

## SCIENTIFIC ACCOMPLISHMENT IN COMMERCIAL BEEKEEPING IN THE UNITED STATES

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### Introduction

In North America, the beekeeping industry in the late 1800's. The invention of the movable frame hive by L.L. Langstroth in 1851 was most important; this was a time of change in the Americas and it was only reasonable that apiculture should be involved in the agricultural revolution which was underway at that time. In the early years, beekeepers experimented with types of hives and strains of bees; soon, however, they came to regard colony management as the key to success in commercial beekeeping. With this realization came the standardization of beekeeping with the result that all beekeeping equipment, east or west, north or south, is interchangeable. Supply manufacturers recognize this fact and the factory made equipment follows standard dimensions. This also protects the beekeeper's investment and allows him to obtain a good resale value when it is time for him to sell his equipment. The extension service in the United States has done much to encourage the standardization of beekeeping equipment over the years.

Prior to 1906, the time when the pure food and drug laws were passed in the United States, most beekeepers produced comb honey. This was because much of the liquid honey on the market was adulterated and the consuming public had little confidence in it. World Wars I and II brought about price increases in honey but also forced beekeepers to become more efficient because of labour shortages. Efficiency, labor shortage and price, taken collectively, changed the beekeeping industry and after World War II most beekeepers produced only liquid honey. In New York State, for example, no commercial beekeeper any longer makes a living producing comb honey. The small amount of comb honey which is found on the market is produced largely by hobbyists.

As agriculture is changed in the United States, the need for large numbers of honey bee colonies for pollination has provided beekeepers with an added source of income. Some beekeepers devote almost full time to the pollination business. Special management techniques and modifications in some equipment are made as a result of this special industry.

Soon after 1900 there also developed a package-bee and queen-raising business. The continued success of the package-bee business in the United States is, in part, testimony to the continued failure of beekeepers to successfully overwinter colonies in the northern states. This, to a lesser extent, is also true of the continued success of the queen-raising business, though many young queens are also used to replace poor queens.

### Research

The ideas for changes which have been brought about in the beekeeping industry have come from many sources. Some have originated in the laboratory, others have come from the minds of commercial or hobby beekeepers. Large numbers of foreign bee journals come to our country each month and beekeepers, researchers and extension personnel are very adept at gleaning from these new methods and ideas which might be adopted in our industry. Beekeepers are fast to think up new ideas and labor-saving devices. However, one can point out that labor-saving devices do not really save anyone but the consumer time and money. News ideas spread too fast for any one individual to capitalize on an invention for more than a few weeks or months.

Research and new ideas in the beekeeping industry come from a variety of sources in the United States. These include the United States Department of Agriculture, the state colleges and agricultural experiment stations, the private colleges and universities, private corporations and individuals. The best coordinated of these sources are the U.S. Department of Agriculture's six bee culture laboratories under a single head, Dr. Marshall Levin. The individual state colleges and State agricultural experiment stations, which are usually one and the same, are financed largely by the states though increasingly by federal monies; despite federal money, these units remain more or less independent, reporting through their own administrators to the State legislatures only. The independent colleges and universities report to their president and board of trustees; unfortunately, the inflation which is taking place world wide, is decreasing the amount of money available to these independent agencies for research and their emphasis is increasingly on teaching. However, in past years, and even today, research-minded faculties in these institutions continue to make their contributions to research. Private corporation make little contribution to agricultural research since this is so heavily subsidized by the State and Federal Government; it is in the areas outside of agriculture that we find private industry making the greatest research contributions. Private

individuals continue to contribute a great deal to new knowledge in apiculture as well as in other areas. The individual beekeeper is oftentimes handicapped by the lack of a library, laboratory facilities and oftentimes the lack of a technical background; interestingly, however, the private individual often has more practical experience and is frequently better able to judge what should not be done better than some researchers.

I should now like to review more specifically some of the things which have been done and to also talk about research which should be done. I will be especially concerned with the practical aspects of beekeeping.

