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CHAPTER 1

THE WORLD'S BEEKEEPING — PAST AND PRESENT

by EVA CRANE*

The present book is the direct successor to one written by Lorenzo Lorraine Langstroth, published in 1853 under the title *Langstroth on the Hive and the Honey-bee* (1853). This made known Langstroth's practical application of the concept of the bee-space in 1851, and laid the foundation of modern beekeeping. The first part of this chapter gives a brief account of the history of beekeeping with the honey bee *Apis mellifera,* and touches on some of the archeological discoveries made since the last edition of the book was published. Other bees of economic importance are also mentioned. Finally a summary is given of the extent of beekeeping in various parts of the world today.

BEEKEEPING UP TO 1600

Honey bees now live in all parts of the world except the extreme polar regions, but this was not always so. Until the 17th century they were confined to the Old World, where they had evolved and were widely distributed long before man appeared on earth. Primitive man harvested honey comb from bees' nests in hollow trees and rock crevices. The operation with *Apis mellifera* is shown in many rock paintings found in Africa, and some in Spain (Fig. 1), and with other species of bees in India and Australia. It is still carried out in various parts of the world, and honey can be a lifesaving food for primitive peoples in times of severe famine.

Beekeeping proper started when man learned to safeguard the future of swarms and colonies established from them, by a certain amount of care and supervision, keeping them in separate purpose-made hives which substituted for natural dwellings of bees. For convenience and safety, a number of hives were often sited together in an apiary. Hive construction depended on what materials were at hand, and on the local skills of various communities. It is almost certain that the beehive had no single origin: it was a likely development in any region populated by honey bees, when man changed from hunting and collecting food to producing it, and started a settled existence.

The earliest centers of culture were in the Middle East, in hot, dry open country. Pottery vessels were made during most of the Neolithic period, from perhaps 5000 B. C. onwards, and the first hives there may have been pottery

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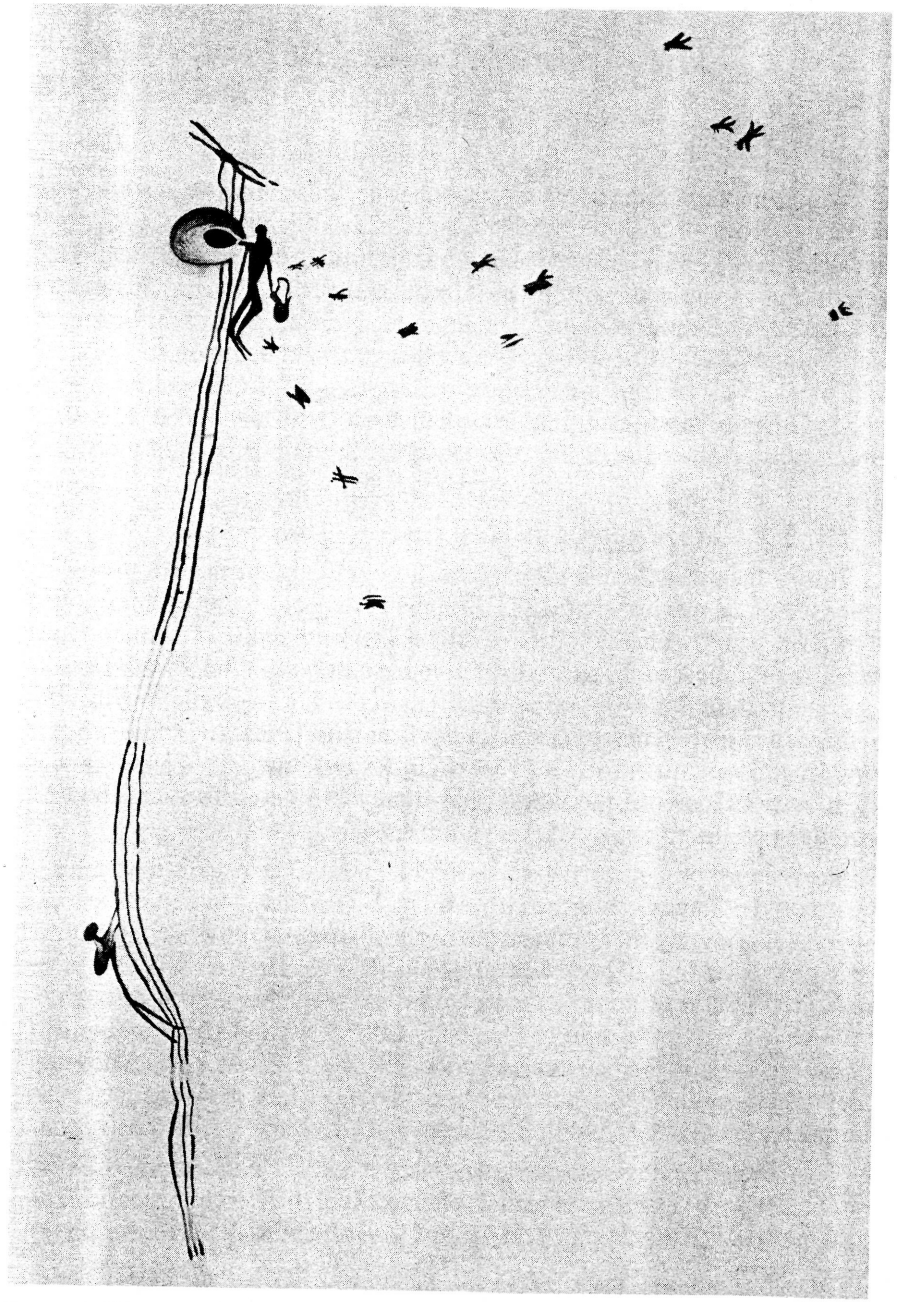

