelets.
- In the long run you will want at least two or three supers per colony. In**

the first year you may not need any.

Bees

. 3 lb. package of Italian bees with queen.

Necessary Equipment

- . Hive tool, 10".
- . Smoker, 4" diameter or larger.
- . Veil and helmet.
- . Feeder (top feeder recommended).

Optional Equipment

- . Gloves.
- . Coveralls.
- . Queen excluder.

Richard E. Bonney (retired)
Department of Entomology
Fernald Hall
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Current contact person:
State Bee Inspector Al Carl,
(617-727-3020 X123)

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Hugo Veerkamp

GOOD APITHERAPY PRACTICE

Making An Informed Decision

Bee venom therapy is an alternative form of healing. It has been practiced for centuries for many different conditions using a variety of means. The available resources for the patient and therapist will determine the actual way the therapy will be carried out. What is needed are some basic guidelines to help determine whether bee venom therapy is an appropriate alternative for you.

The purpose of this publication is to provide assistance to those would like to explore the benefits of including bee venom therapy as part of their healing process. This publication is a primary and it is my intent to expand it at a later date. Time and work commitments prevent it now.

I receive countless comments from those who struggle to find the necessary resources and information on how to plan and continue their therapy. This is especially so for those with multiple sclerosis and arthritis, but the steps of planning are as applicable for most health conditions.

The successful use of bee venom and the outcome of treatment is proportional to the knowledge of the administrator of the venom and the efforts you invest in your own healing. Experience shows, people who prepare for the therapy and make an informed decision on using bee venom therapy obtain better results and continue the therapy much longer as compared to those who don't. Being prepared means knowing the difference between the positive and negative symptoms of bee venom and how to change your program accordingly. The condition of the person during treatment will change and this may mean changing the application method. The ability to "read the negative symptoms" signals the therapist on the next course of action or inaction.

The most traditional way of administering bee venom is to use live bees. Another way is to use products containing bee venom. Before you make your final decision on what form of bee venom therapy you wish to begin you need to take some steps to become familiar with the basics of the therapy. Only then can you make an informed decision.

The following steps will help you know what questions to ask and what basic rules to follow in your research. Investigate each step carefully and make notes of your results. Summarize the gathered data and then make your decision. If you decide to give bee venom therapy a try, be prepared and follow all steps of the therapy guidelines. Therapy guidelines are not found in this publication. You will have to read books on bee venom therapy to get these. Be a good guardian of your health on your journey of healing.

Let's begin:

- **Consult** with your medical practitioner and discuss in detail all treatment options both conventional and complimentary;
- **Research** and undertake all available conventional therapies that are indicated for your condition, are consistent with your beliefs and whose risks make the therapy worthwhile;
 - Do you want to follow a non-drug approach?
 - Are you prepared to live with the after effects: permanent? short term?
 - Can you afford the therapy?

- Are there practitioners with the area who practice the therapy?
- Are drugs/supplements readily available?
- Are you prepared to make temporary/permanent life-style changes for this therapy?

• **Decide** whether to undertake bee venom therapy. If at this point you decide not to, you need not read any further since your research has already indicated, for whatever reason, it is not suitable for you at this time. Don't throw this out as you may revisit it at anytime in the future. Your circumstances, finances and emotional situation may change to where bee venom therapy will be a viable alternative. Congratulate yourself regardless, as at this point you have made an informed decision on your health;

• **Inform** your medical practitioner about your plan and ask his/her support. If support is adamantly refused seek out a practitioner who will, even if not endorse it wholeheartedly, agree to monitor your progress and will at least be supportive of the choice you have made;

• **Seek** your family's and friends' support as there may be times when their physical help and definitely their moral and emotional support will be needed. If this is not forthcoming seek out self-help groups for similar conditions or who you know will be non-judgmental and supportive;

• **Gather** information on bee venom therapy. This will include a visit to the local library and an Internet search, including Medline and the Apitherapy Research Service to uncover all obvious information. Contact your local beekeeper group to get names of those who have bees and those who likely are doing therapy themselves or supplying bees. There may be apitherapists or acupuncturists who do the therapy or are willing to. There are many books now available on bee venom therapy. See recommended books at the end of this booklet. You can never read too much on the matter;

• **Choose** which form of therapy is most suitable considering your condition and circumstances i.e. live bees, bee venom preparations, apitherapies and apiceuticals;

• **Revisit** your medical practitioner to discuss your research and a treatment plan. If allergy testing is required it can now be arranged. Discuss integrating this method with other conventional therapies that are not contraindicated with bee venom therapy. Will you be able to discontinue taking contraindicated medications? Are there risks to your health condition;

• **Prepare** to begin bee venom therapy about two to three months before you actually start. You must be free of medications, primarily steroids and NSAIDs, for at least two to three months before you administer bee venom in the forms of bee stings or solution. A drug free period of five to six months is preferable. Cleansing and detoxification protocols may be helpful. Taking bee hive products like honey, bee pollen, propolis and royal jelly can also contribute to your healing. Herbal and mineral supplements can strengthen your immune system and make you stronger to start the therapy. Pay attention to those contraindicated with your health condition;

• **If you chose** bee sting therapy, locate a source of bees in your area. Discuss with the beekeeper price, availability, the beekeepers treatment timing and protocol (of the bees that is) and how you can keep the bees alive and healthy the longest. Consider purchasing your own beehive; not only will you have your own supply of bees, but also honey, propolis, pollen and more unintentional stings than you expected! If there is no beekeeper in your area check the provincial or state apiarist for beekeepers who may ship. There is also a full listing of suppliers in the booklet "**Bee Venom Therapy and Multiple Sclerosis - A Bibliography, Research and Resource Guide**;"

- **If you choose** to use bee venom products; locate suppliers and inquire about the availability of the needed products. Especially ask the supplier about the support that comes with the product. That is, will they give advice on how to use it, how often, when, contraindications, and other circumstances to maximize the positive effects. Keep in mind, the product may be purchased more cheaply elsewhere, but if no support comes with it it may be more expensive or less effective in the long run. At Apitronic Services all of our products come with the above described support only if purchased through us. Your options on products containing bee venom include ambrocations, creams, drops, honey and bee venom blends, solutions, liniments, liquids, ointments, tablets and homeopathic formulations;

- **Obtain** an Anakit® or Epipen® from a pharmacy and keep liquid Benadryl® handy in case of allergic reaction to any bee venom (stings or products). Read the user instructions immediately after purchasing it, review it again weekly. Practice holding it and go through a mock-up of how you would use it. When an emergency occurs you may not have the time or presence of mind to start reading the instructions. We have all heard of persons losing consciousness sometimes within less than a minute. Personally, when I was stung on one occasion, I had less than 30 seconds before my breathing became so labored I was light-headed. A helpful booklet "First Aid for Bee and Wasp Stings" is listed at the end of this publication;

- **Gather** the products you will need for your therapy and familiarize yourself with their use. If difficulties or questions arise, consult the supplier for help;

- **Book** an appointment with your medical practitioner to have a check up just prior to you starting the therapy. This will ensure you are physically and psychologically able to start and will also act as a benchmark for you and your practitioner to measure your progress;

- **Start** the therapy under the supervision of your medical practitioner or apitherapist;

- **Follow** your medical practitioner's or apitherapist's treatment protocol exactly and do not make changes without prior consultation;

- **Be patient** and expect a personalized, slow, gradual, progressive and tolerable treatment plan. The need for a minimum amount of bee venom comes with selecting proper administration areas to maximize the benefits of bee venom (appropriate acupuncture, acupressure and trigger points);

- **Be careful** with bee venom! Do not over administer and always follow the guidelines of BVT and the proper nutritional protocols;

- **Document** observations and notes on the course of treatment in a diary. Never stop reading and rereading the literature you have. Keep searching for new things you may not have heard about before;

- **Evaluate** your treatment protocol with your medical practitioner or apitherapist including the quality of bees, therapy materials and their use, administration area, nutritional protocol and how you actually follow the basic guidelines of therapy. Always feel free to discuss the difficulties you may be having as modifications may be possible which will make success more readily apparent and more likely to occur. Ask feedback from those who supplied the product and therapy materials. Do not ask someone who may use different methods and materials; the answer can be confusing as different methods apply to different protocols. This is especially true when using summer vs. winter bees, bee stings vs. venom solution,

bees just removed from the hive vs. bees kept in a box or jar for weeks or strong reversed tweezers vs. adjustable tweezers;

- **Ensure** you always have a continuous supply of bees and/or enough bee venom product for the therapy. Unexpected circumstances may prevent your source's access to products;
- **Share** your personal experience with others using bee venom and for those you believe may too be helped by it. Be prepared for skepticism but feel confident that your success will be your greatest ally;

After reading all of these steps, you may ask "what next?" When asked what publications I would suggest to learn more about bee venom therapy, especially for multiple sclerosis sufferers, my choices would be these two publications.

Mihály Simics: **Bee Venom Therapy and Multiple Sclerosis - A Bibliography, Research and Resource Guide:** This publication lists 235 references and resources for books, literature, tools, therapy materials and videos.

Charles Mraz: **Health and the Honeybee:** This book will introduce you to the basics and techniques of bee venom therapy including points where to sting.

I also recommend you study our **Bee Venom Therapy Supplies and Books** catalogue. It offers over 110 items for those who wish to practice bee venom therapy. This wide selection of products will provide several options for professionals and lay therapists alike. I will be happy to assist and guide you in choosing the most suitable ones whether you are a novice or a professional. Our advice covers the following as well as any unique or personal inquiry which we will try to resolve.

- Books, booklets and/or literature to read to help you with your therapy options;
- Where to locate information on a specific health condition;
- Tools, kits or individualized items needed to start the therapy;
- Products and their suppliers;
- Supportive documentation and instructions for all therapy materials and products that we sell;
- Referral service of professionals and lay therapists in your general area;
- Apitherapy Research Service and Book Search;

Just by reading this small booklet you have taken a step toward making a choice that will impact on your health. Informed decisions are the keystone to the success of any therapy. The best information is that which we seek out ourselves. By educating ourselves we become stronger and more able to endure the very difficult trials life often puts in our path. I wish you well in your search. If there is some way that I or my company can assist you along the way please feel free to get in touch with us by whatever means you are able.

RECOMMENDED READINGS

The following books were written by physicians and considered to be classics of bee venom therapy. They will provide you a solid foundation of understanding of bee venom therapy.

Beck, F. Bodog, MD (1935) Bee Venom Therapy - Bee Venom, Its Nature, and Its effect on Arthritic and Rheumatoid Conditions. Hardcover reprint in 1984. It is also know and published as: The Bible of Bee Venom Therapy, soft cover (1997), 238 pp.

Broadman, Joseph., MD (1962) Bee Venom - The Natural Curative for Arthritis and Rheumatism. 224 pp., Soft cover reprint: Bee Venom Therapy (1997), 220 pp.

Kim, Christopher, MD (1992) Bee Venom Therapy and Bee Acupuncture Therapy (Medical textbook for physicians and acupuncturists), 550 pp. (in Korean and English)

Potschinkova, Pavlina, MD (1996) Handbuch der Apireflextherapie. 396 pp. (in German)

First Aid for Insect Stings

Simics, Mihály (1995) First Aid for Bee and Wasp Stings. Apitronic Publishing, 32 pp.

Internet Resources

Bee Venom Therapy Supplies and Books — <http://www.beevenom.com>

Apitherapy Reference Database — <http://www.saunalahti.fi/~apither>

American Apitherapy Society, Inc. — <http://www.apitherapy.org/aas>

German Apitherapy Society — <http://www.apitherapie.de>

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e-mail: msimics@direct.ca | <http://www.beevenom.com> | <http://www.beevenom.net> | <http://www.apitherapy.net> |

<http://www.corp.direct.ca/beevenom/>

**Bee
Online**Online Publication of the
American Apitherapy
Society.

Please read our disclaimer

**Bee Venom Treatment of Rheumatic Disorders***Dr. Frantisek Kuthan**Summary of paper presented concerning apitherapy at the International Apicultural Congress of Apimondia in Bucharest, Romania. Original article in German.*

In osteoarthritis of the knee in the stage of major or minor irritation, we observed after Virapin injections a rapid effect on the rest and starting pain and minor improvement of concomitant hyarthrosis. About half the patients showed grade I and II improvement and in one fifth not even a temporary effect was observed. When comparing HCA with Virapin, the effects of Virapin were somewhat worse than those of HCA, but when achieved, they were rather more durable. Patients not responding to HCA showed a favorable response to Virapin in about half the cases and vice versa. The combination of HCA and Virapin proved to be most effective and in only one out of 25 cases the effect of HCA alone was stronger than that of the combination. Similar results were observed in osteoarthritis of the minor joints (Table 2). Thus, we succeeded in bettering with the aid of Virapin a good half of all these patients and in substituting for Virapin occasional injections of HCA in a considerable number of cases. Somewhat exceptional were 10 serious cases of osteoarthritis of the hips. Here, only in three of them did treatment with Virapin bring temporary alleviation in spite of the intraarticular application of Virapin and counter-irritative injections within the typical painful zones.

Moreover, we applied Virapin in treating periarthritis of the shoulder in 40 cases (Table 3). First and second grade improvement was observed in 22 of 40 patients. Those were mostly inveterate cases in the stage of chronic frozen shoulder, treated before by physical methods, X-ray irradiation or otherwise. When compared with HCA, Virapin seemed to be somewhat more effective, none the less, the combination of Virapin plus HCA proved to be markedly better than HCA alone. In recent cases, an almost regular success rate has been achieved after a few injections.

Similarly good results were obtained in discopathic sciatica cervicobrachial neuralgia and other vertebral disorders (Table 4). In these diseases rapid improvement in 16 of 25 cases occurred (after intradermal injections of Virapin within the painful zones over the spinous processes and paravertebral muscles), which may be considered a very good result, considering that all patients had been treated before by various methods and that the treatment of these disturbances themselves is very time-consuming and difficult.

Updated
May 2000

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Most successful however, was the bee venom treatment in paraarticular and extraarticular rheumatisms such as fibromyositis, myogeloses, enthesitis, tendinitis and tendosynovitis (Table 5). A single dose of Virapin was divided into a maximum number of intradermal papillae over the typical painful areas, over the trigger points and painful muscular nodules. In 35 of 50 cases the troubles disappeared completely, in six cases permanent, and in a further six, temporary improvements could be observed. The cure was unsuccessful in only three patients. Thus, about 70 per cent of the patients treated got rid of their troubles within a few days, exceptionally within a few weeks. Virapin proved to be far more efficient than procaine, histamine, distilled water or ionization with various drugs. The reason is to be seen in the rapid diffusion and in the protracted skin reaction due to the Virapin induced papilla, making the counter-irritant effect far more prolonged than that of other medicaments applied intradermally. From many other painful syndromes, I emphasize the potent analgetic and vasodilatatory effect of bee venom in headaches of spinal origin.

Why become a member of the AAS ?

Maintenance by Stefan Stangaciu, MD, LAcup.

Please send all your e-mail comments to:

AAS_webmaster@apitherapy.org,
or write the society.



The Life of the Bee

BY

MAURICE MAETERLINCK

Translated by

ALFRED SUTRO



NEW YORK

DODD, MEAD AND COMPANY

1919

The Life of the Bee

seek other skies when the day for migration returns. Nor is it a kind of mechanical habit of the race, or blind craving for life, that will fling the bees upon any wild hazard the moment an unforeseen event shall derange the accustomed order of phenomena. On the contrary, be the event never so masterful, the "spirit of the hive" still will follow it, step by step, like an alert and quick-witted slave, who is able to derive advantage even from his master's most dangerous orders.

MBF

It disposes pitilessly of the wealth and the happiness, the liberty and life, of all this winged people; and yet with discretion, as though governed itself by some great duty. It regulates day by day the number of births, and contrives that these shall strictly accord with the number of flowers that brighten the country-side. It decrees the queen's deposition or warn

MBF = Miscellaneous Bee File
(to be used for later years)

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The Swarm

disease, or war. No, the exile has long been planned, and the favourable hour patiently awaited. Were the hive poor, had it suffered from pillage or storm, had misfortune befallen the royal family, the bees would not forsake it. They leave it only when it has attained the apogee of its prosperity; at a time when, after the arduous labours of the spring, the immense palace of wax has its 120,000 well-arranged cells overflowing with new honey, and with the many-coloured flour, known as "bees' bread," on which nymphs and larvæ are fed.

MBF

Never is the hive more beautiful than on the eve of its heroic renouncement, in its unrivalled hour of fullest abundance and joy; serene for all its apparent excitement and feverishness.

Let us endeavour to picture it to ourselves, not as it appears to the bees,—for we cannot tell in what magical, formidable

The Life of the Bee

fashion things may be reflected in the 6,000 or 7,000 facets of their lateral eyes and the triple cyclopean eye on their brow, — but as it would seem to us, were we of their stature. From the height of a dome more colossal than that of St. Peter's at Rome waxen walls descend to the ground, balanced in the void and the darkness; gigantic and manifold, vertical and parallel geometric constructions, to which, for relative precision, audacity, and vastness, no human structure is comparable. Each of these walls, whose substance still is immaculate and fragrant, of virginal, silvery freshness, contains thousands of cells, that are stored with provisions sufficient to feed the whole people for several weeks. Here, lodged in transparent cells, are the pollens, love-ferment of every flower of spring, making brilliant splashes of red and yellow, of black and mauve. Close by, in twenty thousand reservoirs, sealed with a seal

The Swarm

[19]

Strange little republic, that, for all its logic and gravity, its matured conviction and prudence, still falls victim to so vast and precarious a dream! Who shall tell us, O little people that are so profoundly in earnest, that have fed on the warmth and the light and on nature's purest, the soul of the flowers, wherein matter for once seems to smile, and put forth its most wistful effort towards beauty and happiness, — who shall tell us what problems you have resolved, but we not yet, what certitudes you have acquired that we still have to conquer? And if you have truly resolved these problems, and acquired these certitudes, by the aid of some blind and primitive impulse and not through the intellect, then to what enigma, more insoluble still, are you not urging us on? Little city abounding

AGA
MBF

The Swarm

tragic and distant quest of love. This they will never do, however, if they be provided with a fragment of comb containing brood-cells, whence they shall be able to rear other queens. Indeed, their affection even may turn into fury and hatred should their sovereign fail in her duty to that sort of abstract divinity that we should call future society, which the bees would appear to regard far more seriously than we. It happens, for instance, at times, that apiarists for various reasons will prevent the queen from joining a swarm by inserting a trellis into the hive; the nimble and slender workers will flit through it, unperceiving, but to the poor slave of love, heavier and more corpulent than her daughters, it offers an impassable barrier. The bees, when they find that the queen has not followed, will return to the hive, and scold the unfortunate prisoner, hustle and ill-treat her,

109

AA*
MBF

* aB sovereign is ever safe

The Life of the Bee

patent to any one who may gather a swarm into a glass hive.

MBF | We have to admit, first of all, that we know not yet by what process of alchemy the honey transforms itself into wax in the enigmatic bodies of our suspended bees. We can only say that they will remain thus suspended for a period extending from eighteen to twenty-four hours, in a temperature so high that one might almost believe that a fire was burning in the hollow of the hive; and then white and transparent scales will appear at the opening of four little pockets that every bee has underneath its abdomen.

When the bodies of most of those who form the inverted cone have thus been adorned with ivory tablets, we shall see one of the bees, as though suddenly inspired, abruptly detach herself from the mass, and climb over the backs of the passive crowd till she reach the inner

The Life of the Bee

pinnacle of the cupola. To this she will fix herself solidly, dislodging, with repeated blows of her head, such of her neighbours as may seem to hamper her movements. Then, with her mouth and claws, she will seize one of the eight scales that hang from her abdomen, and at once proceed to clip it and plane it, extend it, knead it with her saliva, bend it and flatten it, roll it and straighten it, with the skill of a carpenter handling a pliable panel. When at last the substance, thus treated, appears to her to possess the required dimensions and consistency, she will attach it to the highest point of the dome, thus laying the first, or rather the keystone of the new town; for we have here an inverted city, hanging down from the sky, and not rising from the bosom of earth like a city of men.

To this keystone, depending in the

MBF
dedication

8
conversion
to
Speer
in 1941

14/

The Life of the Bee

space, or too little, between the combs. This they will remedy as best they can, either by giving an oblique twist to the comb that too nearly approaches the other, or by introducing an irregular comb into the gap. "The bees sometimes make mistakes," Réaumur remarks on this subject, "and herein we may find yet another fact which appears to prove that they reason."