### **Removing Honey from Colonies**

Removing full supers of honey from colonies continues to be a difficult task. Smoking, shaking and brushing bees from individual combs of honey was the only method known in the late 1800's when the industry was first developing. The Porter bee escape was discovered in 1891 and proved a boon; bee escapes are still widely used by many beekeepers in North America today. Not everyone can use a bee escape efficiently. Also, the fact that two trips to the apiary are required, one to put on the escape and one to remove the honey, deters their use. Interestingly, many people do not know how to put a bee escape in a multi-storey colony by themselves and without aid from one or other persons.

The fact that carbolic acid would repel bees was known soon after 1900. However, it was not until Charles Mraz, a commercial beekeeper from Vermont, developed a proper pad and discovered the right combination of material that the first practical repellent came into use in the 1930's. Carbolis acid is not on the list of approved chemicals for use in the food industry today.

Dr. Alan Woodrow of the U.S. Department of Agriculture found that propionic anhydride would repel bees in 1962 and this became a popular material which replaced carbolic acid as a bee repellent. It is still used today.

In 1963 Professor G.F. Townsend of Guelph University made the important discovery that benzaldehyde, artificial oil of almonds, would repel honey bees. Townsend's work is an excellent example of the practical application of laboratory knowledge. Benzaldehyde is the favorite method of removing honey from colonies today. The fact that it is non-toxic to bees man is especially helpful.

In the early 1960's several people experimented with forced air to blow bees from supers with combs full of honey. Several types of bee blowers are on the market today, each with certain advantages and disadvantages.

To sum up the status of methods of removing honey from colonies is a simple task. All the methods mentioned, including smoking, brushing and shaking, are still in use today in every country including the United States. No one method is perfect. In fact, the depth of the super and which is the most convenient depth to use is part of the problem. Clearly, this is an area where good, imaginative research is needed.

### **Extracting**

Extracting, the process of removing honey from the comb, is one area where modern research has failed the large beekeeper. The hobbyist, because of the cost of more elaborate equipment, will be forced to use a knife and some type of old-fashioned radial extractor for some time.

In the 1920's and 1930's commercial beekeepers built centralized extracting plants so as to be able to handle and process larger amounts of honey. However, on a commercial basis most beekeepers still think in terms of manipulating combs rather than supers of combs. Several beekeepers have made extractors which will hold whole supers. A few have devised supers from which individual combs need not be removed to be uncapped or extracted. In such cases special machines have been devised which will uncapp the combs in place.

The problem has been one of standardization. Large bee supply companies who might make machinery both for the uncapping and extracting of supers of combs do not care to manufacture machinery for this purpose until they are certain there will be a sufficient number of orders to cover the cost of development. In the background lurks the threat of federal legislation which may limit the weight an individual farm worker may lift. While this is clearly a ridiculous thought, far worse regulations have been perpetrated on the public with the thought that they are for the common good. Should, for example, a weight of only 50 pounds (22.7 kg) be selected, then the size of a super is limited. Hand in hand with this problem is that of a satisfactory bee repellent. Benzaldehyde drives bees about seven inches (17.5 cm) under good conditions. Often, however, it works well over only shorter distances. The depth of a super for commercial use may be limited by this consideration.

Thus, perhaps it is unfair to blame the lack of development of better extracting equipment on research. Perhaps if industry were to settle on a precise depth for honey supers in the same way that they and the bee supply industry have standardized the length and width of a Langstroth super, we could then develop, with the aid of agricultural engineers, the equipment which is so badly needed.

## Honey and Honey Products

In the United States it is estimated that slightly over half of the honey produced is used in the baking trade while slightly less than half is sold as table honey. In the 1930's Professor E.J. Dyce discovered a method for producing a finely granulated honey which has a better flavor, longer shelf life and is easier to spread than honey which granulates naturally. This discovery is one of the few which has gained wide acceptance in the industry. While there are many honey products, either on the market or which have been tested, few are sold today.