FIGURE 1. Honey-collecting scene from a rock painting in La Araña shelter, Bicorp, eastern Spain, made around 6000 B.C. and found in 1924 (copy by E. Hernández-Pacheco).

vessels in which swarms happened to settle. In ancient Egypt and other Mediterranean regions, long cylindrical hives were made of mud, clay or other materials, and used in a horizontal position. Figure 2 shows honey harvesting about 1450 B.C. The beekeepers used smoke to drive the bees from the back of the hive to the front, and honey combs could be removed without killing bees; the brood combs were recognized and could be left intact. Hives in Ancient Greece followed a somewhat similar style, and fragments of pottery hives have been excavated from 26 sites; Figure 3 shows a complete hive. In hot, dry regions the hives were often stacked together, and sometimes embedded in a wall, to provide insulation against the heat.

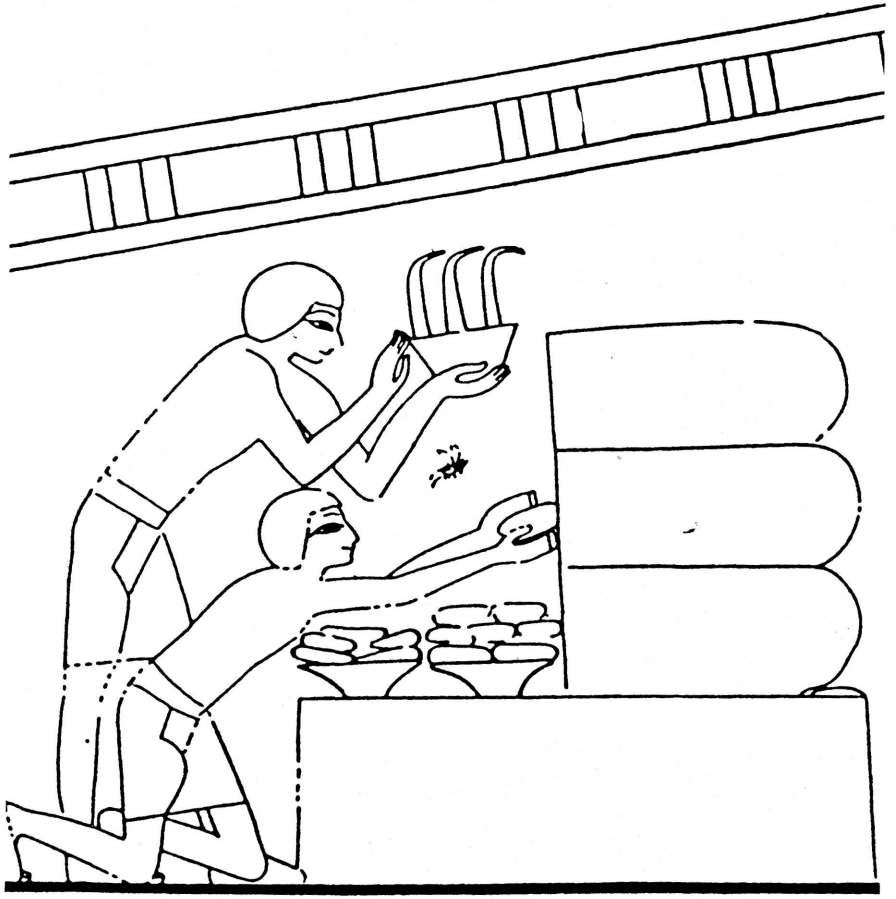

FIGURE 2. Honey harvesting from hives, shown in a wall painting *c.* 1450 B.C. in Rekhmire's tomb, West Bank, Luxor, Upper Egypt (Davies, 1944)