[54]

MBF We know that the bees construct four
kinds of cells. First of all, the royal
cells, which are exceptional, and contrived
somewhat in the shape of an acorn; then
the large cells destined for the rearing
of males and storing of provisions when
flowers super-abound; and the small cells,
serving as workers' cradles and ordinary
store-rooms, which occupy normally about
four-fifths of the built-over surface of the

The Swarm

a future that goes further and further back ever since the world began. And, for the sake of this future, each one renounces more than half of her rights and her joys. The queen bids farewell to freedom, the light of day, and the calyx of flowers; the workers give five or six years of their life, and shall never know love, or the joys of maternity. The queen's brain turns to pulp, that the reproductive organs may profit; in the workers these organs atrophy, to the benefit of their intelligence. Nor would it be fair to allege that the will plays no part in all these renouncements. We have seen that each worker's larva can be transformed into a queen if lodged and fed on the royal plan; and similarly could each royal larva be turned into worker if her food were changed and her cell reduced. These mysterious elections take place every day in the golden

MBF

Wahrhaft
officers
1939

2 xerography
here

The Life of the Bee

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The Life of the Bee

means of ascertaining whether it be notwithstanding the efforts of the superior will, or independently of these, or lastly because of these, that a species has been able to survive.

* All we can say is that such a species exists, and that, on this point, therefore, nature would seem to be right. But who shall tell us how many others that we have not known have fallen victim to her restless and forgetful intellect? Beyond this, we can recognise only the surprising and occasionally hostile forms that the extraordinary fluid we call life assumes, in utter unconsciousness sometimes, at others with a kind of consciousness: the fluid which animates us equally with all the rest, which produces the very thoughts that judge it, and the feeble voice that attempts to tell its story.

* Mh on ¹⁹²D.T.
Iteration evolution. D.K.'s use
of the ill-formed
a vicious.

The Nuptial Flight

the entire truth lies captive within their two hands. For the first have made ample preparations to receive the truth, have provided most hospitable lodging within them; and even though their eyes may not see it, they are eagerly looking towards the beauty and grandeur where its residence surely must be.

We know nothing of nature's aim, which for us is the truth that dominates every other. But for the very love of this truth, and to preserve in our soul the ardour we need for its search, it behoves us to deem it great. And if we should find one day that we have been on a wrong road, that this aim is incoherent and petty, we shall have discovered its pettiness by means of the very zeal its presumed grandeur had created within us; and this pettiness once established, it will teach us what we have to do. In the meanwhile it cannot be unwise to devote to its

*

* Epigraph for the current novel.

The Life of the Bee

signate
search the most strenuous, daring efforts of our heart and our reason. And should the last word of all this be wretched, it will be no little achievement to have laid bare the inanity and the pettiness of the aim of nature.

[91]

"There is no truth for us yet," a great physiologist of our day remarked to me once, as I walked with him in the country; "there is no truth yet, but there are everywhere three very good semblances of truth. Each man makes his own choice, or rather, perhaps, has it thrust upon him; and this choice, whether it be thrust upon him, or whether, as is often the case, he have made it without due reflection, this choice, to which he clings, will determine the form and the conduct of all that enters within him. The friend whom we meet, the woman

The Life of the Bee

in their hereditary memory, must be inseparable from the calyx of flowers where their flight, for so many centuries past, has been sumptuously and voluptuously welcomed.

[98]

It is a little more than a hundred years ago that Huber's researches gave the first serious impetus to our study of the bees, and revealed the elementary important truths that allowed us to observe them with fruitful result. Barely fifty years have passed since the foundation of rational, practical apiculture was rendered possible by means of the movable combs and frames devised by Dzierzon and Langstroth, and the hive ceased to be the inviolable abode wherein all came to pass in a mystery from which death alone stripped the veil. And lastly, less than fifty years have elapsed since the improve-

The Life of the Bee

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* Mh on ¹⁹²D.T.
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The Life of the Bee

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To this keystone, depending in the

MBF
dedication

8
consecration
to
Speer
in 1941

141

Nearly 500
 Doubtless
 But

Handwritten signature 'Duc' in black ink, followed by a large, dark blue ink scribble or stamp. The entire mark is enclosed within a hand-drawn oval.

Residue of notes *

* How placed.

The Queen must die. BEE'S

1896

[illegible]

1895

25 E, 4 F

July ~~E 190A, 191A, 192A~~ E (190A, 191A, 190B) Late start 22
54C, 22C (also 622) 22C, 4-31, (22, 35)
83 Da, E 24, 27, 28, 16F (or 4 d in Feb '96) ~~38~~

August ~~p22~~ JJ-4, ~~p13, p21, p22, p7~~ ~~very~~
J21

Sept ~~p23~~ (Cassini purchased) ~~24, 26, 31~~, J-21, J-18, ~~p41, 42~~

Oct ~~p43~~ ~~p4~~ pheromone, ~~p3~~

Nov ~~4, 5~~ (also to 12) ~~6~~

Dec ~~5, 54, 55, 58~~, ~~16, 17~~, ~~p7, 8~~ (Bantian?)

1896

Jan Paulin born Jan 21, 1896

Feb cleaning flight D11, D12, D12', D12A, D12B, ✓
~~p8, p25~~ 22C D12C, D13, D13A, 13B, C, D, E ✓
? ~~31, 31A, B, C, D~~ E11, E10 ✓
H 5E, 92, 189, H 108 ? to F, 96F ✓

March ~~p43, p8~~ (Angela m. linal) Jidion Hunt

April

~~April~~ Play flight 95A E 25 H-93 H 203
May-172C ~~p26, 27~~ Breeding ~~p14, p10, p33~~ ~~clerk~~ JX14

June 20F ~~defect~~ p11, p35 honey p36, 37+ J-18
H 7A talk w Ade 1 85B, 87B, 15B

July (GFN?) ~~2a, 40~~ within feeding, p32?

August ~~E 14F, E 121-123, E (58)~~ H-20, H-148, ~~J-31A, C13?~~ ~~p34~~ ~~1, 2, 6, 188?~~

Sept. ~~cost~~ ~~p14~~, H-87, J-296, J3-3, ~~51~~ ~~honey + honey~~ ~~very~~ ~~very~~

Oct p52, J3-5

Nov J3-1, J3-2, 86F, 87F J3 ~~40-42~~

Dec 51A 51H7

(x deleted - not needed) x - photon

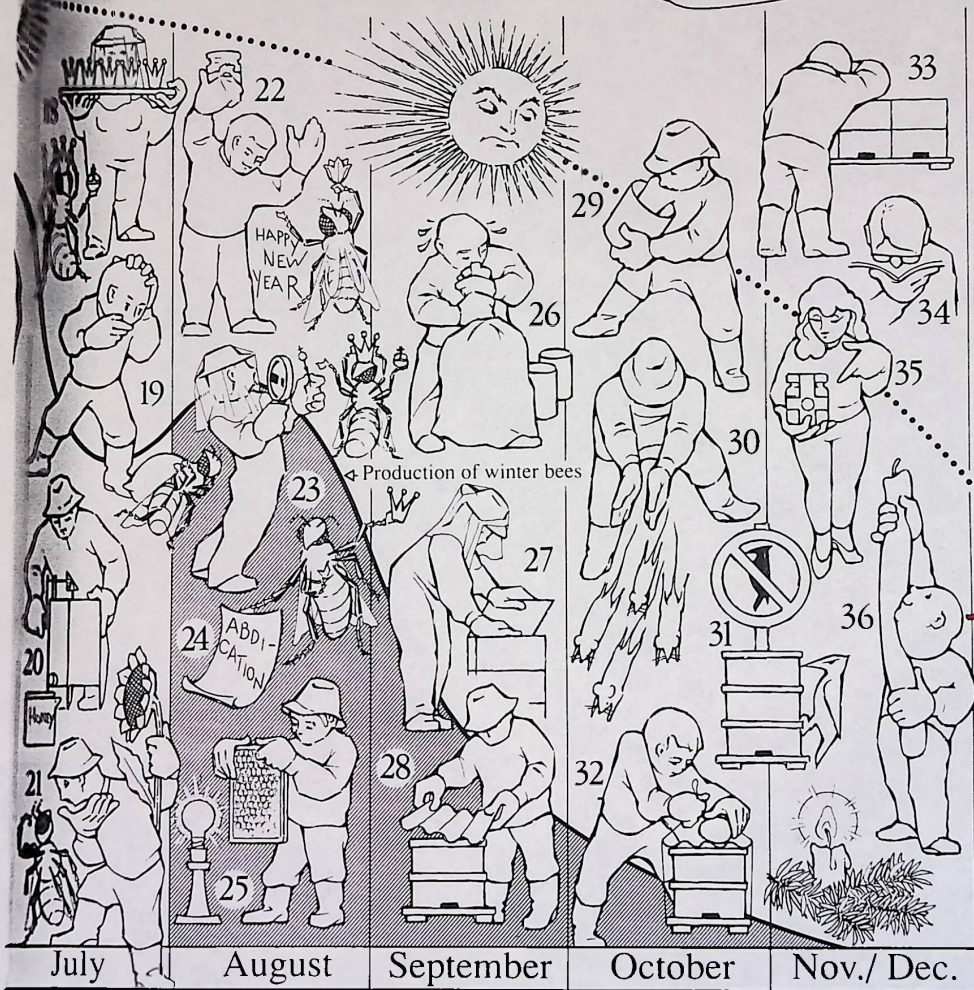
~~*~~ ~~x~~ ~~2~~ ~~4~~ ~~5~~ ~~6~~ ~~7~~ ~~8~~ ~~9~~ ~~10~~
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~~51~~ ~~52~~ ~~53~~ ~~54~~ ~~55~~ ~~56~~ ~~57~~ ~~58~~ ~~59~~ ~~60~~
 14 doubles

- A 95, 107, ✓
 B 85, 87, (15) - ? ✓?
 C 54, 22, (also Feb) 72, 177 ✓
 D 832⁸³⁰ 11, 12, 12', 12A, 12B, 12C, 13, 13A, B, C, D, E
 E 190A, 191A, 190B 24, 27, 28, 21, 70, 25
 F 16 (95 or 96) 70, 147, 122-123, (68) 86, 87,
 G 138 (or 188) GFN
 H 31, 59, 92, 189, 108, 93, 203, 20, 148, 87, 61
 J (21, 21), 18, XIII, 31A, 296, 51HA
 W 4, 3, 42, (40-42 ?)

The Bee Year at a Glance

18 Raise new queens. 19 Prevent robbing. 20 Extract honey. 21 Supply plenty of pollen sources. 22 Start of new bee year. 23 and 24 Exchange queens. 25 check combs. 26 Supply winter food. 27 Last examination of the hive. 28 Cover hive. 29 Clean feeders. 30 Take precautions against mice and 31 birds. 32 Batten down winter roofing. 33 Last check. 34 Read bee literature. 35 Find buyers for your honey. 36 Make candles.

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The Sensory Basis of the Honeybee's Dance Language

By by Wolfgang H. Kirchner and William F. Towne

Novel experiments, such as training bees to respond to sounds and recruiting them using a robot, have ended several debates surrounding the dance language.



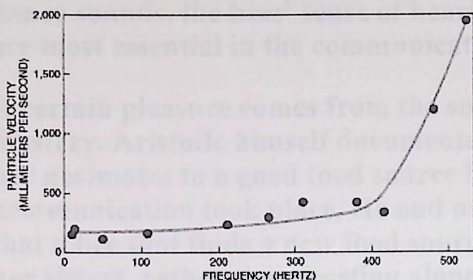
For many centuries, naturalists have observed that honeybees tell their nestmates about discoveries they make beyond the hive. Nevertheless, the system of communication that the insects use remained a mystery until the 1940s, when Karl von Frisch of the University of Munich in Germany first discovered the significance of bees' dances. In the hive the steps and waggles of a successful forager correlate closely with the exact distance and direction from the nest to the resource she has discovered. For the next two decades, most scientists believed bees relied primarily on these silent movements to communicate.

In the 1960s this view was challenged in two ways. The first challengers were Adrian M. Wenner, then a graduate student at the University of Michigan, now at the University of California at Santa Barbara, and Harald E. Esch of the University of Munich, now at Notre Dame University. Working independently, the two researchers discovered that the dances were not silent after all. As the bees dance, they emit faint low-frequency sounds, and Wenner and Esch both suggested that the sounds might play a critical role in the bees' communication. The use of sounds, they reasoned, might account for the bees' ability to communicate effectively in the complete darkness that prevails inside their nests. At the

time, however, many scientists believed bees were deaf, and so the issue remained open.

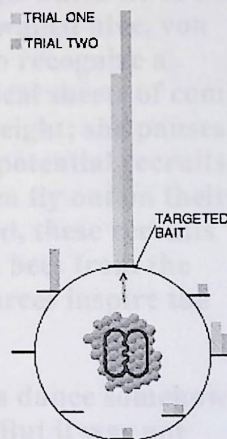


Sight and Sound in the Honeybees' Dance



FREQUENCY RANGE of the sounds a bee can detect extends well below the range heard by human ears. The graph shows how fast the air particles near a dancer's wings must travel to generate audible signals. Within this range, the bees show an ability to differentiate between sounds having varying frequencies.

THE DANCING ROBOT successfully recruited its nestmates to food away from the hive. The experimenters placed eight baits around the hive and programmed the robot to dance concerning one site. Observers in the field recorded the approach of searching bees. Most of the robot's recruits went to the bait indicated by its dance.



Wenner later raised the second challenge to von Frisch's description of the dance language, rethinking his first hypothesis at the same time. Bees, he argued, use none of the information in the dances or the sounds. Instead he proposed that the insects rely on odors to find the new resource advertised by the dancer.

Now both of these debates have been resolved. Bees, it turns out, can hear, and their ears are well suited for detecting the sounds associated with the dances. Observation of how the insects respond to a robot that

dances and sings like a live forager shows that both sound and dance are needed to communicate information about the location of food. Silent dances, the experiment demonstrates, communicate nothing, and sound without dance also fails. Odors too are involved but appear to lack the importance that Wenner ascribes to them. Beyond the resolution of these issues, we have also recently learned much more about the nature of the dance sounds, the bees' sense of hearing and the aspects of the dance that are most essential in the communication.

A certain pleasure comes from the solution of such a long-standing mystery. Aristotle himself documented the honeybee's ability to recruit her nestmates to a good food source but did not speculate on how the communication took place. He and other naturalists did, however, observe that a bee that finds a new food source returns to the nest and dances for her sisters, rather than feasting alone. Pliny reportedly constructed a hive that had a window made from transparent horn, through which he could monitor dancing bees. By studying bees kept in a glass-walled hive, von Frisch and his followers in the 20th century were able to recognize a pattern in the dance: The forager walks across the vertical sheets of comb hanging in the hive and traces out the shape of a figure eight; she pauses in each loop to shake her body from side to side. A few potential recruits chase after the dancer attentively for some time and then fly out on their own toward the target. Provided they like what they find, these recruits return to the nest and dance as well, sending even more bees from the hive to investigate the site. Eventually, the best food sources inspire the most dances and so attract the most bees.

In the 1920s von Frisch first proposed that the forager's dance somehow gave the other bees information about the food source. But it was not until 1943 that von Frisch discovered that the direction in which the dancer faced during her wagging run pointed toward the food site in relation to the sun: If she wagged while facing straight upward, toward the 12 on a clockface, then the food could be found in the direction of the sun; if she wagged 60 degrees to the left of 12, facing the 10 on a clockface, then the food lay 60 degrees to the left of the sun. In addition, he noticed that how fast the dancer completed her circuits corresponded to the distance between the hive and the feeding site: the closer the food, the more frenzied her pace. Von Frisch and his colleagues made detailed

accounts of the dance language. With a stopwatch close at hand, they could observe the dance, decipher its meaning and then locate the food supply of which it spoke. The accurate translations were a stunning accomplishment.

Nevertheless, several serious questions remained unanswered. First, investigators could not prove that the dance truly functioned as a language. Perhaps the correlation between the excited forager's movements and her finds in the field were merely coincidental and of no real significance to the bees themselves. Moreover, researchers had yet to figure out how the bees perceived and interpreted the dances. The scientists could clearly see the dancer through the glass wall and clock her movements, but the bees themselves, normally enclosed in dark nests, certainly did not have this benefit. What were the dances like from the bees' point of view?

Years after von Frisch interpreted the symbolism of the dances, Wenner and Esch independently found that dancing bees make sounds during their wagging run. Both men suggested that the sounds might help the dancer attract an audience in the dark nest. Many researchers doubted this premise because they thought bees could not hear airborne sounds. Still, the notion was not ignored altogether. Many insects, including bees, are quite sensitive to vibrations. Hence, some investigators speculated that the sounds the foragers produced could vibrate the combs under their feet as they danced. The comb vibrations might then advertise the dance to those bees who could not otherwise see the forager.

One of us (Kirchner), together with Axel Michelsen of Odense University in Denmark, answered part of this question several years ago. In their experiments, Michelsen and Kirchner aimed a laser beam at the comb near a dancing bee to determine whether or not the dance sounds generated vibrations in the comb. Surface vibrations, if any occurred, would cause minute changes in the light reflected from the comb. In this way, it was possible to measure the vibrations without touching the comb and possibly triggering additional tremors. These measurements revealed that dancing bees do not rattle the comb but that their audience does. The dance attenders sometimes emit a short squeak by pressing their thoraxes against the comb. This action vibrates the comb enough so that the dancing bee stops her movements. She then doles out small samples of the

food she has collected so that her audience knows not only the direction and distance to the feeding site but how the food smells and tastes as well.

Although this result was intriguing, we still did not know whether honeybees could hear the sounds a forager made during her wagging run. Because the sounds seemed likely to be involved in the dance communication, we have analyzed them thoroughly. Initially, we discovered that the forager made the dance sounds by beating her tiny wings and that the follower bees stood quite close to her when she did so. Therefore, our measurements of the sounds needed to be made in the same proximity.

In further collaboration with Michelsen, we gauged both the pressure changes and the air-particle movements near the dancer. Some insects' ears do not respond to sound pressures as human ears do but instead react to back-and-forth oscillations of nearby air molecules. In fact, it turned out that the pressure changes a dancing bee produces when she beats her wings are relatively small--which no doubt explains why the pressure-sensitive ears of scientists did not detect them for so long. But we found significant air movements within a few millimeters of the dancer's vibrating wings. We concluded that whereas the dance followers produce sounds by vibrating the comb, the forager transmits her own sound signals exclusively through the air. As a result, the noises from the forager's instructions and her followers' requests do not drown one another out.

Two research teams, using different experimental approaches, then tested the hypothesis that the forager transmits dance information acoustically. In the first line of inquiry, Kirchner and Kathrin Sommer, a graduate student at the University of Würzburg in Germany, changed the dance sounds simply by shortening the dancer's wings slightly. Clipped wings have a smaller vibrating surface and so produce sounds that have a higher pitch and a smaller amplitude. Sommer found that bees whose wings were experimentally shortened continued to forage and dance normally. The insects could not, however, recruit nestmates. Similarly, bees from a mutant strain, called "diminutive wings," that have congenitally small wings cannot recruit at all--even though they fly and dance normally. Sommer studied a colony of honeybees, half of whom were normal bees and half diminutive-wing bees. She found that the

normal dancing bees recruited both normal and short-winged bees equally well; in contrast, the mutant dancing bees recruited both strains poorly.

In the second series of experiments, Michelsen and Kirchner used a model bee that could perform the honeybee dances. Others had employed robotic bees in their research before, but none of the devices could make the correct sounds while it danced. Thus, a new attempt seemed worthwhile. Michelsen and his co-workers in Odense constructed the computer-controlled model bee, which danced in Würzburg for five summers.

Michelsen's team fashioned the model bee from brass and coated it with a thin layer of beeswax. The brass bee is slightly larger than a worker honeybee. Workers cut a razor blade to the appropriate size to make a set of wings. An operator can vibrate these metal wings on command by tweaking a stiff wire that connects them to an electromagnet. He or she can rotate the model in place by turning a thin rod attached to its back. A step motor at the far end of the rod steers the model's rotations automatically during its figure-eight dance. This same motor makes the model waggle from side to side. An x-y plotter, wired to a sliding metal sleeve placed around the rod, moves the model backward, forward, or left or right as needed. Finally, a thin plastic tube that ends near the model's head delivers food samples (sucrose solution) from a syringe. Yet another step motor regulates this mechanism. A desktop computer controls all the motors, which in turn direct the dance.

Each experimental session typically lasted for three hours. First Michelsen and Kirchner scented the model and its samples of sugar water with a faint floral fragrance, then placed baits in the field that gave off trace amounts of the same odor. At each of the baits, an observer recorded the approach of searching bees. The results showed repeatedly that the mechanical dancer could indeed recruit live bees. Most of the bees invariably went to the bait in the direction indicated by the model's dance steps.