Professor P.H. Tracy wrote about honey cream, a combination of pure cream and honey, in 1932; while this is a delightful product, it has a short shelf life, is too costly and contains too many calories for wide acceptance. Honey jelly, a product to compete with other jellies on the market, is mentioned many times in the literature and was marketed by one firm in the 1950's; it did not gain wide acceptance and tended to assume a rubbery consistency after a short while. A small amount of honey may be added to peanut butter and the peanut butter is improved; however, the reverse is not true and a honey-peanut butter which was marketed in the late 1940's and early 1950's was not accepted and took on a rubbery consistency within a few months. Honey ice cream, where honey is used as the primary sweetener in the ice cream, has been market tested many times; honey lowers the freezing point depression of the ice cream requiring lower than normal storage temperatures which are not practical, and this product has never gained a foothold. A variegated honey ice cream was introduced by the University of Florida in the mid-1950's but never reached the market; this ice cream stored well at normal temperatures. Honey butter, a combination of pure creamery butter and honey, is marketed by two firms in the United States and one in Canada today; the process is a secret one and has remained such since its discovery in the 1930's. Only a few million pounds of honey are used in this product; while it has widespread distribution and acceptance it is a luxury product and this slows a wider distribution. Honey wine is increasingly popular with at least eight firms making the product in North America today; it may be expected that the use of honey in making wine (mead) will increase in the future. Several countries are now exporting honey wine. The use of honey in fortified alcoholic drinks has been popular for some time and the use of honey in this regard does not appear to change. A small amount of honey is used in the drug trade as a sweetener.

It would appear that exploration and increased propaganda concerning the use of honey in cooking might be a profitable way to expand world consumption. Except among beekeepers and a few food enthusiasts, good, and I stress the word good, honey recipes are not common. A review of literature suggests that honey does not combine well with many products as a major ingredient. The real future for honey will continue to be in baking and as a table product; still, there is clearly room for research in this area.

## Pesticides

New federal legislation in the United States provides compensation for persons who lose bees because of pesticides. For years a controversy raged about what should be done about this matter. Many people took the view that honey bees were trespassers. Others pointed to the good done by bees. Meanwhile, many beekeepers suffered because of the indiscriminate use of certain pesticides.

I suggest that this legislation was passed not just because of a public outcry but rather because there was good documentation of what was happening. If beekeepers might be criticized for any one thing it would be their poor records. Too many beekeepers do not keep as careful records as they should. However, documentation by researchers in the United States to show how serious the pesticide problem really was, was finally sufficient to correct this difficult situation.

## Bee Diseases

Modern medicine has more than doubled the life span of an individual man. It is interesting to speculate that good bee medicine might do the same for bees and thereby increase honey production or the time bees might have to spend in the field. Dr. G.F. White's discovery that honey contains the enzyme glucose oxidase and that this is one system bees use to protect themselves against microbes which might otherwise attack the bees and their stores is the type of research we should encourage. Dr. Blum and his colleagues found a natural protective system in royal jelly. Drs. Pain and Maugenet's discovery of the natural system by which pollen is protected is equally important. However, it should be emphasized that all three of these discoveries came in the 1960's. This indicates very clearly that we are still in the era of discovery. The real importance of these discoveries is that we are now in a better position to supplement the natural efforts by bees to control bee diseases.

Many bee diseases are always present but become serious only when a colony of bees is under stress. Stress, or at least eliminating stress, is a management problem. Further, not all bee disease problems pose equal problems everywhere. A prime example of this is the trouble caused by *Nosema* in the northern

United States and Canada; the same disease is of little consequence in the southern states. However, one can find *Nosema* infections everywhere at all times of the year.

Bee disease investigations are of prime importance. It would be helpful if we knew precisely how much damage certain of these diseases really cause. If we could better pinpoint how extensive losses really are we might be in a better position to spend more time and effort in their control.