A number of additional experiments using the model bee followed. These trials were designed to determine how important various aspects of the dances are to the dance followers. For example, in some experiments, the

model delivered food samples but did not dance. In this case, far fewer recruits ventured to the targeted bait. Also, the model failed completely to recruit live bees when its metal wings did not vibrate; these silent dances did not work, demonstrating that the sounds are truly an essential part of the honeybee's dance language.

The model bee's ability to recruit its nestmates showed that von Frisch was correct about the communicatory function of the dances. Earlier, however, despite what many researchers felt was compelling evidence supporting von Frisch's theory, some of our colleagues doubted that the bees used the distance and direction data encoded in the dances. Wenner and Patrick H. Wells of Occidental College and others have argued persistently that the coordinates given in the dance represent correlations only and are not signals. They believe recruits depend solely on odors to find feeding sites.

Von Frisch himself first attempted to test the significance of the dance movements. He found that recruits could no longer find the correct food source when he laid their hive horizontally on its side. The maneuver prevented the dancer from using gravity to orient the direction of her wagglng run. As a result, the dance attenders could not interpret her actions correctly.

James L. Gould of Princeton University later punctured the odor hypothesis. He showed that a forager can dispatch her nestmates to a site she has never visited. Such a feat would be impossible if the recruits relied on odors alone to track down a feeding site. The event could occur, however, if the searching bees gave priority to the information they received from the dance. In these experiments, Gould placed a bright light in the hive, which the dance followers mistook for the sun. In doing so, they interpreted the dances erroneously. These misdirected bees most often searched in the field using the misaligned dance information and seemed to ignore other cues such as odor. Gould concluded that they evidently preferred the message given in the dance to the other signals. Finally, the experiments using the model bee confirmed von Frisch's hypothesis; the dances do indeed represent a sophisticated form of communication.

The model bee has helped us answer other questions raised by von

Frisch's observations, such as determining which components of the dance language represent what kinds of instructions. For example, when the model danced so that her wagging run appeared on the outside of the figure-eight path, the recruits followed the direction indicated in the wagging run, rather than that given by the orientation of the figure eight as a whole. Thus, the wagging run alone, during which the sounds are produced, tells the recruits the direction in which they can find the food.

Although the experiments using both the model bee and the diminutive-wing bees confirmed that the dance sounds are an important part of the dance language, a crucial element of the picture was absent: the identity of the structure through which bees hear airborne sounds. Several previous attempts made to resolve this issue had shown that bees seemingly could not hear at all. Yet because we now knew that the dance sounds traveled exclusively through the air, we felt inspired to reinvestigate the question. In these renewed trials, we tested the bees using sounds very similar to those that dancing bees make.

In our first series of experiments, we trained the bees to associate a sound, lasting for five seconds, with a very mild electric shock, arriving four seconds after the sound had started. We generated the sound at the open end of a narrow glass tube. The shock alone, if delivered while the bee was feeding, would drive the bee from the feeder for a few seconds; shortly thereafter she would return and continue feeding. We then posed the following question: If a bee repeatedly experiences a tone followed by an adverse stimulus, will she eventually learn to withdraw from the feeder within the first four seconds of the sound, before the shock? If so, then she can hear--and of course learn. We found that bees can indeed be trained to respond to airborne sounds, although they learned to do so very slowly.

More recently, we have employed a different training technique. In these experiments, a bee entered a very simple Y-shaped maze. We played a sound at one end of this two-sided feeder. The side from which the sound came changed unpredictably from one trial to next. If the bee turned toward the sound, she received a reward of sugar water; if she went away from the sound, she received nothing. We observed that the bees learned quickly to turn toward the sound. Claudia Dreller, a graduate student at Würzburg, used the procedure to explore the frequency and amplitude

range in which the bees could hear. Dreller's work showed that honeybees sense only low frequencies, those below 500 hertz. They hear these tones with sufficient sensitivity to pick up the sounds of a dancing nestmate, which range from 250 to 300 hertz. They also show some ability to discriminate between frequencies in this range; they can discriminate between low- (20 hertz), medium- (100 hertz) and high-pitched (320 hertz) sounds. We do not yet know for what purpose the bees might use this latter ability.

The same training technique enabled us to find out through what sensory structures the bees detect the sounds. We altered some of our trained bees by removing one antenna, fixing a certain antennal joint or removing sensory hairs from their head. We found that bees use a structure called the Johnston's organ, a chordotonal organ made up of nerve cells in the second joint of a bee's antennae, to pick up airborne sounds. Some flies and mosquitoes rely on the same structure to perceive sounds.

If we now put the pieces together, we can see how the dance language works. The dancer emits sound signals that help the dance followers determine where the dancer is and how she is moving, which in turn offers them critical information regarding the direction and distance to the feeding site. The dance attenders receive these signals through the Johnston's organs located in their antennae, which are always held near the dancer. Because these organs are bilateral—one on the left and one on the right—the dance followers can use them to judge their position with respect to the dancer and therefore understand the direction to the food. At the same time, the followers emit sounds that vibrate the comb. The forager stops her dance when she receives these signals and delivers samples of the food she has collected. These appetizers give the dance followers additional hints about the taste, smell and quality of the food source. The bees attend the dancing for a while and then fly out to find the food source on their own. If they are lucky, they will find the food. If they fail, they will return to the nest and try again.

This dance language is clearly a very complicated, highly developed system of recruitment. To understand how such a system evolved, we and other scientists have examined the recruiting techniques of related species. The genus *Apis*, to which all honeybees belong, has no close living relatives. Bumblebees and stingless bees are their nearest kin, and,

unfortunately, it seems that bumblebees do not recruit at all. Many species of stingless bees, on the other hand, do recruit. But, as far as we know, none has developed a symbolic language similar to the dance language of *Apis*. All four species of honeybees studied so far (three of which live in Asia) speak some variant of the dance language. As Martin Lindauer discovered in the 1950s, when he was at the University of Munich, all species use similar distance and direction codes, even though there are some differences.

Although we have looked for dance sounds in four species of honeybees, we have found that only three produce them. These three species hold something else in common: they all must occasionally dance in the dark. Two of them, the familiar western bee, *A. mellifera*, and the Asian bee, *A. cerana*, nest in lightless, enclosed areas such as hollow trees or other similar cavities. The third sound producer, the giant bee, *A. dorsata*, nests in the open on single sheets of comb, hanging under rock outcrops or thick branches of trees. Fred C. Dyer of Michigan State University first showed that *A. dorsata* sometimes dances at night, and Kirchner discovered only recently that this bee produces sounds. *A. dorsata*'s signals were very difficult to detect because these sounds are particularly low in pitch.

The single species that dances silently, the dwarf bee, *A. florea*, dances in the open like *A. dorsata*, but only during the day. Dancers of this species make gestures that may, in daylight, serve as visual signals to attract dance followers in the same way that sounds assist those bees who dance in the dark. Because some indications suggest that *A. florea*'s habits are the most primitive, we assume that the complicated acoustical communication system of the other three species most likely evolved from a visual display when these bees developed habitations that cut them off from light.

Now that we can finally listen to the bees' language and even speak it a little, we face a host of new questions. For example, we have yet to learn for what purpose the bees possess the ability to distinguish between different pitched sounds. In addition, perhaps they use similar airborne sounds in ways that we do not even suspect at this time. In the hopes of revealing their communication system in full, we will continue to eavesdrop on their conversations.



FURTHER READING

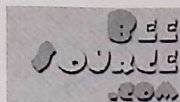
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 - **COMMUNICATION AMONG SOCIAL BEES.** Martin Lindauer. Harvard University Press, 1971.
 - **THE HONEY BEE.** James L. Gould and Carol G. Gould. Scientific American Library, 1988.
 - **ACOUSTICAL COMMUNICATION IN HONEYBEES.** W. H. Kirchner in *Apidologie*, Vol. 24, No. 3, pages 297--307; July 1993.
-



THE AUTHORS

WOLFGANG H. KIRCHNER and **WILLIAM F. TOWNE** began their collaboration in 1987 and jointly discovered the auditory sense of the honeybee. Kirchner has studied the mechanisms and evolution of dance communication in honeybees for the past 10 years. He received a Ph. D. in 1987 from the University of Würzburg in Germany, where he currently holds a faculty position. Towne has studied the dance communication of honeybees since 1980. He received a Ph. D. in biology from Princeton University in 1985 and is an associate professor of biology at Kutztown University in Pennsylvania.

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SOUND COMMUNICATION IN HONEYBEES

POINT OF VIEW

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It has been known for some time that bees perform an intricate dance in directing their hivemates to a source of food. Now it appears that they also transmit information by means of sound

by Adrian M. Wenner

[Effect of sound on bees in a hive]

Can we ever fully understand how the members of another species communicate with one another? The question has been given a new implication by the recent proposals that we listen for messages from the planets of other stars. Whether we ever detect such messages or not, we can investigate the question here on earth. We now know of many forms of communication in other species. None is subtler or more interesting than the "language" of the honeybee.

It is no accident that Karl von Frisch of the University of Munich chose the bee for his now famous investigations of animal communication. A honeybee colony is a marvelously compact community of some 50,000 individuals; it takes care of itself and usually ignores its human investigator; its members are highly social and could not survive without constant intercommunication, and the more one looks into their methods of conversation,

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the more remarkable they are found to be.

The obvious features of honeybee communication have been reported widely and are now a familiar story. When a foraging bee finds a source of food, it flies back to the hive and conveys to its fellows the distance and direction of the source. In the course of doing so it performs on the vertical surface of the comb a wagging "dance" in which its abdomen traces a figure eight. The orientation and rate of the dance, it has been supposed, tells the location of the food source. This hypothesis runs into an awkward difficulty: the interior of most hives is so dark that the bees probably cannot see the dance. Investigators of the phenomenon have found, however, that the bees follow the dance by means of their antennae, which touch the dancer's body.

Robert C. King of Servomechanisms, Inc., and I, working in my laboratory at the University of California at Santa Barbara, looked into the question further. The dancing bee traces the figure eight with the tip of its abdomen. That is not, however, the part of the body on which the observing bees usually concentrate their attention: their antennae tend to rest on the dancer's thorax. Does the thorax also describe a figure eight during the dance? We marked foraging bees with a spot of white paint on the thorax and later photographed its movement during the course of the dance in the hive by means of a series of rapid-flash exposures. The pictures showed that the thorax did not describe a figure-eight

pattern [*see illustration*].

The dance pattern itself, then, can hardly convey an unequivocal message. What can? Using a tape recorder, I had discovered that during the dance the bee emitted a peculiar sound at the low frequency of 250 cycles per second. This sound was made while the bee was wagging along in the straight run of its dance. It suggested a surprising new outlook on the whole problem. Perhaps the honeybee communicated with its fellows not only by the dance movement but also by sound signals!

To test this possibility I made tape recordings of the sounds made by dancing bees after they had visited dishes of sugar syrup placed at different distances from the hive. Would the sound patterns show a relation to the distance traveled? In other words, did the foraging bee tell its hivemates the distance by means of a sound language?

Analyzed with the sound spectrograph, the sounds proved to be made up of trains, each train being further broken into pulses with a frequency of about 32 per second [*see illustration*]. The bee emitted a train of sound during each straight run of its wagging dance. A careful analysis showed that the average length of the sound trains during a given dance (and also the average number of pulses in a train) was directly proportional to the distance the bee had traveled to the food source [*see illustration*]. The correlation was so good that it seems altogether likely - certainly as

likely as any other proposed mechanism - that the bee reports the distance by means of this sound language.

How is the sound produced? The first and most obvious guess was that the bee might create the pulses of sound with the wagging of its abdomen. To resolve this question I attached a small piece of cellophane to a microphone and placed the microphone so that with each waggle the dancing bee would tap the cellophane. The sound pulses proved to be about two and a half times more frequent than the wagging taps, so it became clear that the sound could not be arising from the wagging. Harald Esch, now at the University of Munich, who independently had discovered the honeybee's dance sound at about the same time as I had, also demonstrated that it was not produced by the wagging. Instead of a cellophane-and-microphone device, he used the ingenious method of attaching a small magnet to the bee's abdomen; as the bee moved the magnet it generated a fluctuating electric voltage that was recorded simultaneously with the pulsed sound, so that the waggle and pulse rates could be compared.

The function of the sound train was illuminated by considering the question of whether or not the bee's judgment of distances is affected by the wind. Analysis of the sound-train records showed that it is to some extent. When a bee flies to a source of food against the wind, the sound trains indicating the distance tend to be a little longer

than when it does not buck a wind. The deviation from the true distance is not nearly so much, however as one might expect on the basis of the wind velocity. A possible explanation is that the bee adjusts its flying efforts to the wind so that it always flies at about the same ground speed; thus, whatever the wind velocity it can still use the elapsed time of travel to a goal as the measure of its distance. I measured the flight speed of bees under various wind conditions and found that they do tend to fly at a constant ground speed. For example, flying against a wind of five meters per second (about 11 miles per hour) bees are slowed by only about a fourth of that amount. They minimize the wind effect by flying closer to the ground. When the wind is too strong (more than 13 miles per hour), the bees simply stay in the hive.

We may conclude, then, that the foraging bee's communication to its fellows in the hive is made up of two elements: the dance and the accompanying sounds. The angle of the dance from the vertical is correlated with the angle between the food source and the overhead sun, and the length of the train of sound during the straight run of the dance tells the distance. This may not be the whole story, however. Some current experiments indicate, for instance, a strong correlation between the rate of pulse production and the strength of the sugar concentration in a food source. It may conceivably turn out that the foraging bee's entire message is carried by sound signals.

[Transmittal of information by foraging bees]

The sound spectrograph's indication of regularity and precision in the bee's dance sounds naturally drew attention to other forms of bee "talk." As everyone knows, the bee is a rather noisy animal. Even its buzz in flight, however, is not just noise. The buzz has modulations and variations. When bees begin to swarm, an experienced beekeeper can detect the event by the sound alone, even though he may be surrounded by other buzzing bees from hundreds of hives. When an individual bee is aroused to attack, its buzz rises in pitch and fluctuates in intensity. And recordings within the hive show that bees in the hive make at least 10 distinctly different sounds, some of which have already been related to specific activities.

Two of these sounds are particularly noticeable. One, known as the characteristic hum of a beehive, is produced by the "ventilating" worker bees: bees that stand anchored on the comb or some other structure in the hive and create currents of air by beating their wings. This sound, varying in intensity, has a basic frequency of 250 cycles per second and often has strong overtones. It is usually much louder than the buzz of a flying bee, undoubtedly because the sound emitted by the ventilating bee is enhanced by the resonant vibration of the structure on which it is standing.

The other type of loud sound in the hive is

heard when the hive is disturbed. When an intruder - for example an ant - approaches, the bees guarding the hive rock forward on their legs and issue a short burst of sound; they may go on repeating these warning bursts every two or three seconds for 10 minutes or more. When the hive is jarred, the collective reaction of hundreds of guarding bees is heard as a sharp, loud buzz. This is followed shortly by a "piping" of workers throughout the hive, which consists of faint beeps at half-second intervals, the sound being a complex one with a fundamental frequency of 500 cycles per second. The piping goes on for several minutes. Apparently it serves to soothe the hive; it has been found that a recording of such piping, played to the hive, will quickly quiet the disturbed bees.

The most interesting of all the hive sounds, however, is the piping of the queen. Naturalists have long known that queens inside the hive emit two kinds of sound, called "tooting" and "quacking." A close analysis of these sounds and the circumstances of their emission now provides the strongest evidence that bees use sound to convey specific messages.

Tooting is the regal identification of a virgin queen soon after she has emerged from the cell in which she developed. A hive cannot tolerate more than one queen at a time. In a hive that lacks a queen several queen-bearing cells develop simultaneously in a comb, but one matures earlier than the others. Once this queen has emerged, has hardened and has become steady on her

legs, she proceeds to visit other queen cells, tear them open and sting to death their potential but not yet mature queens. Often, however, the worker bees do not allow her to dispose of all her potential rivals in this way; they bar her from some of the cells. She then begins to toot and continues to do so day and night, perhaps for a week or more. Her tooting rises in intensity and sometimes can be heard more than 10 feet from the hive.

Meanwhile the maturing queen bees still in cells try to get out in their turn. The worker bees hold them back, however; as fast as one of them opens the cap of her cell the workers push it back in place and glue it shut. Thereupon the imprisoned queens also start to pipe, but in a different pattern and at a lower tone than the free queen. The workers let out some of these quackers, but only one at a time. The reigning queen and the newly released rival then battle until one is killed. Sometimes the series of fights between the survivor and the new rivals goes on until only one queen is left. This survivor, still a virgin, then flies away from the hive to mate successively with several drones (on the wing) and returns to begin laying eggs.

All this has been studied in hives set up for detailed observation. The tooting and the quacking have also been recorded and analyzed spectrographically. The pattern of the first turns out to be a long toot (lasting one second) followed by several shorter toots. Its fundamental frequency is 500 cycles per second, and this

is overlaid with overtones that are varied considerably in emphasis, just as they are in human speech [see "Attention and the Perception of Speech," by Donald E. Broadbent; *SCIENTIFIC AMERICAN*, April, 1962]. The quack differs from the toot in two ways: it has a lower fundamental frequency and it begins with short sounds instead of a drawn-out one.

Do the tooting and the quacking say different things to the bees? We investigated this question with a set of controlled experiments. First we recorded the tooting of a free, reigning queen in its hive. Analysis with the sound spectrograph showed that this tooting put the major emphasis on the third harmonic. We therefore mimicked this harmonic with an oscillator and played it in the same tooting pattern (a long toot followed by several short ones) in a second hive that contained a free queen and a caged one. To each sounding of the artificial toots the caged queen almost invariably responded by quacking [*see illustrations*]. We then tried varying the frequency of the tone, while keeping the long-toot-short-toot pattern constant. Within a wide frequency range (600 to 2,000 cycles per second) the change in frequency seemed to make little difference: the queen still responded with quacks as long as the typical pattern of toots was the same. On the other hand, when we played the quacking pattern, the caged queen did not respond at all.

There is not much doubt that the tooting and the quacking represent certain

messages. What do the messages say, and what functions do they serve? A reasonable working hypothesis is that (1) the tooting announces the presence of a free queen in the hive, (2) the quacking reports the presence of challengers ready and yearning to be freed from their cells and (3) all this information guides the worker bees. One queen tooting and others quacking means that there is just one free queen, and a quacker (but not more than one) may be released to challenge her. This procedure will result in the rapid killing off of all but one of the contenders, but that may be to the good; it will enable the hive to settle down quickly to a peaceful regime. Occasionally, however, particularly in the spring, a virgin queen or an older egg-laying queen may leave the hive permanently, taking along half of the adult bees, in the phenomenon called swarming. In the swarming season, therefore, it is essential to have a queen in reserve when the free queen departs; a quacking queen may represent survival for the hive and is not to be released until the swarm has left.

We must come back now to the important questions: How does the bee produce sounds, and how does it perceive them? As to the production of sound, four hypotheses have been put forward, and the answer is still not clear.

The most interesting suggestion is that the bee makes its sounds by ejecting air through its spiracles: the breathing openings in the side of its body. On purely theoretical grounds it is quite plausible that

the insect could produce the observed sounds by a whistling or a bagpipe effect. But recent experiments in our laboratory and also by other investigators generally negate this theory. For one thing, if helium is substituted for nitrogen in the air in which the bee produces its sounds, this does not change the frequency of the sound; if the spiracle theory is correct, it should, because the density of a gas affects the frequency of the sound produced by vibrating a column of the gas. For another thing, it has been found that the sounds of a piping queen do not always coincide with accordion-like movements of its abdomen, so that its abdominal spiracles cannot be producing the sound. Finally, James Simpson of the Rothamsted Experimental Station in England has shown by delicate spiracle-blocking experiments that the bee's thoracic spiracles play no part in sound production.

The other possibilities are that the bee produces sound by vibrating its wings or the sclerites (hard plates) at the base of its wings or the entire surface of the upper part of its body. Simpson and I and others have been investigating these possibilities. At the moment the wing-vibration theory seems to be the most promising.

Until recently this idea was rejected on two grounds: that a bee's wings are too small to produce sounds of the frequencies and intensities heard, and that experimenters who have clipped the wings have not found that this changed the intensity of the bee's piping. The second idea is simply wrong; careful experiments show that clipping the

wings does affect the bee's sound-making. It raises the frequency and reduces the intensity of the sound, and the change is proportional to the amount of wing removed [*see illustration*]. It appears, therefore, that wing vibration is responsible at least for amplification, and probably for production, of the bee's sounds. It is hoped that experiments now under way will answer the question more definitely.