### **Growing Better Bees**

Bee breeding is still in an embryonic stage. There are many reasons for this but again the major problem is a lack of knowledge of basic bee behavior. We have no good method of controlling breeding on a large scale except through the use of islands; this is too expensive to be practical. Artificial insemination, helpful as it is, is still a laboratory tool and useful only in the early development of a breeding program. The fact that it was only in the 1950's that it was found that queen bees mated more than once, and that in the 1960's that the sex attractant was discovered, shows how little we really know about bees.

Some people have thought that the use of selected strains of bees might provide an answer to our problems. Again, with some minor exceptions, this does not appear to be true. Some researchers have moved bees around the world in the hope that they might discover a new or better race of bees. To my mind this is a dangerous practice. Only recently have we discovered two species of mites in Asia which might pose serious threats to our industry were they brought into areas where they did not exist. The introduction of the African bee into South America is an example of the type of error which can be made; this kind of thing should be avoided and the fact that a problem did result from the importation of a bee into an area where it was not native should serve as an example to all concerned.

Someday, when we have more knowledge about honey bee biology we may produce better bees. However, until that time colony management is most critical and the area where beekeepers can most profitably invest their time and effort.

The research by Prof. Walter Rothenbuhler and his students in the genetics of bee behaviour has been most encouraging. Rothenbuhler has shown that certain behavioral patterns may be linked to specific genes. This gives us the knowledge that we may breed bees for certain desired behavioral characteristics.

### **Management**

I still require that my students be familiar with Dr. C.C. Miller's *Fifty Years Among the Bees*. The last edition was printed in 1920 but it was written several years before that date. Equally important are George S. Demuth's two bulletins, *Commercial Comb Honey Production*, published in 1919, and *Swarm Control* which was released in 1921. These three publications, despite all of the research which has been done in apiculture, contain the best advice available on how to manage a colony of honey bees for maximum honey production. The only possible exception to this thought would be the work by the late Dr. C.L. Farrar which led to the development of the two queen system of management. In my opinion, the two queen system involves too much labor and with present labor costs in the United States it is a prohibitive system of management. However, many beekeepers in the United States and Canada use and prefer the two queen system of management for honey production.

I suggest that the reason that research has failed to develop better methods of management has been our lack of knowledge about basic bee behaviour.

Behavioral research is among the most exciting being conducted today with researchers from many countries involved. I suggest some major changes in bee management may be forthcoming within only a few years.

In this regard the work of Professor von Frisch has been most important perhaps because it so accurately pinpointed how little we know about bees. However, in my opinion the important research which is underway today has to do with pheromones. We have barely scratched the surface in this regard; what we have learned to date indicates that we might be able to fathom the factors which control social order. If so, some major changes in management will come about.

### **Pheromones**

Pheromone research is probably the most important research in the whole of apiculture today. In making the arbitrary statement, I do not wish to detract from those who are concerned with diseases, honey plants, marketing, bee breeding, and a host of other study areas. I merely mean to emphasize that any major changes which will come about in bee management will be a result of greater knowledge in the pheromone area, especially as concerns the relationship between the queen and the workers.

It is difficult to talk about pheromones and to know to whom we should give the most credit. In searching the literature it is evident that many people have contributed to our present understanding. The big breakthrough in honey bee pheromone research was Dr. C.G. Butler's queen substance theory and his discovery, together with Dr. Callow, of the chemical nature of queen substance. To my mind this discovery ranks with that of Professor von Frisch, but like the work of von Frisch, there is still more to learn. This in no way lessens the importance of the discovery but it is very clear that we have a long way to go before we will understand queen substance fully.

The research of Drs. Boch and Shearer on alarm odors and worker scent is likewise important in the overall picture. Still, even here we do not have the final story and field application of our knowledge is yet to come.

### **Summary**

I have talked about only a few areas of bee research. I wish to emphasize that contributions to our knowledge have come from a variety of sources; this will be true in the future. Whether we are concerned about pollination, honey production or wax production, our problem is still a lack of knowledge of bees and bee behavior. We are filling some gaps in our knowledge but much remains to be done. We have a thriving industry world wide and a fascinating animal with which to work. The next few years will be most interesting to watch.