Other recent studies have shed some light on how bees "hear" sound. In the experiments in which artificial tooting was played to a caged queen it was found that the queen responded only when the sound was transmitted via a vibrator attached to the hive; when it was transmitted through the air, even with the vibrator suspended close to the bee, she did not respond at all [*see illustration*]. Similarly, worker bees show no reaction to piping when it is airborne. On the other hand, a disturbed hive can be quickly quieted by drawing a wet finger along the observation window, which causes a squeaking sound that arises from vibration of the glass. All these observations indicate that the bees receive sound through their legs from the vibrating structure on which they stand. Quite possibly they have receiving organs for sound on their legs below the knee.

There is also evidence that they receive sound through their antennae. Eleanor H. Slifer of the University of Iowa has found that each bee antenna has thousands of "plate organs" that are remarkably like the larger tympanic (eardrum-like) organs of

other insects. She has established that these plate organs are not permeable to chemicals that might be used for communication. Although this finding does not eliminate the possibility that these organs are chemoreceptors, there is now good reason to entertain the notion that they do respond to mechanical stimuli. Charles Walcott of Harvard University has made some experimental findings that support this view: he discovered that vibrations transmitted to a bee's antennae caused electrical impulses to be generated in the antennal nerves.

Conceivably the honeybee receives sound both through its legs and through its antennae. Thus it may receive a sound communication from another bee directly by touching the other bee's body with its antennae - as evidently occurs during the foraging bee's dance in the hive. The double receiving system would have a great advantage for bees in a noisy hive: in spite of the din of piping, which they apparently receive through their legs from the hive's vibrations, they would still be able to perceive the faint dance sounds by touching the dancer with their antennae.

Listening to the sounds of bees, recording them, analyzing them and designing experiments to explore their meaning, one cannot help feeling that much of this is akin to the problem of communicating with beings on another planet. With bees we have the advantage of being able to study them here and now.

The Author

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The Swarm

orders; she obeys, as meekly as the humblest of her subjects, the masked power, sovereignly wise, that for the present, and till we attempt to locate it, we will term the "spirit of the hive."

But she is the unique organ of love; she is the mother of the city. She founded it amid uncertainty and poverty. She has peopled it with her own substance; and all who move within its walls — workers, males, larvæ, nymphs, and the young princesses whose approaching birth will hasten her own departure, one of them being already designed as her successor by the "spirit of the hive" — all these have issued from her flanks.

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What is this "spirit of the hive" — where does it reside? It is not like the special instinct that teaches the bird to construct its well planned nest, and then

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His soldiers are not ready to
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have to ~~wait~~

who is forever disturbing the most constant laws, and producing grandiose, inexplicable phenomena. In the natural order of things, in the monotonous life of the forest, the madness Langstroth describes would be possible only were some accident suddenly to destroy a hive full of honey. But in this case, even, there would be no fatal glass, no boiling sugar or cloying syrup; no death or danger, therefore, other than that to which every animal is exposed while seeking its prey.

Should we be more successful than they in preserving our presence of mind if some strange power were at every step to ensnare our reason? Let us not be too hasty in condemning the bees for the folly whereof we are the authors, or in deriding their intellect, which is as poorly equipped to foil our artifices as our own would be to foil those of some superior creature unknown to us to-day, but on

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HITLER'S YOUTH

connection the undersigned respectfully encloses venture Certificate No. 36,323 dated 1st April um of 900 gulden registered in his name and one acher together with accountant's receipt for the ey paid over in the sum of 200 gulden. near Lambach, 19th September, 1895.

(Signed) Alois Hitler,
ner Collector (Retd.), Imperial Customs
and Excise.

er document in Alois Hitler's own hand which is a letter of similar contents dated 25th July 1896.

Linz

urchase dated 14th November 1898, Alois Hitler house in Leonding with meadow attached com- lf an acre. The purchase price was 3850 gulden of which he paid 2500 gulden (£220) in cash, the covered by an existing mortgage debt. Soon family moved into their new home.

Garden House', as it was called, in the centre of ng at that time of about 3000 inhabitants, Alois remaining years of his life, busying himself with l the few fruit trees that were included with the : he kept a cow, but as most of the fodder had to ld it again rather than lose money. At ten each red to the nearby 'Gasthaus Stiefler' for a quarter- ile every evening he attended a gathering of his :ld in rotation at one of the inns in the village. reral people still living in Leonding who have s of the Hitler family, but as they have long since heir answers to suit the political complexion of .on them, the information they supply must be rve. In general, their statements bear out the ound off this picture of Alois Hitler's life in llowing condensed version of three talks which

Hafeld 1896

ALOIS SCHICKLGRUBER/HITLER AND HIS FAMILY 51

I had in 1948 with Herr Mayrhofer. Adolf's former guardian, may be of interest. Mayrhofer was eighty at the time of our conversations, but remarkably youthful both physically and mentally. He is a farmer and was for many years Mayor of Leonding.

'Every day,' he told me, 'Alois Hitler used to look in on us when we were having our midday dinner. He took an interest in all that was going on ... his beehives didn't pay, though, and he tended his fruit-trees by the book. He lost a lot of money in Hafeld. ... He was strict with his family, no lid gloves as far as they were concerned; his wife had nothing to smile about.'

'And did he often chastise Adolf?'

'He never touched him, I don't believe that, but he often scolded and bawled at him. "That miserable urchin!" he used to say. "I'll bash him yet!" But his bark was worse than his bite. The boy stood in awe of him though.

'The old man never set much store by religion,' Herr Mayrhofer continued. 'But he never spoke against it. He liked to call himself a "free-thinker". He was never in church, except on the Emperor's birthday.'

'And then only to air his uniform, and show that he was somebody!' I suggested.

'Yes! Yes!' laughed Mayrhofer. 'That's just about it!'

'Why did he fall foul of the priest?' I asked.

At first Herr Mayrhofer pretended he knew nothing about that. Then, when I repeated the story of how the parish priest and the headmaster of the school started a soup-kitchen and the local free-thinkers had taken it as a clerical manoeuvre to acquire a say in State education, he admitted that Alois Hitler had been the spokesman in their campaign. We went on to speak of Adolf's mother.

'And Frau Klara?'

'She used to come to us two or three times a week to buy vegetables and such. Very neat and clean, she was—quick in her movements. A real nice woman.'

'She used to stay and have a gossip, I suppose?'

'No, not shel We'd have liked to have had a chat with her

they were total lost in else everywhere in the town - why she runs a village store? Marcora, from Hitler was so different reputation.

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The Life of the Bee

ment we need only call attention to the essential trait in the nature of the bee which accounts for the extraordinary agglomeration of the various workers. The bee is above all, and even to a greater extent than the ant, a creature of the crowd. She can live only in the midst of a multitude. When she leaves the hive, which is so densely packed that she has to force her way with blows of her head through the living walls that enclose her, she departs from her proper element. She will dive for an instant into flower-filled space, as the swimmer will dive into the sea that is filled with pearls, but under pain of death it behoves her at regular intervals to return and breathe the crowd as the swimmer must return and breathe the air. Isolate her, and however abundant the food or favourable the temperature, she will expire in a few days not of hunger

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The Life of the Bee

accusing her of laziness, probably, or suspecting her of feeble mind. On their second departure, when they find that she still has not followed, her ill-faith becomes evident to them, and their attacks grow more serious. And finally, when they shall have gone forth once more, and still with the same result, they will almost always condemn her, as being irremediably faithless to her destiny and to the future of the race, and put her to death in the royal prison.

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[35]

It is to the future, therefore, that the bees subordinate all things; and with a foresight, a harmonious co-operation, a skill in interpreting events and turning them to the best advantage, that must compel our heartiest admiration, particularly when we remember in how startling and supernatural a light our recent inter-

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Notes from
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the book

Illustrations by Pamela Johnson

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WILLIAM LONGGOOD



beehive, a hollow tree, some recess not inhabited by other creatures. The returning scouts report their findings by "dancing" on the surface of the cluster, as foragers show the way to food sources, but more about that later.

Several scouts dance at the same time, some pointing in one direction, others in another; some indicate places nearby, others a considerable distance away. Some dances are more lively and cause greater excitement than others. The enthusiasm and intensity of the dance is in proportion to the suitability of the discovery and the dancer's enthusiasm. Among the things the scouts look for are the size of the entry hole, whether it is sheltered, if there are drafts, the smell (which must be pleasing), and who knows how many other things besides, states von Frisch:

Within a few hours, or sometimes only during the course of days, something really extraordinary happens. The most vivacious of the dancers who have found a selected place gain more and more followers; these have taken a good look at it and show their approval by making propaganda for it by dancing themselves. Also other dancers, who until now have canvassed for less attractive dwelling places become converted by the swirl of the successful ones. They follow their advice and look at the other accommodation until they are convinced of its worth. Many of the bees which cannot show such enthusiasm as the lucky discoverers for their accommodation simply cease dancing altogether if things take this turn. Thus an agreement is reached; all dance the same measure and in the same direction. When everything is ready, the swarm dissolves, to fly off under the direction of hundreds of its members who already know the way to the objective which has been chosen as the best available.

von Frisch also offers this comment: "There is much that man could learn from the bees, but he does not have the patience. Before the foregoing events have been brought to a conclusion, he interferes and draws the swarm into his hive—just as he so

often destroys natural processes with his coarse hands for his own ends."

Left to themselves, swarms generally found their new city in a hollow tree or, more likely, some inaccessible place from which they cannot be evicted without considerable cost and destruction of property. They are especially fond of old houses, entering them through the caves; they seem to like being near people, and there is the advantage of a warm nest and space between walls where ordinarily there would be insulation in newer houses. The damage done to a house by removing bees is usually greater than leaving them alone, but many people are uneasy about sharing quarters with them. I usually try to persuade those who want to poison or remove these visitors to leave them alone. Bees are not undesirable tenants; they "pay their rent" by pollinating flowers and gardens, mind their own business, and are cheerful, uncomplaining, and undemanding neighbors.

If lucky, a beekeeper can gather a swarm when it settles down near the parent hive. Bees are so gentle at this time that they can be taken with almost no danger of getting stung, even scooped up with bare hands or ladled out like so many beans. The trick is to get the queen, and the rest of the swarm will gather around her. By nipping off the branch they cling to, the entire cluster can be popped into a swarm box (a wooden frame with screened sides and a lid), or a perforated can or bag, and that's all there is to it.

Ingenious contraptions have been developed by beekeepers to collect swarms. The ultimate in sophisticated homemade gear is a gunnysack net tacked onto a barrel hoop which is attached to a long pole for overhead work. Some beekeepers specialize in gathering swarms. I read about one bee-hunter who caught 104 swarms in a single season. Others track swarms, which requires skill and stamina, as pursued and pursuer may travel several miles over rough terrain to a new home.

It has been my experience that swarms tend to alight high

A laying worker, with neither spermatheca nor sperm, can be no more than a parody of her fertile mother, a bogus imitator. Nor, so far as is known, can she produce queen substance to protect her from rival laying workers. This probably accounts for there often being more than one laying worker in a hive. But why does only one bee become a laying worker? A few, at most? Why don't all females have a go at motherhood? How does this ersatz queen establish her claim and protect her territory?

The laying worker has still another biological liability. She lacks the long ovipositor with which a queen deposits eggs in the bottom of each cell. Literally short-changed by birth in this respect, she has only an undeveloped ovipositor. She can, at best, usually manage to leave her eggs high up on the edge of the cells, a sure sign of an amateur guilty of inferior workmanship of the highest order.

Even this is not her overriding shortcoming. She has no sense of reality; arrogance without technique or proper equipment is not enough. With no instinct or a proper laying strategy to guide her, she is likely to deposit more than one egg in each cell, probably on the shaky theory that if one is good, two must be better and three better yet. She is prone to scatter her unmistakable drone eggs all over the combs, instead of going up and down the line purposefully, grouping them for easy care, like a true queen. Worse, with no nurse bees being produced to care for eggs laid by the bogus mother, the majority will never hatch. The hive is already demoralized by the loss of the queen. Now, with no worker brood emerging, it is dwindling in size. The end is inevitable.

Drones produced by laying workers tend to be smaller than those from regular queens, due more to mechanical rather than biological limitations: the worker tends to place her eggs in the smaller worker cells rather than in the larger drone cells, as unaware of her own limitations as she is of the demands of the job. These smaller drones can function sexually as well as not-

mal drones; size and sexual prowess are rarely equated in any species.

Beekkeepers usually can tell at once if there is a laying worker by the laying pattern and absence of anything but drone brood. But this can be deceiving. If a regular queen uses up her entire supply of stored sperm, she is no better off than a laying worker, producing only drones; she becomes a caricature of her former self, performing a ritual that is meaningless to the life of the hive, a queen in name only to the doomed colony, if it neglected to begin superseding soon enough.

FIFTY-SIX



A laying worker seems a bizarre response by nature to a desperate situation, but desperate situations tend to bring bizarre responses. She is an aberration, and nature's preferred solution to error is ultimate death and starting afresh. This, almost inevitably, is the fate of the laying worker.

The laying worker is virtually impossible to get rid of. She looks like any other bee to human eyes, so cannot be told apart from others. She has, further, the human failing of enjoying the privileges and prestige of power, refusing to step down if a fertile queen is introduced; she may be so intoxicated by her assumed role that the rest of the colony is beguiled into sharing her delusion, a happenstance common enough in human societies where demented or psychopathic leaders with enough charisma and conviction attract followers of fanatical loyalty.

With bees, this allegiance is carried to such extremes that, if a real queen is introduced, the colony will usually kill her and retain the bogus queen, a bee cult of personality! Can bees not tell the difference between a laying worker and a genuine queen,

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one another of new feeding grounds and perils; plants passing along word of weather aberrations and insects inviting friends and relatives to feast in a lush garden; climate changes, language expressed in scents, sounds, vibrations, touching, dances, and electric impulses; and God knows what else.

We still tend to reject that which we can't understand or prove in the laboratory. We still have not accepted the linkage among species or learned the common language of interdependence spoken by all life. We still do not know how many other worlds exist within ours, and outside, unknown and unsuspected by us. The enormity of the concept does take some getting used to. It must all be challenging and somewhat unnerving to the scientific mind that demands proof.

Laying workers are common enough in apiaries. Just as parthenogenesis is found throughout nature, females of some species produce only one sex, and others are capable of giving birth to both sexes. Is the laying worker a kind of spin-off of parthenogenesis? And does a female laying eggs without fertilization represent some well-thought-out alternate strategy of reproduction, an expedient solution to a shortage of males, or was nature herself tired and overwrought when she conceived the idea? Since parthenogenesis is so widespread it is believed to have developed independently among many species in many places, it could be an impromptu response to the mighty urge for life under any terms, an ingenious solution to an unmet need, fortunately one not copied by humans, who are having quite enough trouble with the standard way.

Parthenogenesis, outside the apiary, does seem to have its place, based on such wide acceptance and practice, but aphids have carried it to extremes. Only in the fall are both sexes produced; they mate and fertile eggs are laid by the female; those eggs alone surviving the winter. Females hatch in the spring and a dozen or more generations follow without further matings.

If bees were going in for partial parthenogenesis as an emer-

gency measure, why didn't they go the next logical step and learn to produce both sexes, like the aphid? Bees probably rejected aphids as role models, deciding these simpletons had nothing of value to teach them. The prolific aphids are not only regarded as garden pests, bearers of disease viruses, but have not thrived in proportion to their astronomical numbers. Aphids are more or less controlled by the notorious aphid lions (lacewings), also called golden eyes; and who knows whether these deceptively exquisite predators evolved to devour aphids, if aphids appeared as food for aphid lions, or if they emerged in tandem or found each other by chance or design?

The answer is not important; it all works out to much the same thing, another of nature's precarious and protective balances. There is, in any case, no problem of overproduction by worker bees or need for further controls. Drones are produced only in modest numbers and are dispatched by a built-in self-destruct mechanism designed by pitiless but ever-efficient nature.

FIFTY-FIVE



The queenless hive, without queen substance to regulate it, assumes a new identity if a laying worker takes over. It must adapt to a terminal situation. The worker queen herself faces insurmountable handicaps. She is neither physically nor psychologically equipped for her new role. She can no more fulfill the queen's function than the queen could fill that of a worker. Both queen and worker have ovaries to produce eggs and an oviduct through which eggs can be released, but there is a crucial difference: the queen has a spermatheca in which she stores those millions of sperm that produce fertilized eggs.

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around orchards. It is often claimed that insects do not suffer when poisoned, but anyone who has watched them die, twitching, writhing, and finally paralyzed, would have trouble accepting this claim.

After an embryo bee is sealed into the cell, spinning her web and pupating, the various organs and vital processes are formed—heart, nervous system, muscles, alimentary canal, and bloodstream. Some great intelligence directs the show and the bee, in her shroud, follows its commands. On the twenty-first day after the egg was laid, the new worker chews away the wax capping to emerge from her cell and join the colony, playing her small role in the great design.

Here I have described the worker bee, her structure and components, and yet, it is more inventory, or laundry list, than description. I have told little about what a bee is really like. Essence and spirit are not qualities easily captured on paper; it is, at best, a bookkeeper's view of life.

TWENTY-NINE



The honeybee, we assume, is what nature intended her to be. She filled an existing need, or found a response to her need. We do not know if the bee adapted to the flower or the flower to the bee, but these two mighty instincts worked out a mutual accommodation. Bees, unlike man, know their role. Untold generations have carried on the same traditions and practices; long, long ago they decided where they were going and held true to course.

In pursuing the adventures of the bee, there is one profound mystery that, above all, intrigues and eludes philosopher and scientist alike. During her brief life, a worker, as we have seen,

performs many diverse chores. She assumes these roles without training or prior knowledge that we are aware of. A British writer, Herbert Mace, who pondered the dilemma I refer to, noted that the worker is descended from parents who have never performed the chores expected of her, neither having the organs nor the requisite intelligence for what is required of their offspring. How then, he asks, is this complex instinct transmitted?

By special food the ovaries of the embryo queen are developed, he observes, "but it is quite another matter to understand how the withholding of such food can produce, for instance, the pollen basket of the worker, which both the queen and drone are destitute of. In a word, how are the working qualities of neuters transmitted to an offspring they have no part in the production of?"

Is it genetic transference? Some unidentified dietary element or secretion passed along? A more complex governing biological mechanism of which we have no knowledge? Is it some abiding animus that dwells secretly in the hive conferring this ability, this biological sleight of hand?

The mystery becomes increasingly complex. The queen is a mother in a biological sense only. She has no maternal instincts or abilities. She does not care for her young. After depositing an egg, she is completely through with it, like the most wanton of insects; giving birth is an end in itself. Her daughters, the workers, who cannot themselves generate a fertile egg in their atrophied ovaries, are left to care for their younger sisters and drone brothers. It is these incomplete females who provide the "mother's milk" and nurturing for the offspring they cannot normally produce.

The irony is compounded because, with a secretion from their glands, they can produce queens like their mother, but cannot themselves become queens. Their lifelong role, from birth, is limited to being surrogate mothers and servants of the hive, an odd arrangement, even among insects, as if nature

largely a mechanical operation. I have never lost that sense of awe and wonder. Indeed, it increases each year as new miracles unfold.

THREE



My own package of bees arrived a short time after the demonstration. I picked up the package at the home of the couple who had given the course and was sent on my way with cheery cries of "good luck!" It was an odd and moving sight to see the bees, those small creatures I had assumed responsibility for, in the screened wooden shipping cage. They were gathered in a tight cluster, about the size of a small pineapple, huddled around the queen in her miniature individual perforated cage.

The cluster is a natural mechanism to protect the queen, keep the individual bees warm with their collective body heat, offer common security, and serve the colony's sense of unity as social creatures; they are so dependent upon the community that, if isolated, a bee will soon die, even though given the right food and correct temperature. A supreme discipline rules the hive. Bees must be part of a colony in order to survive. Unlike humans, they cannot go it alone.

FOUR



For several months after getting my bees I belonged to an association of amateur beekeepers, one of the few organizations I ever joined. But disenchantment came soon.

Only a small part of each session was devoted to bees. Most of the time was spent in political maneuvering, schemes and coups to overthrow those in office, and endless debates over procedural rules. The meetings were, according to the bylaws, run by *Robert's Rules of Order*, but there was continual debate over what Robert had really had in mind. No one ever consulted the book, if indeed there was one.

Ours was a varied membership, made up primarily of older men with a few women, mostly wives of members, and a scattering of young people. Some of our group were obviously lonely and wanted companionship, others were bored and wanted an audience, and a few seemed genuinely interested in learning more about bees; the latter generally didn't last long.

Some of our members did not keep bees at all but once had kept them, or they knew someone who did, or they hoped to at some future date. The membership was small, held together by a hard core of regulars who juggled the elected offices among themselves and periodically conspired to find some unsuspecting soul to act as corresponding secretary, the one office that had no appeal. I was once solicited as a candidate for this unglamorous post and replied that I preferred being a foot soldier to a general, a comment not held in my favor. Turnover in the association was lively.

The jewel in our crown was the county bee inspector (later defrocked by county budget cuts), who was a charter member. He was usually president, which was fitting because he also kept the most bees. When occasionally voted out of office, after Robert failed to rescue him from some parliamentary pitfall, he would bide his time or boycott meetings until a new election of officers. Occasionally a new member would reveal a power complex coupled with weak organizational skills; failing to win high office, he would drop out and join the competing beekeeping association to seek recognition there. One perennially unsuccessful candidate for vice-president resigned to start a new bee group with himself as president, going off Cape to find a following, as I recall.

Bees -
T.B.F.

Some

and
again in

1910

Alois: Not

1896

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1941 Speer

14 • WILLIAM LONGGOOD

certain circumstances even she is eliminated in a dark bee plot euphemistically known as "supersedure," which usually involves the queen's murder by her own daughters, but more about that later. The most ordinary colony is better organized than the most efficient man-made factory. And yet, even these models of nature's organizational efficiency and industry are sometimes less than perfect, beset by such human failings as sloppy workmanship, useless endeavor, and what appears to be poor management or faulty judgment. Bee colonies, like human societies, vary in the standards they set for themselves and in the life-styles they adopt. Some prosper while others barely manage to struggle along, existing on the bee equivalent of welfare provided by their keeper, and some fail altogether, often victims of their own shortcomings.

Worker bees make up almost the entire population of the hive. These are females that lack the ability to produce a fertilized egg necessary to generate a female worker bee like themselves. There is only one queen to a hive, although there have been cases in which a second or even a third have been tolerated, but this is so rare that it suggests some kind of perversion of nature's intentions.

* The queen's only function is to lay eggs, as many as two thousand a day. Indeed, she is known as an "egg-laying machine." Completing the makeup of the hive are those comic-tragic, but vital, lusting clowns, the drones. There are relatively few of them in each hive and the number may represent less a necessity than a bee equivalent of conspicuous consumption. Drones are males conceived from unfertilized eggs laid by the queen. Their sole function is to mate with virgin queens, and most live and die without ever fulfilling this mission. The drone lives a life of bullying, nonproductive ease, like the worst free-loading relative, unless summoned to duty, in which case he may sacrifice his life, probably to his own surprise and dismay. For their intemperate ways, the surviving males eventually get their comeuppance in a bloody fall rite known as the

* Hives with thousands about 5 per

1891

THE QUEEN MUST DIE • 15

"massacre of the drones," a drama that will unfold here in its place.

A worker bee's existence is regulated by a biological timetable, which is one of the profound mysteries that govern a hive. During her brief life, she performs many diverse chores: scavenger, nurse, producer of wax, molder of honeycomb, housekeeper, forager, fanner, water carrier, undertaker, guard, warrior, and, finally, martyr. She passes from one of these roles to another, depending on age and experience. A bee is like a worker in industry who is rewarded for her experience and length of service with successive raises and promotions, until the employee is considered more liability than asset and the employer seeks to unload her and bring in a successor who is young, inexperienced, and inexpensive; success often bears a price tag of diminishing returns.

For the bee, indignity rarely accompanies old age. As noted previously, she either resolves the problem by working herself to death or is dispatched by her younger sisters. The climax role for a worker is that of forager, or field bee, gathering pollen and the nectar that will be converted into honey; but at the same time she is expected to perform other, often menial, hive duties. Efficiency and hive demands and not personal status or job assignment determine her roles throughout life and into death. We know of no prima donnas or egotists in the hive. The function of a bee is always contingent on community need.

Scientists believe that bees, next to humans, have the most elaborate social structure and specialization of labor in the animal kingdom, one far more complex and sophisticated than formerly thought. Only ants and termites approach bees in the intricacy of their societies.

For the multiple, specialized tasks a worker bee performs, she has no training or prior knowledge that we are aware of, but takes to each succeeding role naturally. How does this extraordinary progression come about? Is it genetic transference? Some unidentified dietary substance or secretion that is

Queen to soldiers

Lecture to AH

1987 may come down with a severe bowel disease that, left untreated, can cause a colony to weaken or lead to heavy loss of life. Worker bees are so incredibly clean that they will risk death by flying in cold weather rather than befoul their home. Only the boorish males are guilty of soiling the hive, and there are not likely to be any of them in the winter colony.

When there is a long spell of cold and the bees can't get out to relieve themselves, on the first warm day they fairly explode from the hive; it is not unusual to see the snow splashed almost solid brown for several hundred feet in all directions. Generally bees do not go far from the hive on cleansing flights. This is sensible on their part. If they went any distance and the temperature suddenly dropped, they probably wouldn't make it back.

Bees, unlike humans, have a sound sense of their life mission. They work hard in the spring, summer, and fall, and in the winter they loaf, or take it fairly easy, like retirees at leisure. But that is not an altogether accurate statement. The bees that work so diligently from April through September are probably not the same ones that more or less knock off during the cold months. In the summer the field bees work so hard that their average life is only four to six weeks. Their wings beat about two hundred times a minute, which musicians say is in the key of C sharp below middle C. The fragile wings become ragged and torn, and finally wear out altogether so that they no longer will support flight. An experienced beekeeper can usually tell a bee's approximate age by the condition of her wings.

1988 Hive values are such that when a bee no longer can fly and be an asset to the colony, she will remove herself from the hive rather than be a burden. If she lacks the grace to commit suicide, or to depart of her own will, she will be kicked out of the hive or killed outright by those she served so faithfully while she could. Human societies have no monopoly on ingratitude and treachery.

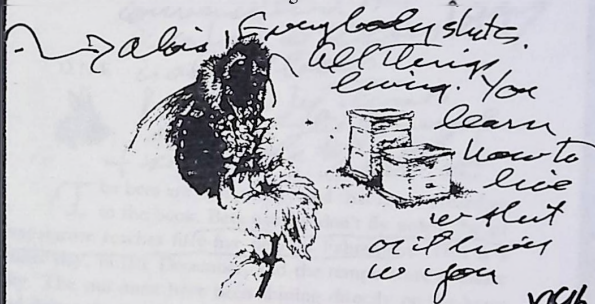
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Alois can perform himself to bees

In 1943 AH Charles they are not
bees honorable on bees,

THE QUEEN MUST DIE • 13

There is little sentiment in a hive. The motto, indelibly and invisibly etched in bee genes, is "work or die." Every female bee, except the queen, is expected to give full measure in hard labor for her keep, and the queen has her own biological obligations. This is a completely socialistic society, the direct opposite of the competitiveness and spirit of individual advantage that governs most human societies. No goods are owned privately. The collective wealth is the pooled honey in the combs and dedication to a common goal. The individual bee owns



nothing, and owes full allegiance to the colony. In exchange she is provided a place to live and work while she is a productive member of the community. AH never forget this

Many human communes could have used bees as their models, but such experiments seldom come off. Humans rarely are capable of the self-sacrifice and dedication of bees. On the other hand, bees are not wracked and diverted by sexual desire as humans are, and such wholehearted fidelity to ceaseless work may be a questionable virtue: is this drive motivated by pleasure or compulsion? Is it socially useful or only for personal gain?

AH went down to the queen
Every individual, except the queen, is expendable, but under

* after lecture by Alois, AH
wonder he will never be
wracked in that manner

* death is
to bees

1886

* This gives great comfort
to Kela, "He did not
win but this after all"

Note!

The only good
conversation A.H.
ever has is about 1897

ONE

is about bees.



Perhaps he thinks
of it at the funeral
& so is able to laugh
a little. *

The bees are flying today and that is not according to the book. Bees usually don't fly unless the air temperature reaches fifty-five degrees Fahrenheit. This is a winter day, in late December, and the temperature is under fifty. The sun must have been shining directly on the hives and driven the temperature up inside, deceiving the bees. It must be a bit of a shock to them to venture outside, expecting benign warmth, and getting a blast of chilling air. It may be that the bees were not deceived but are merely being perverse. Bees almost never follow the rules laid down for them by their tenders. Beekeepers are forever grumbling about "those damned bees." But we have only ourselves to fault because we wrote the book, not the bees. We created our own false expectations. Apparently, once outside and on the wing, the bees decide to complete the business that made them leave the hives. The snow is soiled with their droppings. It is startling how many brown spots there are; they dapple the snow and white hives as if someone had flicked a wet paintbrush. Every couple of weeks the bees need a "cleansing flight" in the winter to rid themselves of accumulated wastes or they

The procession starts moving up the ramp, slowly at first, then faster until there is almost a stampede to get inside. Some crowding may take place at the entrance, but never chaos and no display of ill temper, shoving, or unpleasant expressions of "me first." Bees are wonderfully patient little creatures, with no false sense of self-importance.

While this little drama is played out, a beekeeper may sit beside the hive, enjoying the sight with little or no danger of getting stung; for the bees this is a joyful occasion and they are not inclined to sting. They have been through a traumatic experience. Suddenly they are free, taking possession of a new home with a queen. But for the moment they are disoriented. Bees have a strong sense of place. Any movement is upsetting to them. If a hive is shifted only a few feet, a bee will return to the original location and, possibly, perish on that spot, her home within easy reach, forlorn as any world-weary traveler seeking a former habitation that no longer exists.

Bees are delightfully curious but not the least adventurous. They resist any change of routine forced upon them, an inflexibility of habit that often causes their destruction, although it may have helped them survive as a species. Persistence might well be as important in survival as adaptation, for who knows whether new conditions will last or prove to be of short duration?

How many species are extinct because they mistook some environmental aberration on the unmarked evolutionary road for permanent change? Bees, with their programmed consistency, seem to have followed a fairly straight and unerring course through the centuries, but will it continue with man having taken over from nature as the evolutionary force itself?

Once installed in their new quarters, the bees are given combs of honey from other hives or fed sugar water. This provides instant energy to start drawing out comb, making wax, and performing the numerous chores required in building a city. It might also serve a subtle psychological purpose, like the Wel-

come Wagon, raising spirits and making them feel at home.

When all of the bees have disappeared into the hive, a few handfuls of dry grass are stuffed into the entrance to discourage second thoughts about taking off. Bees despise involuntary confinement, and immediately set to chewing away the grass. By the time they have freed themselves, within twenty-four hours or so, they are settled in. Perhaps they become so engrossed in removing the grass that they forget its purpose; means and ends are often confused. The queen will soon be released from imprisonment and the colony will start fulfilling the role assigned it by nature.

T W E L V E



With a bit of luck and reasonably good management, a colony can continue indefinitely. I still have my original hive from ten years ago, although it is true that the line of succession has been disrupted by the introduction of an occasional new queen, after the reigning queen failed, died, or was dispatched by her discontented daughters. The same hive has housed dozens of generations with never a break in occupancy, but none of the present colony is related to the original inhabitants.

It seems remarkable that the physical hive is the only common thread in this chain of continuity. In the wild, colonies have been known to last, uninterrupted, for fifty or sixty years. In such cases there is, presumably, a direct line of descendants and the characteristics of the original colony are passed along through unbroken genetic transmission.

Each new queen that takes over passes along different traits of temperament that soon dominate the hive. If a colony is

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ok | ugly and stings at the slightest provocation, this can be changed by substituting a queen of more docile disposition; as soon as the old bees die off and are replaced by the offspring of the new queen, the mood of the hive softens. Colonies can also differ in other characteristics, including their industry, tidiness, method of building comb, the amount of honey gathered, and the size of the colony. Many common characteristics exist among all hives, but at the same time there are startling differences from one to another.

In all healthy, normal hives the population ratio is much the same. The colony is composed almost entirely of females. This matriarchal society works with compulsive dedication, and yet, we are forced to believe that for them there is no sense of drudgery or martyrdom. They give more voluntarily than could be demanded of any slave; for them there is no crying out in frustration and despair, no decamping to a better life or easier life-style.

It seems odd that nature imposed on the workers almost the entire burden of running and supporting the hive. A colony may vary from as few as thirty thousand to sixty thousand members, and in excessively successful communities eighty thousand or even a hundred thousand or more, with, generally, no more than a couple of hundred drones at most. Even if nature saw fit not to have a larger number of males, why didn't she make them contribute more to the upkeep of the hive, and when not sexually occupied at least to support themselves? Why this disparity?

Did nature brush drones off, as if saying, "Oh, you know how men are, they just get in the way!" I like to think there is more to the grand design, but females play the dominant role in many species. The drone's sole contribution is his sperm. Could it be that nature considers sex an occupation worthy of all the energy and attention one can give it? Is this, then, why the females, the sustainers of the colony, are all lifelong virgins and spinsters? So they won't be distracted by lust from hive obligations?

* Geomutien Alois says
he will change the queen

Every worker bee is wholly dedicated to the colony, almost like nuns who have taken vows of chastity, poverty, and obedience. However, we assume that nuns choose their path. Bees, unlike humans, can never question the bargain they struck with life, for no bargain is struck; the terms are imposed upon them at birth and, apparently, they accept their lot willingly enough. This must be the major difference between humans and other orders of life: man has choices.

In their unique social organization, bees do not concern themselves with the variables through which humans pile up enormous fortunes. One bee, through greater intelligence, diligence, avarice, or drive cannot exploit the industry or stupidity of another, or lay waste the land that belongs to all for personal gain. All share equally in such resources as exist. Production is geared to need rather than to an artificially created demand. The huge surpluses of honey accumulated through efficient management by beekeepers represent an imposition on bees to exploit their natural drives.

Wily nature takes no chance on defectors rebelling against the rigid hive order. Each member is biologically dependent on the community for life, as we have noted. Honeybees depend not only on physical contact with the colony, but also require its social companionship and support. Isolate a honeybee from her sisters and she will soon die. Few can survive twenty-four hours of separation from the colony, even in warm weather. A bee's dependence on this physical and psychic companionship is as striking in its way as the heroic legends concerning individual men and women who have lived through unbelievable hardships in prolonged isolation, each obeying the laws that separate and unify the species.

THIRTEEN



The honeybee's family tree is, regrettably, not all that it could be. It too has its sour apples, members she would probably as soon forget, along with others that, while respectable enough, have taken a different evolutionary path. Here I digress briefly to examine some of the varieties of bees, to better understand the honeybee, see her in a larger perspective, to look at some of her relatives, how they differ from her, and what they are up to these days.

The outstanding characteristic of honeybees is their social nature: they live together in large communities, store quantities of honey, and care for their young. While honeybees receive the most attention, they are, in fact, a minority in the bee family. Their wild cousins, the solitary bees, are much more abundant. Honeybees also are found in the wild, but most absconded from hives, finding such boxlike quarters too confining and, possibly, domestic life too respectable or stifling; the majority, however, have taken the path of least resistance, living in man-made quarters in exchange for providing honey and service.

In common, all bees provide the same essential service, pollinating plants, but they operate from a different base, often complementing one another. All bees are believed to have developed from hunting wasps, but along the way they followed different stars, experimenting, mimicking, innovating, adopting, and rejecting, the successful living, ever-changing form and style, until we arrived at the diversity we have today.

Solitary bees are, as the name suggests, loners, each going it by herself. Each female builds her own nest, provisions it, and lays eggs. She provides the eggs with a food supply, consisting

of a honeycake mixed with pollen, and seals egg and food into a comb of her making. There is no further contact between parent and offspring; this is true of most insects and seems to put honeybees a cut or so above their wild kin and other insect neighbors.

There are said to be at least five thousand species of wild bees in North America alone, but little is known about them. When creatures have little or no commercial value, if they are neither especially harmful nor useful and not strikingly beautiful, fascinating, or bizarre, they are largely ignored to go their own way. This also holds true of most people of little or no distinction.

Solitary bees dwell in a variety of places, usually a hole of some kind in the soil or a convenient cavity of one kind or another. Despite their solitary nature, they are not altogether antisocial; many are quite gregarious, large populations dwelling in ground burrows an inch or two apart. These can cover vast areas and are known as "bee towns." The inhabitants are like recluses who can't quite take the final step of cutting themselves off completely from their own kind. A nesting site studied in Utah contained some two hundred thousand female bees, covering several acres.

We have no way of knowing what honeybees think of this life-style, if they envy the freedom it brings, but scientists believe that wild bees may be in a stage of development on their way to becoming social bees. Groups of individuals occasionally are found nesting together at night on a tree branch; they collect on the same branch every night and disperse during the day, possibly experimenting with a new way of life but still undecided and not wanting the neighbors to catch them at it.

Some female solitaires go a step further by laying their eggs together in a single nest, another step toward communal living. Often a community of solitary bees will stack one on top of another as a single unit. Although some varieties are handicapped by lack of a stinger, they are biters. Stinging bees are

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said to be more productive as pollinators than biters, indicating a connection between the two.

While solitary bees have not made it socially as yet, they are highly valued as pollinators; they are especially effective in servicing wild plants and out-of-the-way growths, such as forests and ranges, not ordinarily visited by honeybees. Many are specialists, concentrating on various growths which depend on them for their existence. Solitary bees do not store great surpluses of honey, in the manner of honeybees, but gather only as much nectar as they need for their own use. This makes them more efficient, as they do not make repeated trips to a hive to unload, but, on the other hand, they tend to stop working when their needs are met.

Researchers are attempting to colonize one variety, the wild orchard bee, which normally lives in beetle holes or in old lumber and logs. To tempt it to a more domestic life, holes are bored in wood and plastic blocks, a kind of bee condominium. Success has been limited, but a few do move into these homes and others follow, in the best middle-class tradition of social mimicry. The wild orchard bees are driven to orchards, where they do their job, and then are driven to another site. They are, in effect, being turned into migratory workers following the harvest, which wouldn't seem to be exactly what nature had in mind for them.

Another relative of the honeybee that has made its mark as a pollinator is the bumblebee, or humblebee as she is known in England. *MBF* Bumblebees, almost twice the size of honeybees, are regular visitors to the fields in summer, working alongside honeybees and frequently mistaken for them. Bumblebees are also socially inclined but are considered to be more primitive in development than honeybees. The female is impregnated in the fall and she alone survives the winter, snuggled into a hole in the earth, or some protected crevice, occasionally rousing herself to sip from a small pot of honey at her side.

Come spring, the female bumblebee lays eggs in the nest,

and with her offspring forms a working colony. As the young bumblebees develop, they gather nectar while their mother devotes herself full time to laying eggs. Bumblebees pollinate in the same way that honeybees do, pollen clinging to their large hairy bodies. Often they visit the same flowers, but bumblebees have longer tongues and can reach nectar in plants that are inaccessible to honeybees. Bumblebees are especially effective in pollinating red clover; their greater weight enables them to depress the wing petals of the blooms so they can gather the nectar within, at the same time pollinating the plant.

Darwin uses the bumblebee to illustrate one of nature's more complex and unlikely relationships: the amount of red clover produced depends on the number of bumblebees, and the number of bumblebees depends on the number of field mice, who eat the nests and combs of bumblebees; the number of mice, in turn, depends on the number of cats present. Ultimately, the amount of red clover depends on the number of cats. Large crops of red clover were found around English villages because of the number of cats. Most relationships in nature are more subtle, probably unrecognized because cause and effect are so far removed and invisible, but we interfere with natural processes at our own risk, usually to our disadvantage.

The less virtuous members of the bee family, referred to in the opening of this section, are wild bees who have become thieves, living off the labor of others, and parasites. Parasitism, like theft, is prevalent in nature, as it abounds in most human societies. To nature, I suppose, it is just another means of reproducing and, at the same time, a form of "balancing the books" among the species.

Insects, particularly wild bees, have been wonderfully innovative and have displayed wide variations in technique. Some bee parasites spend their days searching out the nests of other bees. They sneak into the nursery, depositing eggs, which the unsuspecting host mother will rear as her own offspring; before departing, the parasite mother may eat a few of the host moth-

By the time the queen is freed from her cage, usually in two to four days, the hive is ready for her to begin laying eggs. Should the colony be disturbed too soon, by checking to see if the queen has been released, the workers may kill the queen, probably holding her responsible for this latest disruption. Bees, the evidence suggests, can act as irrationally and self-destructively as human societies.

Killing a queen is a monstrous act for bees. Usually it happens only in moments of great stress, in panic, rage, by accident, or calculation if the colony is dissatisfied with her performance; in the latter instance a successor queen raised by the colony is waiting to replace the failing or rejected sovereign. A queen marked for death, or killed in pique or panic, may be stung fatally by the workers, but this is rare, at best. Some authorities insist it never happens. No individual or "hit squad" apparently wants to take on such a horrendous responsibility as regicide. By this rash act of aggression, comparable to assassinating a president or leader and causing the reshaping of an entire society, a colony may destroy not only its queen but its means of existence.

Queens are sometimes killed accidentally when the entire colony, if threatened, forms a solid protective mass around her and inadvertently smothers or crushes her. For the luckless queen, the usual life-sustaining cluster becomes a death trap.

A queen marked for execution is usually assassinated by the entire colony in a formalized death ritual known as "balling the queen." Her only offense, probably, is that she no longer is able to lay enough eggs to satisfy her daughters, now turned executioners. All members of the colony participate. They form a solid ball around their mother, pressing harder and harder. The ball becomes progressively smaller as it squeezes in, until the queen is crushed, suffocated, or starved.

This is an ingenious political solution. No single executioner can be blamed. No culprits are fingered and punished as enemies of the state. There can be no individual blame or account-

ability in a collective act of homicide. There is no cover-up to expose.

It is, in effect, like a mob lynching. But we have no idea whether the "mob" is set into motion by judicial decision or triggered by an enraged individual gone berserk, whose own excitement inflamed murderous passions in others. Some authorities believe the lethal mob is set in motion by one or two ringleaders or bees that panicked, which is common to mobs. But whether by judicial fiat or spontaneous madness, the queen must die.

SIXTEEN



I have a neighbor who loves flowers with the passion of the bees themselves. We were discussing the bees from my hives who visit his yard. How is it, he asked, that if bees are smart enough to fly miles for honey and find their way home, when they get trapped inside the house they stay against a windowpane instead of having sense enough to go out an open window?

He thought this indicated a lack of intelligence in bees. I pointed out that bees always fly toward the light. In nature there is no equivalent of glass. Their behavior suggests not a want of intelligence but a lack of experience. Light, to a bee, represents warmth and life; it must be akin to the sun itself. What other brilliant light exists in nature? Moving toward sunlight is, for a bee, instinctive and logical.

Maurice Maeterlinck, in his classic, The Life of the Bee, cited an experiment in which a fly was able to escape from a bottle in which it was placed more readily than did a bee, the exper-

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complex the plan, generally, the greater the intelligence or the higher the order. By looking at the plan it is usually possible to tell much about those who conceived and executed it. A city built by bees is an indication of their intelligence or, at least, the order imposed upon them and which they obey. The hive, provided by man and furnished by bees, with its interchangeable supers and removable frames, its storage vats and passageways, nursery and nest, is an almost perfect representation of the architectural dictum that form follows function. It is perfect of its kind, accommodating both man and bees.

The work continues until thousands and thousands of the contiguous six-sided wax combs are completed. More astonishing, both sides of the sheets of foundation are drawn out at once by crews working independently of one another on opposite sides of the frames. Somehow the workers are in constant communication through a solid barrier of wax, as the base of each cell lies precisely at the point where the three sides of the cells on the opposite side meet to give greater strength. How do we explain this fact of engineering, this mystery of communication?

Few of nature's creations are more acclaimed than new honeycomb, the creamy hexagon cells exuding their fragrance of flowers and honey; this unique material, with its rich incense, is the essence of life in the hive, formed of the juices of the bees themselves, combining beauty, great strength, and efficiency.

NINETEEN



The hexagon cells of beeswax, like the substance they are made of, have been studied, analyzed, and measured, but these calculations fail to capture the genius

of the bee. Each cell is about a half-inch deep, but can be made deeper. All are not uniform in size, if inspected closely; larger cells are built for drone brood than for the smaller workers and still larger ones for queens. To compensate for the discrepancy in size, bees build so-called transition cells to make the finished comb come out even. These odd-shaped accommodation cells are used only to store honey or pollen and are not for rearing brood. MBF

Comb always looks the same, but there are minute variations from cell to cell, comb to comb, and hive to hive. Nature's universal rule in all things is diversity within uniformity. She could be saying, "I will give you the design, but you must figure out how to achieve it." Thus, we have likeness but not sameness, infinite variety of execution within conformity of design.

When sheets of foundation are drawn out, there is normally just enough space between the adjoining frames for two bees to pass, the "bee space" I previously wrote about. Later, alleys and passageways will be chewed in the combs so the workers can move quickly to and from the cradles and great storage vaults of honey; these thoroughfares differ from one hive to another, depending on how the architects or planners conceive their city, or the workers take it upon themselves to alter it, taking shortcuts or improvising new routes.

Allowances apparently are made for local differences and creative impulses among colonies. Impromptu cuts in comb sometimes seem to be based on whimsy alone, serving no real purpose to the observer and seeming to contradict the meaningful industry that we expect. I have seen corners chewed out of honeycomb far from the scene of action. Why this odd and unnecessary passageway? I speculated. Later it occurred to me that this was not intended as a passageway at all—the bees had needed wax for a quick patch or repair and this was a convenient source that could be replaced when the crisis had passed, or left if not needed.

If there are damaged or incomplete combs in the hive when

it is occupied, the bees will reconstruct them rather than start afresh. These efficient engineers know the work goes faster restoring, enlarging, or completing old or damaged comb rather than building new. By the same logic, they prefer drawing out foundation, with its embossed designs, to starting from scratch.

The science of modern beekeeping is based largely on that one simple truth: bees will draw out foundation before they will build from nothing. This alone makes possible the movable frames and interchangeable hive bodies which enable beekeepers to rob their charges without killing them. Beekeeping is, in essence, taking advantage of the bee's instinct to produce in the most efficient way. She is betrayed by her instinct, as man may be the victim of his own intelligence and loss of instinct.

TWENTY



He knows his own need to be practical at all costs.

It is not by chance alone that bees decided upon the delicate hexagon shape for their honeycomb. Mathematicians consider it the most efficient form possible, providing a cask that holds a maximum of honey with a minimum of wax. The walls are so incredibly thin that it would take two thousand to three thousand laid on top of one another to equal a single inch. At the same time, the shape and substance of which it is made have such amazing tensile strength that one pound of beeswax will form thirty-three thousand cells holding twenty-two pounds of honey. A single hive body filled with honey weighs about eighty pounds, making backache a common ailment among beekeepers.

Beeswax is as mysterious as it is remarkable. Although the major ingredients are known, it has never been duplicated in

also - they have made calculations

the laboratory. It has an antiseptic quality that allows it to last for centuries; beeswax was found in the tombs of the pharaohs, still pliable, and it has been rescued from the sea after years of immersion with no damage. Beeswax is widely used in industry, with more than a million pounds used annually in cosmetics alone, but a shortcoming that limits its usefulness is the wide variation in quality, depending on the comb from which it is rendered.

For many years scientists disagreed over whether bees purposely designed and used the hexagon because of its efficiency, or it evolved as a result of natural forces. Those supporting the latter thesis argued that if numerous round cylinders or objects are pressed together they will be forced into a six-sided figure, and they proved it by experiments with peas and other substances and mathematical calculations. Their theory, sound as it appeared, was discredited in other experiments using bees. Forced to build single figures, the bees formed a six-sided base and maintained the hexagon while drawing it out. The figures were not as perfect as in comb but there was no denying their intention. Bees also have their own clever mathematicians, engineers, and architects.

In the wild, honeybees build the same hexagon-shaped combs, but not in the orderly arrangement provided by foundation. Foundation is well named. It is the basis of hive order. When bees make comb on their own, not guided by foundation, it may take on the most fantastic shapes, with greater irregularity in the sizes of the individual cells, as the artists and architects, having no matrix to inhibit them, are free to give vent to their own creativity or rash impulses. But invariably, regardless of design, the bee mathematicians insist upon the same six-sided cells, even in combs twisted in wild pretzel-like configurations. Bees are beholden to the hexagon imperative while free to choose their own art form.

Even in man-made hives, bees frequently ignore or violate the factory discipline thrust upon them by orderly frames of

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Bees are, however, above all, practical. They prefer pollen from a single type of blossom when it is available, but if it isn't, or if there is a shortage or they tire and one type of blossom is exhausted, they simply switch to another. This may be the root of infidelity among all species: if the object of commitment is not convenient, will not another at hand do just as well?

Nature, always amoral in sex, seems to be at least agreeable to the cross-pollination of plants, occasionally using the method to produce beautiful and useful new varieties. This may be evolution in operation, or nature's way of being experimental and permissive, but she doesn't want to overdo it, so it happens only now and then.

TWENTY-TWO



Pollen is to bee larvae what bread is to humans—the staff of life; mixed with honey and stored in combs, it is well named bee bread, providing not only the sustenance of bee life but having a breadlike taste. Pollen is a source of protein, while honey gives energy for growth and warmth. Nutritionally pollen is a complete food, consisting of a high percentage of nitrogen, sulfur, phosphorus, carbohydrates, oil, and sugars; it has at least ten vitamins and a dozen minerals; an average colony consumes about seventy pounds annually for its own use, representing a staggering number of bee flights and industry.

Gathering the tiny grains of pollen must be a tedious business at best, going all day from flower to flower, taking a speck here, a speck there. But is it any more tiresome or boring than squandering one's days and life juices performing any of the infinite repetitive tasks most humans must do in order to live?

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Bees, unlike many humans, seem content enough to earn their bee-bread by the "sweat of their brow."

To a beekeeper, seeing bees return bearing pollen is a reassuring sight. That and the hum of contentment within tell him that the queen is laying brood and all is well. On a summer day, pollen-laden bees return to the hive in a procession, baskets loaded, bumping down on the landing board and scurrying inside with their treasure.

Inside the hive, the pollen bearer scurries up a frame of honeycomb, which probably holds hundreds of eggs and larvae. She selects a cell that is empty or only partly full of pollen, usually near the upper edge of the frame where the substance is deposited close to the brood. Thrusting her rear legs with the pollen baskets into the cell, supporting her abdomen on the edge and clinging with her forelegs, she uses the brushes on her middle legs to kick free the pollen from her baskets. These brushes have many uses, including that of a handkerchief to wipe pollen dust from her eyes. A bee is really quite well equipped for almost any emergency encountered in line of duty.

Pollen is not used at once, in the way that the devilish propolis is. The honeybee leaves her load where it falls and hurries off in search of more. Her attitude suggests that she considers her time too brief and valuable to squander it on a chore that a less-skilled hive member can handle.

Later a young house bee, not yet ready for field duty, will pack the pollen into the cell, or she may move it elsewhere and combine it with deposits left by other workers. Pollen is then capped with a mixture of honey and beeswax that will preserve it indefinitely.

In recent years pollen has become another article of commerce provided by bees. Ingenious traps have been devised to rob them of the substance for human use. Bees are forced to pass through contraptions made of fine wires, which scrape the pollen off their bodies and it falls through wire mesh into collecting pits; an unbelievable amount of pollen is collected in

At sea this
tells it to Spear

this way, but the more that is taken, the harder the guileless bees work to gather new supplies. The harder she works, the more she is exploited. Should we pity her or exalt her labor?

The bee is not the slave of man but of her own instinct.

Pollen taken from bees is sold as a wonder food by health stores. Athletes, and especially runners, are major users, claiming that it gives them stamina and energy. Aside from pollen's inherent food values, researchers have been unable to substantiate the glories attributed to it. But those who buy and sell this life force of flowering plants and embryo bees insist that it contains mysterious and marvelous powers that elude the test tube, a testimony that the bees themselves undoubtedly would endorse.

TWENTY-THREE



In visiting the fields for pollen and nectar and performing hive tasks, it is not to the future alone that the bee pays tribute, but to ancient memories that speak in silent voices heard across millions of years. One of these voices tells her to gather propolis, that sticky, resinous material with which she seals her hive against the elements.

The word propolis is of Greek derivation, pro meaning before and polis city, a reference to its use by wild bees to close off their cities, which were little more than an exposed cavity in a tree or the face of a cliff. Propolis is no longer necessary in today's man-made hives, but is lavishly used just the same, as if the nest were still exposed and had to be protected against the weather.

Propolis itself is as sticky when the weather is hot as it is brittle when cold. Often it is described as sap, but it is of a different chemical composition. It comes primarily from trees.

and is very sticky, which is why it is known as "bee glue." Once it gets on the fingers it is virtually impossible to remove without the use of mineral spirits, or rubbing the fingers vigorously in the dirt, removing propolis and skin together.

Bees go almost berserk in its use, as if trying to keep out the elements and all intruders as well. They not only seal each crevice, but may lock together every movable part of the hive until it is a solid unit and must be pried apart with the steel hive tool; sometimes old wood splits before the propolized parts separate.

The longer propolis sets, the harder it gets. In cold weather it shatters like ice. It has certain protective or antiseptic qualities, and bees spread it thinly in cells of honeycomb as a seal, like varnish or shellac, to protect the surface from drying out. Otherwise it is a nuisance to beekeepers and must be scraped off the hives when they are examined. To the bees this must seem a wanton act of vandalism, undoing all of their trouble gathering it.

Bees gather propolis much as they collect pollen, but even for them it is a problem. When the days are warm enough for the stuff to be soft and pliable, a honeybee lights on a juicy bud and uses her mouthparts to tear out a chunk of the material, careful not to let the clinging filaments entangle her. She removes it carefully from her mandibles with the claws on her rear legs and stuffs it into her pollen baskets where it is kneaded into a ball-like shape, a wonderfully adroit maneuver performed while she is flying to another bud for more.

When both baskets are full, containing about a drop of propolis in all, she returns to the hive. What follows has its comic aspects, but to the bee it must be irksome and hard on her dignity. Unable to remove the gooey stuff herself, she clings desperately to the hive, while other bees tear off the propolis with their mandibles. Often the carrier is pulled loose from her moorings and there appears to be ill temper and recriminations on both sides.

Bees often return from gathering propolis late in the day and

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by then the stuff has set so hard that it cannot be removed until the temperature rises again. The carrier is almost immobile, and walks as if she has a cast on her leg. In the morning she doesn't go directly to the fields but suns herself until the substance softens and can be removed.

Propolis, unlike pollen, is not stored until needed but is used at once, perhaps smeared on an inner cover, a wall, or used to bond frames to their supporting edges, often serving no apparent purpose and wasteful of time and effort, or so it seems, although it is possible that there is a purpose that eludes us.

How does a propolis-gatherer feel about this? Is it considered hazardous duty or punishment? Is it an honor, requiring strength and agility and entailing risk? Does she ever look about her and see the propolis she gathered with such difficulty being smeared senselessly about and grumble to herself, "Why am I doing this?"

Or do we assume that the force of instinct is so powerful that she obeys without question? Will evolution ever relent and free our modern bee of this ancient burden that no longer seems to have meaning? Or is she destined forever to respond to the same voices that spoke to her wild ancestors?

TWENTY-FOUR



Nature both gives and takes life with a lavish hand. As her first law is multiplication, her second is decimation. Thus we have the great cycle of life begetting death and death begetting life, two mighty forces as divergent and yet complementary as the mature Atlantic salmon swimming from the vast sea up an obscure stream to spawn in the pond where it was conceived, great armies of lemmings periodically

marching toward the sea in what is, in effect, a suicidal migration, or huge herds of pilot whales inexplicably beaching themselves to die.

I have already noted the prolific reproduction of flies, aphids, and some other creatures. A single oyster can discharge 125 million eggs, or spat as it is called. But even this prodigious output is topped by a termite queen that was clocked laying one egg every second, eighty thousand a day, or more than twenty-eight million a year, and capable of continuing at that brisk pace for up to fifty years, which must be some kind of record even among insects. Such fecundity makes the queen honeybee's two thousand eggs a day seem small potatoes indeed. MBF

The most primitive and elementary form of all life is probably an egg, possibly nature's most ingenious creation. An egg may produce a single individual, divide and produce two, or keep dividing and produce many. In some insect species a single egg may result in fifteen hundred to twenty-five hundred individuals. Nearly three thousand small parasitic wasps were counted emerging from a caterpillar in which not more than a dozen eggs had been laid.

Bees do not go in for this sort of thing, really a kind of reproductive exhibitionism. One bee per egg! That is the rule. Within each egg is the matrix of the bee's life, millions of years of experience condensed in one tiny fragment of protoplasm, the intelligence or programming called instinct, the destiny she will fulfill. Each egg is so small that it would take 240,000 to weigh one ounce. Imagine! The white, cylinder-shaped egg, hardly bigger than the tip of a needle and almost invisible to old eyes, is deposited in its cradle by the queen mother, standing on end, held upright by a dab of adhesive. After three days it begins to tilt over on its side, preparatory to hatching, the declining angle indicating its age. What unknown sensors rule the unfolding drama in this speck of living matter? MBF

The egg is the locus of our universe, the origin of life, which not even the greatest minds among us can define, let alone

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Stupidity of people
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explain or duplicate. An egg forms spontaneously inside of a body. It is fertilized by sperm from another body. Out of this union arises a third and new being, like the pair that generated it, yet different, a unique individual with characteristics of its parents and still a personality and character of its own. Is this beginning of a new life not miracle enough for anyone?

TWENTY-FIVE



For the first three days after the egg hatches all bee larvae are fed nothing but royal jelly, one of the wonder foods of nature; it is a pasty, creamy white substance with a strong odor and a somewhat bitter taste, known to be rich in vitamins and containing sugar, proteins, and some organic acids. But there are also mysterious properties that escape the chemist's scrutiny and defy his ingenuity. Royal jelly, like life itself, cannot be synthesized or duplicated in the laboratory. For all of the genius of modern science, nature is still able to withhold her most profound secrets, something like the wily cook who gives away her favorite recipe but omits a key ingredient.

Royal jelly has also become a popular and expensive health food, with miraculous powers attributed to it, but it appears to have a more profound effect on embryo bees than on humans searching for the elusive fountain of youth. Royal jelly is produced only by young nurse bees from glands in their heads. After a few days they are no longer capable of secreting the substance and move along to other tasks.

The most amazing property of royal jelly is that any bee larva from a fertilized egg fed nothing but the substance will become a queen. Other embryos, taken off the substance after

1938 A. H. E. Sperry in relation to himself.

three days, become workers; they are then fed a less exotic diet of pollen mixed with saliva and its unknowns from nurse bees. so-called worker jelly, that is mixed with honey. Oddly enough, worker jelly alone will not support continued larval development as royal jelly does, although it has a higher protein content. Drone larvae, after three days on a diet of royal jelly, are fed a more coarse mixture of undigested pollen and honey.

How these various dietary elements or their absence cause such profound physiological and morphological differences is not known. It is another riddle of nature, like an unfolding flower revealing its beauty but withholding its secrets. But the bees could properly say, "You are what you eat."

TWENTY-SIX



An egg, or a newly hatched larva, is a beautiful and welcome sight to a beekeeper. It means the queen is present and working. There is no need to search her out, as the eggs and larvae are proof enough that she is on the job.

The larva, or grub, is pearly white and lies curled in the bottom of the cell in a crescent shape, moving occasionally to some unknown command to keep in contact with the food supply. Nurse bees start supplying the egg with royal jelly even before it hatches; the emerging larva virtually floats in a pool of the secretion, absorbing it through an almost-transparent skin. Royal jelly, along with its other mysterious qualities, is so thoroughly utilized by the crib occupant that there are no bodily wastes to be disposed of, a remarkable biological feat in itself. The secretion is also believed to help eggs hatch.

From the time an egg is deposited in a cell, nurse bees keep visiting it. No other species is known to lavish such attention

A. H. to Sperry

on their newborn. Most insects deposit their eggs in a waiting food supply, often in someone's garden, and that's an end to it between parent and progeny. The young must fend for themselves while their mother is off having new affairs and laying more eggs.

The nursery in a beehive is incredibly busy during the brood season. Nurse bees visit each cradle to look in on or feed the inhabitant on an average of three hundred visits or feedings in a twenty-four-hour period, a total of ten thousand during the growth stage; and yet, despite all of this coming and going, there never appears to be any confusion, but only purposeful activity. The nurse bees, it will be remembered, are only hours or days out of the crib themselves, and are already performing their first hive chore automatically, as they will their subsequent tasks.

There must be some kind of system or schedule to regulate the feedings, other than a hit-or-miss operation with passing nurse bees popping a bit of food into a waiting "mouth" each time she passes. If no one knew what anyone else was doing, it would seem that some embryos would be overfed while others would starve. This doesn't happen, to my knowledge, but who does keep track of who has and who hasn't been fed among their multitude of cradles and formless bodies without known voices to complain or summon help?

The amount of food given at each feeding is infinitesimal. A popular saying among beekeepers is that it takes one cell of honey to produce one bee, a frame of honey for a frame of bees. But that hoary expression may be incorrect; research now indicates that embryo bees may require less food than was formerly believed, and one cell of honey provides food for as many as five grubs. Nature is more efficient than given credit for.

An average colony uses about one and a half pounds of honey a day in rearing brood during the peak season. Since it takes four pounds of nectar to produce a single pound of honey, the support system for the young takes most of a colony's energies.

* very financially
sensitive

The average colony requires about four hundred to five hundred pounds of honey annually for its own use; that means almost two thousand pounds of nectar must be gathered by each hive. The stronger a colony is, the harder it must work to maintain itself, and the more complex its logistics.

The constant feeding of larvae causes exceedingly fast growth. Upon emerging from an egg, a grub weighs only a tenth of a milligram, and after five days on a steady diet of honey and pollen the average weight soars to 150 milligrams. If the same held true for a baby, I once read, an infant weighing six pounds at birth would, within a few days, weigh four tons if it were fed and responded like a bee.

As the wormlike figure curled in the bottom of the cell outgrows its horizontal position after a few days, it wriggles about so it stands upright, the head facing the light, in obedience to a command that regulates its growth.

For six days it remains in the grub stage, continuing to be fed steadily, while taking on a more definitive outline. Then nurse bees cover the cell with a cap made of wax, pollen, or a combination of the two. Each nurse seems to have some latitude in her choice of materials, but her creativity must stop there; the cap is slightly raised, or convex, to permit growth, and is porous to admit air for breathing.

A single hive can contain up to twenty thousand cells of brood, the occupants in various stages of development. The eggs and tiny unformed bodies are in an oval shape, like a football, and ringed with pollen on the upper corners. I never remove a frame of brood from a hive without being stirred by the exquisite artistry in the creation of new life. The bees do not seem to resent this intrusion during periodic inspections, if it occurs during fine weather, almost as if they are pleased to have their handiwork admired.

TWENTY-SEVEN



Once the cell is capped, another miracle takes place as the occupant within completes her development. Honeybees, as members of the insect order hymenoptera, undergo a complete metamorphosis, changing from one form to another.

These growth stages are common among insects undergoing metamorphosis, some having as many as seventeen separate transformations; at each stage the change may be so radical that they appear to be different types of individuals. Other insects undergo only partial metamorphosis, like that garden terrorist the squash bug, which increases in size through a series of molts while remaining active and recognizable in form. A third group, which includes the speedy silverfish, hatches from eggs as perfect miniature replicas of their parents, growing to adulthood in a process of direct development, much as a human infant reaches maturity.

The initial growth stages of the bee are as egg and then as larva. In the larval or grub stage she is largely formless, little more than a worm, somewhat thick in the middle and tapered at each end, the head slightly larger than the tail with only a suggestion of facial features. She admittedly isn't much to look at in this stage.

The third stage of development takes place after the cell is capped. The grub, again obeying some internal command, spins a cocoon of fine hair around itself, like a silken shroud, and pupates, or rests. This is the first time the embryo bee takes a hand in her own development, previously leaving everything to the nurses. It is here, out of sight, that nature works her miracle, transforming this shapeless living matter into highly

specialized organs in a new and more complex form of life.

Do we here have a speeded-up process of evolution, radical changes that once required millions of years now taking place in days? What did the original bee look like as it descended from its Carboniferous ancestor 250 million years or so back, when the first six-legged creatures appeared and the earth labored in converting carbon dioxide into coal?

Our little contemporary worker bee presumably does not concern herself with such idle speculation. After spending three days as an egg and six in the larval stage, she pupates in her cocoon for twelve days, a total of twenty-one days in all, compared to sixteen for her queen mother and twenty-four for her drone brother. The honeybee, so far as is known, has not deviated from her schedule and incipient life-style for millions of years, while other forms were experimenting and changing around her, as if she decided long ago that she had a good thing going and would stay with it, and evolution could go hang.

TWENTY-EIGHT



From the time a worker bee crawls unsteadily out of her crib, all golden, downy, all innocence and new life itself, she is ready to embark on her work. She has reached her fourth and last stage of development, perfect of her kind, structurally suited to the tasks she must perform. The first day is spent gaining strength and, it seems reasonable to assume, trying to comprehend the strange situation into which she has suddenly been thrust.

Anatomically, she is made up of three parts, with a head, thorax, and abdomen, and covered with a hard outside skeleton, or exoskeleton, made of chitin, a hard, horny substance

found throughout nature. Chitin serves as a kind of cast or armor to protect the soft inner tissues, the opposite of a human's inner skeleton and soft outer body.

In her head are the mouthparts, set vertically in the face, with powerful mandibles, or jaws, that chew sideways instead of up and down like a person. Her tongue is a strawlike sucking tube used to extract nectar from the most delicate flowers; the length of the tongue, or tube, in sucking insects determines which flowers they can gather nectar from and pollinate; there is considerable specialization among them.

On each side of her head are two huge compound eyes, each having sixty-three hundred facets, in effect like so many individual eyes pointing in different directions, the tiny immovable lenses providing a wide area of fixed vision. There are, in addition, three simple eyes grouped together on top of a worker's head, the two sets of eyes enabling her to see near and far objects and to distinguish among the colors within her visual range, but researchers do not agree on which set of eyes performs which task, information that is probably more important to investigators than to bees.

The drone has two enormous bulging compound eyes on top of his head, giving him a somewhat comical, leering expression; each eye has an extraordinary thirteen thousand fixed lenses, presumably to help him track the queen during the mating flight, and possibly to keep a few thousand eyes on competing drones in the mating chase to see how he is faring.

The queen, who lives out her days in almost perpetual darkness within the hive, has three compound eyes, but each has only thirty-nine hundred lenses, as if nature were reluctant to waste unnecessary equipment on her. This is another example of nature's efficiency in doling out equipment; each functioning part of a colony is provided the degree of sight necessary to fulfill its role.

In the center of her head are two antennae, commonly called feelers, used not only for feeling but also for communication.

hearing, smelling, and probably other undetermined functions. With her antennae she probes the darkness of the hive, measures danger, distinguishes friend from foe, and sniffs out pollen and nectar. A bee's antennae may be the primary equipment that puts her in touch with forces that elude researchers who try to cross that fine and invisible line between science and the unknown powers she is tapped into.

A drone has 37,800 nostril-like olfactory centers in each antenna, compared to only 500 in a worker, again, probably, to aid him in the nuptial flight; at the same time it indicates how nature favors reproductive capacity over the search for food.

The acute sensory organs in an antenna not only enable a worker to fulfill her complex duties in the darkness of the hive and to sniff out fruit trees or fields of clover in bloom a mile away, but it may have another and more sophisticated role, helping bees and other insects to transmit and receive electromagnetic signals, much as humans use electronic equipment for broadcasting and receiving. If confirmed, this could explain a long-standing mystery of how insects invite their friends and relatives to enjoy the bounty of lush gardens they discover.

Completing the organs found in a bee's head are the glands that help produce the secretions with which she feeds the young, and that possibly regulate the performing of various hive functions.

Joined to the head is the thorax, or upper body, and attached to it are two pair of silvery, veined wings and three pairs of legs. On the front legs are small brushes used to wipe pollen and dust from the eyes; there are also small grooves for cleaning the antennae of pollen. Workers are forever cleaning their antennae, almost like a vain young girl combing her hair. Two hooks on the terminal ends of each foot make possible clustering, and between the hooks is a sticky pad that enables a bee to walk on slick surfaces and vertical planes.

A bee's two pairs of wings make her a powerful flyer, able

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to buck raindrops almost as large as she is, fly against strong headwinds, and carry loads of nectar equal to her own weight. Her wings are stubby, but beat so rapidly that she is able to fly an estimated fifteen to twenty-five miles per hour. The double set of wings hook together in flight, providing power; when not flying they lie flat on the back, making it possible for her to crawl into the small cells of the hive to care for eggs and larvae. For her weight and size, a honeybee is said to fly faster and farther than any other winged creature. She is the opposite of her cousin, the cumbersome bumblebee who, according to aeronautical flight criteria, has been proved incapable of flight.

I like the joke on the bumblebee;
His wings are too small to hold him.
He really can't fly, professors agree
But nobody ever told him.

—Anon.

A honeybee's wings, as noted previously, beat 160 to 220 times per minute, according to the authoritative United States Department of Agriculture 1952 Yearbook, *Insects*, producing the note C sharp below middle C. The publication states that insect wings vary from 350 strokes a second (21,000 per minute) to as few as 6 per minute for the yellow swallowtail butterflies, which seem to float as much as they fly.

The bumblebee manages about 130 beats per minute (D above middle C); June bugs, 46 (F sharp, three octaves below middle C); dragonflies, 20 (F, four octaves below middle C); and the cabbage butterfly, another garden predator, 12, producing a sound inaudible to human ears. A housefly's wings beat only 190 times a minute (G flat below middle C), but with such vigor that she can travel up to 50 miles per hour. A fly's speed and agility are her primary means of defense, while a bee's power enables her to fly long distances with heavy loads of honey, which seems fair enough.

The third segment of a bee's body is her abdomen, separated from the thorax by a narrow waist. In a bee's abdomen are her honey sac, stomach, and intestines. Many believe that a bee's honey sac and her real stomach are one and the same; the crude and uninformed have called honey "bee vomit," but this is a libel. The honey sac lies directly on top of the stomach proper, separated by a shutoff valve so there is no mixing of the contents of the two. If a bee needs a quick pickup in flight, she has only to open the valve and let a bit of nectar or honey trickle into her stomach. When nectar is regurgitated from the honey sac, it contains enzymes that give honey its unique properties.

At the base of the abdomen, like a tiny tail, is the stinger, which will be dealt with later. On the abdomen are also the wax glands, previously referred to. Recent research has revealed that in the abdomen are cells containing iron, with nerves leading to these cells; they are believed to act as a navigational aid, enabling bees to sense the earth's magnetic field. If verified, this could help explain how bees return unerringly to their hives from distant fields. It has long been known that bees use the earth's magnetic field to sense direction, but it was not understood how it was done. It could also, possibly, yield insights into how birds, butterflies, turtles, and other migrating creatures and wanderers navigate over long distances.

A bee does not breathe like a person, taking in oxygen through the lungs, the blood transporting it throughout the body; rather, bees have tiny openings, like open portholes, along the length of the thorax and abdomen, and attached air-conducting ducts convey oxygen to nearly every nerve. Since hemoglobin is not needed to carry oxygen, a bee's blood is not red. This arrangement is satisfactory enough for most purposes, but nature obviously didn't count on insecticides. When poisons enter the breathing holes bees die of suffocation or destruction of the central nervous system; millions of bees, even whole apiaries, are wiped out every year by great toxic storms, particularly

job schedule broken down into the specific number of days spent on each succeeding task. But the progression from job to job is not so precise or straightforward as it was once believed to be. Studies at Cornell University have revealed that unforeseen factors may influence or interrupt the job progression that once seemed to proceed so unwaveringly for all; it is now recognized that there is more job specialization than was formerly believed, more individualism and flexibility within the framework of conformity. Once more nature has surprises for us, a greater diversity than we assumed.

THIRTY-ONE



There seem to be castes of bees that do different tasks, but most of the jobs are temporary, though a bee can stay on a job for a fairly long time," says P. K. Visscher, a Cornell professor. Dr. Visscher paid particular attention to "undertaker bees" who remove the dead from the hive, concluding that the small corps of morticians may refuse to do other jobs and others may refuse to do theirs. He found that about 1 percent of a colony's population takes care of the dead. About an hour after a bee dies, an undertaker bee picks up the body and carries it away, flying up to four hundred feet from the hive before dropping it. He finds it remarkable that a bee can carry a body equal to her own weight such a distance. "Bees," he says, "realize that keeping a dead body around threatens the health of the other bees by carrying disease attracting predators."

Dr. Visscher and other researchers are no longer so sure the bees are born genetically prepackaged to perform their multiple tasks on an inflexible biological timetable. Now they are

asking how bees fall heir to certain jobs. What determines which individuals will perform given tasks? Are they assigned by older bees? Is the division of labor dictated by chemical or other unknown cues? What causes an individual to stay on one particular job for a while before switching to another?

"It's a mystery," says Dr. Visscher. He and other scientists offer several theories to answer the questions they raise. One holds that a bee performs a job, becomes adept at it, and is resistant to take on other tasks with which she is less familiar. "A bee that gets good results by visiting a certain type of plant will become an expert in gathering nectar from its flower and will continue that job," he says. Another theory is that the size and weight of a bee, which can vary according to the size cell she was born in and the amount of food received as a larva, may determine the job performed, just as a human's physical build may predispose him or her to certain jobs and exclude others. A longer, heavier bee, for example, may wind up as a hive guard.

Another theory advanced upsets many existing notions about the uniform characteristics of colonies. It contends that since the queen has several mates on her nuptial flight—it was long believed that she had only one—her offspring will be a genetically mixed bag; some might have a predisposition to a particular type of job by reason of genes inherited from one father, while others might incline toward other tasks because of different characteristics passed along by another sire.

This is a revolutionary way of looking at bees, seeing them not only as an integrated unit but as individuals with personalities and eccentricities or abilities of their own. It also provides new insights into bee intelligence and personality; their job specialization and division of labor suggest that there may be more similarities between bees and human societies than was formerly thought. We may be subject to many of the same laws as bees, and that which we think is free will or choice may, in fact, be dictated by a higher power that we fail to

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job schedule broken down into the specific number of days spent on each succeeding task. But the progression from job to job is not so precise or straightforward as it was once believed to be. Studies at Cornell University have revealed that unforeseen factors may influence or interrupt the job progression that once seemed to proceed so unwaveringly for all; it is now recognized that there is more job specialization than was formerly believed, more individualism and flexibility within the framework of conformity. Once more nature has surprises for us, a greater diversity than we assumed.

THIRTY-ONE



There seem to be castes of bees that do different tasks, but most of the jobs are temporary, though a bee can stay on a job for a fairly long time," says P. K. Visscher, a Cornell professor. Dr. Visscher paid particular attention to "undertaker bees" who remove the dead from the hive, concluding that the small corps of morticians may refuse to do other jobs and others may refuse to do theirs. He found that about 1 percent of a colony's population takes care of the dead. About an hour after a bee dies, an undertaker bee picks up the body and carries it away, flying up to four hundred feet from the hive before dropping it. He finds it remarkable that a bee can carry a body equal to her own weight such a distance. "Bees," he says, "realize that keeping a dead body around threatens the health of the other bees by carrying disease or attracting predators."

Dr. Visscher and other researchers are no longer so sure the bees are born genetically prepackaged to perform their multiple tasks on an inflexible biological timetable. Now they are

asking how bees fall heir to certain jobs. What determines which individuals will perform given tasks? Are they assigned by older bees? Is the division of labor dictated by chemical or other unknown cues? What causes an individual to stay on one particular job for a while before switching to another?

"It's a mystery," says Dr. Visscher. He and other scientists offer several theories to answer the questions they raise. One holds that a bee performs a job, becomes adept at it, and is resistant to take on other tasks with which she is less familiar. "A bee that gets good results by visiting a certain type of plant will become an expert in gathering nectar from its flower and will continue that job," he says. Another theory is that the size and weight of a bee, which can vary according to the size cell she was born in and the amount of food received as a larva, may determine the job performed, just as a human's physical build may predispose him or her to certain jobs and exclude others. A longer, heavier bee, for example, may wind up as a hive guard.

Another theory advanced upsets many existing notions about the uniform characteristics of colonies. It contends that since the queen has several mates on her nuptial flight—it was long believed that she had only one—her offspring will be a genetically mixed bag; some might have a predisposition to a particular type of job by reason of genes inherited from one father, while others might incline toward other tasks because of different characteristics passed along by another sire.

This is a revolutionary way of looking at bees, seeing them not only as an integrated unit but as individuals with personalities and eccentricities or abilities of their own. It also provides new insights into bee intelligence and personality; their job specialization and division of labor suggest that there may be more similarities between bees and human societies than was formerly thought. We may be subject to many of the same laws as bees, and that which we think is free will or choice may, in fact, be dictated by a higher power that we fail to

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recognize. Do we, like bees, live by chance or design?

But is not something missing here in this account of bee specialization of labor? Are there not laggards, shirkers, renegades, misfits, and malcontents among them, and how are such deviates and nonconformists among the industrious dealt with? Perhaps the answer is to come. Dr. Roger A. Morse, also of Cornell and an authority on bees, says, "What we are learning is that the division of labor among honeybees is more finite and precisely defined than we had thought. There is still much to be learned."

One surprise that has turned up is that bees may not always be as industrious as once was believed. Most sources have held that foragers are rarely in the hive for more than five minutes between trips to the field. But one researcher now claims that bees have their own form of loafing or resting; after a foraging trip, he says, a field bee crawls into an empty cell and snugs in for a half-hour siesta; she is quiet but it is not known if she is asleep in the sense we know or merely resting. Upon arousing herself, apparently refreshed, she again takes off for the fields like Mediterranean people returning to work after a midday rest.

A more startling revelation appeared in the newsletter of the Northeastern Kansas Beekeepers Association, *The Bee Buzz*, which I subscribe to. Editor Maynard D. Curtis coolly disclosed that a USDA laboratory found that in 178 hours of consecutive study a bee spent 73 percent of her time "doing nothing," a figure that I am unable to accept with the equanimity of Editor Curtis.

Wherein does truth lie? In the legend or the lab? I like to think it is, in this case, in the lab; I can better identify with the honeybee if she does knock off now and then and isn't quite compulsively industrious; excessive virtue is somewhat intimidating.

"Busy as a bee!" Indeed!

THIRTY-TWO



Play flights are well named, characterized by what appear to be wild confusion and jubilation; there is much buzzing and daredevil aerobatics as the young aerialists circle and dart in daring swoops and dives, exulting in their vigor and release from the confinement of the hive and its tasks, resting their courage and measuring their strength. They have discovered the sunshine after the gloom and darkness of the hive; for the first time they are able to come and go on their own, free as they will ever be. New beekeepers, seeing their first play flight, often think something is amiss, that their bees have gone berserk.

It is, in a sense, a rite of passage, a kind of graduation exercise without the solemnity of diplomas, "Pomp and Circumstance," or a speaker proclaiming that the world is their oyster, or honeyflow, as it were. They first take short flights around the hive to taste freedom, become familiar with the terrain and memorize landmarks. Gradually they increase range and awareness, learning to orient their flight to the sun, that constant reference point that will guide them to and from distant fields of booty.

What urgency within tells the bee that she is ready for this final step from hive bee to fielder? Is she aware that already her life is half spent? Soon the wild exuberance of the play flight is gone. Almost at once, in the compression of time, she is responsible, sober, industrious, bent on fulfilling her duties, the moment of ecstasy gone, the sweetness of fleeting youth forever lost. What happens to bees, puppies, kittens, and children who so soon lose their capacity for play and joy? What abiding sadness is woven into the tapestry of life itself?

THIRTY-THREE



For a new fielder, the great adventure begins the first time she leaves the hive to forage and must find her way back. Is she nervous during this initial excursion? Does she keep repeating to herself various landmarks she can identify? Or does she depend on some kind of homing instinct, a route committed to memory or a navigational system known only to her? Whatever the method, it is almost eerie the way she can go two or three miles distant and fly directly to her own hive. The feat is more remarkable because of the manner in which large apiaries or beeyards are usually laid out.

Beehives are generally placed next to one another in rows, after identical rows, sometimes in pairs but often without even this small distinction. In large commercial operations there may be hundreds or even thousands of hives, all indistinguishable to the human eye, so many identical wooden boxes on some kind of platform, gleaming in the sun. And yet, in some unknown way, our initiate fielder, new to the game and loaded with nectar or pollen, is able to tell her own hive from all the others.

Occasionally a worker bee does mistakenly enter a strange hive, possibly due to a mental lapse or navigational error. This is known as "drifting"—is it due to daydreaming? If she arrives empty-handed, she is almost sure to be challenged by a sentry guarding the entrance and promptly thrown out. If she tries to bull her way into the hive, unable to accept her own error, she most likely will be mauled by the outraged inhabitants and lucky to escape with her life. A worker arriving at the wrong address with a load of nectar or pollen, however, may be permitted to enter without challenge, as a person with full pur-

is rarely denied entry into a bank, even if unknown and with no account number; an appearance of prosperity almost universally confers respectability and assures a welcome, a truth that seems to cut across all class lines among all species.

A drone who enters a strange hive by mistake is usually permitted to enter without challenge, which occurs frequently with drones, perhaps because of their limited intelligence. They pose no threat to steal the hive's wealth, and bees are too hospitable to begrudge giving a stranger a handout. Is this another example of sex discrimination, the male, as usual, coming out ahead? Do the female workers make allowances for male stupidity, or just like "having another male about the place"? Is there a bit of the coquette in these incomplete females? Who is to say?

Often a drone, mindlessly blundering into a strange hive, does not bother to go home but simply moves in as an adopted member of the community. A drone's primary loyalty seems to be to his stomach, apart from his fatal lust. He seems to feel that one set of "women" looking out for him is as good as another; the drone is a virtual fountainhead of rampant male chauvinism.

Worker bees are less adaptable to changing hives or locations than the absent-minded or stupid drones. Generally bees are thoroughly oriented to one tiny spot on this earth that is home. Move the hive only a few feet from its customary place and they will return to the original site. If a hive is to be moved from one spot to another, even in the same apiary, beekeepers first take it at least two miles to disorient the bees, and then transfer it to the new location. If, in moving a hive, the entrance is not completely blocked, the bees will escape and try to return to their former abode. Home is a compelling concept for most species, a refuge of safety in an often perilous world.

Curiously enough, among bees, the homing instinct varies from one race to another. Italian bees are especially prone to return to the hive's original location, even if it is moved only a few feet away. Other strains, particularly the darker races of

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THIRTY-SIX



In the hive's division of labor, no member is as specialized or vital as the queen. She alone is indispensable, her fate tied to that of the colony. A corps of workers attends her, caring for her every need, but we do not know whether this is a position of honor, or merely another job assumed or assigned by the unconscious hive logic called instinct or local authority. It is likely that no task performed by young bees is considered more important than caring for the queen.

Nonetheless, we are aware of no special privileges or prerogatives accorded members of her retinue. Indeed they function more as servants than as ladies in waiting, cleaning up her wastes, feeding, grooming, caressing and bathing her, licking her with their tongues, as she works almost without pause, her mechanical egg laying.

Much has been made of the circle of a dozen or so attendants surrounding the queen as she lays eggs. New beekeepers are told that the way to find the elusive queen is by first locating her circle of attendants. The attendants, it is claimed, never turn their backs on the queen, as befits a royal presence, even encouraging her to greater efforts as she moves from cell to cell, comb to comb, endlessly laying eggs around the clock during the busy season, even as she "sleeps," or does what passes for sleep.

Later I learned that the circle, as usually described, is more romantic myth than fact. Less fanciful accounts point out that the attendants gather around the queen only when she is being fed. This makes sense; the colony always controls how often and how much the queen is fed, as this regulates her egg laying. Too, if the attendants never broke ranks, it would rep-

sent many lost bee hours of work, contrary to hive principles.

Because of the enormous physical drain of laying so many eggs, the queen must eat frequently. The circle forms. An attendant opens her mouth, exuding a tidbit of honey. The queen flicks in her tongue for a snack, hardly breaking stride in her unremitting egg laying, a hive version of eating on the job. Another attendant also thrusts in her tongue for a quick pickup. There seems to be no objection to this sharing of the royal repast, so it must be fair game, a part of the job. Drones often take their food in the same manner, too lazy to go to the honey stores to feed themselves, a practice tolerated by their sisters, who may mark it up as another score to be settled in the fall.

The queen progresses from cell to cell, comb to comb, pausing only to inspect each crib to make sure that it meets her standards before depositing an egg, or perhaps to make sure she isn't confusing a drone cell for a worker crib so she will lay the proper egg. Royalty is notoriously absent-minded and it does take a bit of concentration to avoid mistakes. Occasionally a crib does not measure up, and the queen moves along to the next cell without leaving an egg behind. Her entourage follows, the committee members apparently satisfied with the queen's decision, and she continues to lay eggs, driven by the invisible and indefinable force that gives her no rest.

THIRTY-SEVEN



People unfamiliar with bees often think the queen rules the hive. Long ago it was believed that she was actually the king, with all of a sovereign's authority. This misconception was probably due to her being the largest mem-

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A queen emerge and mature in less time than is required for a worker or drone. We have already noted the physical differences between the queen and her daughters. She has neither their ardor nor their equipment to harvest the fields; her tongue is only about half as long as that of a worker, and even if she visited the blooming meadow she probably could not extract the nectar with her stub of a sucking-tube tongue.

Except for her brief mating flight, she spends her days in the darkness of the hive, a stranger to sunshine and flowers. Her eyesight is only about half that of the workers. A queen can live up to seven years, compared to the brief four- to six-week span of her daughters of summer, but she is usually worn out by her fertility exhausted, after a year or two.

While the queen's wings are short, they are extremely powerful. She can fly faster and higher than her daughters; only the most powerful and swift-flying drones can catch her in mating. Her stinger, although used only on other queens, is a deadly rapier-like instrument that she could easily sink into flesh, administering a painful wound or death to insects like herself, without damage to herself; but she will die rather than sting to defend herself.

The queen's true uniqueness and indispensability reside not in the external organs she has or lacks, but in the two large ovaries in her abdomen for the production of eggs, up to two thousand a day, as I have noted, an oviduct for their passage into the cell crib, and a spermatheca for the storage of sperm which enables her to lay fertilized eggs that become the workers who provide the nurturing qualities in which she is deficient, and unfertilized eggs that produce drones who will mate with future queens.

Everything about her is a contradiction. If queen she is, she is a queen with servants but no subjects. We assume that she is privy to nature's complex strategies only as a blind slave to her own needs. Would she accept her oppressed role if she had greater intelligence to comprehend it? Is it completely acciden-

tal that she is endowed with less brain power than her dim-witted sons or domineering daughters? Why is nature so parsimonious in doling out intelligence to those she exploits the most? Is it to spare them or to serve her own needs?

THIRTY-EIGHT



Because of her own biological complexity and built-in obsolescence, queens are subject to endless manipulation and frequent replacement. If bees decide that a queen is failing, they will replace her with a new queen of their own making in the process called "superseding," a nice euphemism for the premeditated murder of the old queen who will be supplanted by one of her own daughters.

In literary terms we have here the ingredients for a first-class Shakespearean drama: the reigning queen witlessly bringing about her own ruination by providing her successor, a secret privy council plotting against the throne and selecting from among candidates in the nursery the one to become the new regent, keeping the reigning sovereign in the dark so she will continue to serve until convenient to oust her in a coup d'etat, palace intrigues among the conspirators, the double bloody deeds of regicide and matricide by an assassin chosen by lot. We may further garnish our fanciful plot with a bit of sexual titillation: the handsome young prince who will win the beautiful princess, but only at cost of his own life, etc.

Bees do not share the human need for fantasies, romance, and contrived plots to divert them from the realities of life and its agitations, but there is little exaggeration in the scenario presented; the parts that apply are played out without dramatic embellishments as the bees go about their business of

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It was long thought that a queen mated but once. Now it is known that she may have many partners, seventeen in one study, but usually considerably fewer. She continues to mate until she has stored sperm enough to last her lifetime. Queens have been found with up to 7.5 million sperm, averaging about 5.5 million.

The triumphant male's organ still dangling from her, the now-fertile queen returns to the hive, a true femme fatale widowed in the conjugal act. Some researchers say she is received with wild excitement and joy, the exuberant workers eagerly removing the drone genitals and grooming her with their tongues. Others claim this is so much romantic nonsense and she is greeted with no unusual show of emotion. I do not know. I have never witnessed a nuptial homecoming.

Which version are we to believe? We must accept that which appeals to our own nature. The reception may vary from hive to hive, depending on how vital the mating flight is to the future of the hive. It seems reasonable enough to believe that a weak colony, dependent on the queen's successful return, would display a certain jubilation. In her now-fertile body is their future as a colony. For stronger colonies, with reserve princesses in waiting, who is to say what raptures they may express or suppress?

But what of the drones, defeated in the chase and now returned home? What do they think when they see the newly fertile queen return with her bizarre trophy? Will they push quite so hard to catch the next virgin who entices them? And what of the presiding hive mother? For her this moment of triumph can have only one ending. What, if anything, does she think?

FORTY-THREE



The mating flight does more than transform the princess into a queen. She takes on a new personality, no longer a flighty virgin running aimlessly about, almost unnoticed; she has matured physically, now lighter in color, suddenly grown longer, and assumes a stately quality, suggesting a sense of self or pride in her new role. The colony responds to this change and pays her homage as befits her new status and responsibility. Our giddy princess is now a queen in both name and fact.

If there is an old queen in the hive, or rival princesses, the new queen quickly disposes of them, making her the sole mother of the hive. In her spermatheca are the millions of sperm, and from her ovaries will come the outpouring of eggs. About forty-eight hours after mating she can start laying. At first, lacking experience and technique, she may deposit two or more eggs in a single cell, lay in an irregular pattern, or deposit drone eggs in worker cells or worker eggs in drone cells, with somewhat odd results, but soon she has the hang of it.

If she laid all of the eggs theoretically possible, about 2,000 in a twenty-four-hour period, it would amount to one very 43.2 seconds. If all eggs developed, in a week there would be 14,000 new bees, in three weeks 42,000, and in five weeks 70,000. Fortunately these figures are only theoretical or soon the world would be awash in bees. The queen, in fact, does not lay steadily at such a rapid rate, each queen developing her own pace and rhythm. Some eggs never hatch, and old bees keep dying off. The mathematics of calculator and laboratory are seldom those of nature. Bee colonies rarely exceed 80,000 or 100,000, at most.

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Even discounting the number of eggs laid, it is still a torrent of fecundity. As eggs are released through the tubelike oviduct, the queen can, by relaxing or contracting certain muscles, control whether sperm brushes the egg or is withheld, the choice determined by the size of the crib in which the egg is laid. The queen is able to use her front legs, like tiny callipers, to measure the size of the cell in the darkness.

As previously pointed out, an egg fertilized with male sperm becomes a female worker, while those not touched with sperm become drones. Thus, female qualities are provided by the male element, and male qualities by the female, a curious reversal found commonly in nature. A worker bee has a mother and father, while a drone has a mother and no father, making him not subject to the same double-parent genetic influences as his sisters.

All of this is quite complicated, and the process of bee reproduction was misunderstood for many years, despite a correct explanation as early as 1845 by an astute German beekeeper, the Reverend John Dzierzon, whose theory laid the foundation for the scientific study of bees. For another half-century it was commonly believed that the sex of a bee was determined by the size of the cell in which the egg was deposited, rather than vice versa, a conclusion based on the fact that the queen almost invariably laid worker eggs in smaller cells and drone eggs in the larger cribs.

The theory supporting this false conclusion was that the smaller cells pressed upon the queen's oviduct, forcing out sperm that fertilized the egg, and since no pressure was exerted by the larger drone cell she was therefore able to deposit egg unfertilized by sperm. "I see, therefore I believe!"—a problem Galileo ran into on a more cosmic scale. Humans have always had a talent for believing what they want to believe.

In a series of experiments in 1895 it was proved that the queen controls the sex of her offspring in the manner described, although some dichards still held that the sex was determined

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FORTY-FOUR



The queen strides regally over the honeycomb, picks a cell, inspects it briefly, and backs herself over it to deposit a single egg in the bottom. The pose would seem awkward, less than majestic, but she performs it with grace and dignity. She goes about her work methodically, inspecting each cradle and laying an egg or passing by those cells that do not measure up, hurrying on to the next. This, at least, is what we perceive.

Beyond that we have no insight into the level of insect consciousness, if it exists. There is no evidence that the queen takes pleasure in her work, or that she looks upon it as a necessary task and makes the best of her lot. She goes about her business as diligently as any housewife doing domestic chores. The process appears to be completely mechanical. But can we not believe that at least one part of her small brain is making small decisions as she inspects the individual cells, laying an egg or rejecting the crib as unfit?

One wonders. Is this the whole of it for her? Is there no other dimension for this mechanized, driven little creature? Is she, like most inhabitants of the earth, merely performing an imposed task with no comprehension of the grand scheme? Does man alone ponder the unfathomable riddle of existence?

Why do we dismiss other creatures with such cavalier indifference?

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"Why do we dismiss other creatures with such cavalier indifference?"

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He is laughing. "What the hell kind of beekeeper are you letting your bees swarm?" he says. Then he admits that his hive also "threw a swarm" the previous week. "I've been too busy to look after them," he explains, almost apologetically.

"I checked the hive last week and there were no swarm cells," I reply, and I detect the same note of apology in my voice.

We both know the bees are full of honey and euphoria and not likely to sting, so we sit under a nearby pine tree and watch the spectacle together.

FORTY-EIGHT



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Before a swarm can issue, elaborate preparations must be made. Queen cells are capped and pupating princesses await within. Even before building these swarm cells the bees raise drones so the virgin princesses will have mates. As soon as large numbers of drone cells appear, the colony has probably decided to swarm. Sexual logistics dictate this order when it is recalled that a drone takes twenty-one days to form compared to only sixteen for a queen, and twenty days more for a drone to become sexually functional, against only forty-eight hours for a queen. The decision to swarm is probably made at least a month before the actual departure.

Members of the swarm, just before leaving, fill themselves with honey; an average swarm carries with it about a pound and a half, enough to last several days and provide energy to build comb so the old queen can start laying brood at once. A hive without sufficient stores to spare will almost never throw a swarm.

On the day of departure all activity slows down. Bees that ordinarily would go to the fields hang around the hive, one

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the few times they will be seen loafing. Others cluster in a thick mat on the front of the hive; there is no room inside with so many bees at "home" and it is hot and uncomfortable. Only workers not included in the swarm go about their business as usual, the foragers departing for the fields and returning, as if all this unusual activity is no affair of theirs and they are not concerned. There is no suggestion of sentimental farewells.

Often it is believed that the queen leads the swarm, but this is not true; she is, as usual, a follower, taking orders. Several days earlier the bees cut down on her food so she will lay fewer eggs, becoming lighter and better able to fly. By departure time she may be a third smaller than usual and harder than ever to distinguish among the massed workers, themselves larger than usual after gorging on honey in preparation for leaving.

The queen not only doesn't lead the exodus from the hive, but is likely to be in the middle or near the end. She may be fearful and have to be pushed along, hesitate, or even try to drop back and have to be forced out. One thing is sure: the bees will not depart without her.

Swarming must be a traumatic experience for the queen who has never left the comforting darkness of the hive since her mating flight. She may, in terror or confusion, topple over the landing board and have difficulty rejoining the swarm, an indignity that must detract from the sublimity of the occasion.

If the queen has suffered the further indignity and mutilation of having her wings clipped, a drastic measure taken by some beekeepers to prevent swarming, she may fall off the landing board, incapable either of flying or returning to the safety of the hive, in which case she will perish. The swarm will then return to the hive, its mission aborted, the great moment turned into catastrophe.

A swarm is made up primarily of older workers, along with some younger bees and possibly a few fledglings who have never flown before. Young bees are needed to form wax and act as nurses. A swarm can consist of up to about 35,000 bees.

at apt July '44 seeing
himself as the creature whose
wounded bees looked to clip.

traptions to the barbaric practice of clipping the queen's wings. I have never been convinced that clipping is painless, as claimed; at least I have heard no testimony from a clipped queen to that effect, and nerve endings in the wings suggest that the operation may be painful. Even if painless, the bees themselves must find it displeasing to have their queen mutilated; a bee born with a deformity is immediately done away with.

The most common method of trying to prevent swarming is to cut out queen cells and even to destroy drone cells before the bees take off, but this is an almost hopeless task. Swarm cells must be eliminated every few days, and as soon as they are removed the bees build new ones. This is a bludgeoning approach to force nature into submission.

Some beekeepers try to outmaneuver the bees by various other stratagems, attempting to deal with the primary urge rather than its symptoms. One involves a device with little gates that must be opened and closed on various schedules to change the hive dynamics and thus thwart the swarm impulse; it was invented by a British beekeeper name Snelgrove, who wrote a book titled *The Control and Prevention of Swarming*. I built one of Snelgrove's contraptions but it was so complicated that I never installed it, fearing that the bees might become unbalanced trying to figure out which gate to use, and I was never quite sure of what Snelgrove had in mind.

Other stratagems are intended to deceive the bees into thinking they have swarmed when they have never really left home or keep them so preoccupied that they forget or neglect what they had in mind. A bee must keep her wits about her every minute if she is not to be taken in by her wily keeper.

Modern technology is now asserting itself in beekeeping, as it is changing most facets of life. In Great Britain, according to my bee newsletter, beekeepers have taken to installing microphones in hives. When about to swarm, bees make a distinctive sound, alerting the keeper so he can stop them. Somehow this seems a bit sneaky, spying on the bees in this way, buggin'

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them, as it were, unworthy of the British sense of fair play. I can't imagine bees giving into this sort of thing without making a fight of it.

Beekeeping, like most human endeavors affecting nature, has a primary law: tampering begets tampering. Nature, as we now recognize, is delicately balanced. When one change is made, others must follow to accommodate the first disruption. This often sets in motion a chain of unexpected events which ultimately bring about the very result the original tampering was intended to prevent, or worse.

My own feelings about swarm prevention are mixed. I see it from both points of view. It is not easy to reconcile "Stop them at any cost" and "Live and let live." I used to cut out swarm cells, divide colonies, manipulate frames, rearrange hive bodies, and engage in other skulduggeries in an effort to outwit the bees. Now I do nothing. They can take off if that is their desire.

This, I realize, is an attitude of luxury, an indulgence. Bees are a hobby and not my living. If I am fortunate enough to be around when they issue forth with that splendid roar and wild tumult, I merely sit under a tree and enjoy the show. Doing nothing may be my role in the grand design.

FIFTY



Generally, only one swarm issues from a hive, accompanied by the old queen, and this is known as the primary swarm. There should be only this one swarm. That is the rule. However, there may be a second swarm, and that is a perversion of the rule. In some colonies the swarming instinct is so powerful that a colony may develop "swarm fever," throwing off swarm after swarm, a kind of biological anarchy

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kind of weapon that makes it feared and respected, or it employs a protective strategy of defense triggered by fear; situations and protagonists change but fear is a constant.

The bee's primary weapon is her stinger, but compared to the weaponry found in many creatures, it is not terribly impressive; it does not measure up to the fatal sting of some spiders and scorpions. Bee venom is relatively mild, unless one is allergic to it, in which case it can cause severe reactions and possibly death, but this is rare.

A bee's stinger is more of a deterrent than an attacking instrument, a means of commanding respect and instilling fear rather than of obtaining food. While effective enough for the purpose intended, it does not seem especially well designed from a bee's point of view; it is something like firing a gun in self-defense and while merely wounding or frightening the enemy the shooter is instantly killed in the act of firing. As the drone dies in the act of mating, so does the worker lose her life in stinging. It is a curious weapon indeed that, when used, is more deadly to its possessor than to the target.

MBF A worker's stinger is located in the rear of her abdomen, at the tip of what once might have been her ovipositor, like a tiny sharp tail. When a bee decides to strike, her stinger protrudes through the sting chamber and a drop of venom appears on the tip. But in order to sting she must first get leverage by digging in her claws; if the victim is sufficiently quick, this brief warning is enough to swat the attacker before she can sting. It takes fast reflexes to beat a bee to the draw, but she loses in "winning."

Under a microscope, a worker's stinger is shown to be exquisitely shaped, delicately tapered, and polished. It is composed of twin daggers formed in a V shape, each spear lined with tiny barblike serrations. At the top of the V is a bulb, the poison sac, which holds a small amount of venom formed elsewhere in the bee's body. Venom is delivered from the sac through tubes in the lances.

When driven into flesh, the barbs catch like fishhooks, making the stinger difficult to withdraw, at the same time spurting venom into the wound. Given enough time, a bee probably could work her stinger free without damage to herself. But stinging is usually accompanied by considerable excitement, which probably caused the bee to sting in the first place. The terrified creature panics, and in trying to free herself, succeeds only in ripping out her stinger, rupturing her abdomen, and she dies, much as the drone succumbs in mating.

A California investigator let five bees sting him to find out how long they would live without stingers. As usual, the bees didn't respond as expected. Even with their intestines trailing behind them, they would eat honey, fly, and go about their business, even grooming themselves. They lived up to five days, but that was only when separated from the colony and protected. In the hive the healthy bees attacked the injured, making outcasts of them by driving them out of the hive. They made life so miserable for the stingless bees that the latter refused to reenter the hive and died of chilling and isolation rather than of their wounds. What is a bee to think of such treatment? What are we to make of it?

Once the stinger is completely detached from the bee, a strange thing happens: it continues to work its way deeper into the wound while venom keeps pumping from the poison sac, as if it has some independent intelligence or life of its own, the thrust so powerful that it can penetrate a felt hat and even leather, the pumping action continuing for twenty minutes after the stinger is detached.

One of the first lessons a neophyte beekeeper learns is never to remove a stinger by pinching it between thumb and forefinger, because squeezing the poison sac forces more venom into the wound, making it more painful. Stingers should be removed with a quick sideways flick of a fingernail or a sharp object such as a knife blade. The sooner the stinger is removed, the less discomfort suffered.

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