In the great forests of northern Europe, wild colonies in their nests in trees were tended from 2000 B.C. onwards. The earliest hives were probably logs from fallen trees, separated by chipping away the rest of the tree with axe and adz (a technique used throughout the Stone Age), and stood upright. Such hives can still be found in wooded areas of the north temperate zone (Fig. 4). Cork and other types of bark were also made into hives and, later, planks cut from tree trunks.

FIGURE 3. Two pottery hives in Greece; in front, hive from about 300 B.C. excavated near Mount Hymettus; behind, hive in use in 1973 on the island of Antiparos in the Cyclades (photo: M. I. Geroulanos).

In agricultural communities, techniques were developed for making containers of basket work as well as pottery. Baskets were also used to house bees, and they have changed little through the ages; those of coiled straw are made today in the same way as before 5000 B.C. Wicker baskets were woven from materials such as pliable hazel twigs. Two wicker hives are shown in Figure 5, which also provides one of the earliest illustrations of protective clothing for beekeepers.

All these primitive hives fulfilled certain necessary functions: they protected the bees and their combs from wind, rain, and extremes of heat or cold; their flight entrances were made small enough for the bees to guard; and there was some other opening through which the beekeeper could get at the honey and wax which constituted his harvest. Wood, bark, and clay were themselves weatherproof; straw and wicker hives were generally protected with an additional cover, and wicker hives were often plastered with mud and cow dung.

In northern Europe the upright log hives were often large, but with basket hives (skeps) it was easier to vary the size, and quite small ones were used where beekeepers wanted their colonies to swarm early to populate empty

FIGURE 4. Apiary of log hives, with two made from planks in the center, in North Carolina, U.S.A., *c.* 1960 (photo: W. A. Stephen).

hives. Primitive beekeeping then consisted of little more than catching and hiving the swarms that issued in early summer and, at the end of the season, killing the bees (for instance with burning sulfur, or by plunging the hive into boiling water) to get the honey and wax. More advanced beekeepers cut out the honey combs and left the bees and brood; if necessary they provided food in hives for winter.

The horizontal hives used farther south usually had a closure at the back, and the flight entrance at the front end; an Egyptian tomb later than Figure 2 seems to show this (Crane, 1983). Sometimes the front end also had a movable closure. The beekeeper gained access to honey combs from the back and inserted food there. From studies of traditional beekeeping now practised in the Mediterranean region, it seems likely that beekeepers in some Ancient countries — for instance Egypt, Arabia, Crete and Sicily — carried out

FIGURE 5. A well protected beekeeper with two wicker skeps (from Sebastian Münster's *Cosmographia*, Bern, Switzerland, 1535).

various colony manipulations, including the division of colonies in summer (see *e.g.* Crane, 1983).

In the New World there were no native honey bees, but species of stingless bees — social honey-storing bees in the family Meliponinae — are native to the tropics of America and Australasia. In Central America the Maya still keep some species in horizontal log hives (Schwarz, 1948), which are closed at the ends with wood or stone discs, each made to the shape and size required. Wood is perishable, and no hives are known to survive from earlier centuries. However, stone closures have been excavated at 12 sites, 6 in Mexico, 4 in Belize and 2 in Guatemala (see Crane & Graham, 1985). Figure 6 shows locations of limestone discs found at one site, and dotted lines have been drawn to join together 12 discs in pairs, which are likely to have been the two ends of the same hive. This site is on Cozumel, an island off the Yucatán peninsula where 255 of the discs have been found. Also on Cozumel, a pottery incense burner in the form of the Maya bee god Ah Mucan Cab was found, dated to about A.D. 1400, which incorporates models of four hives that appear similar to those used today. It is now in the museum at Mérida. Figure 7 shows some of the end closures from a site in Belize which may date from the Late Preclassic period (300 B.C. to A.D. 300); they provide the earliest remains so far found of beekeeping in the New World.

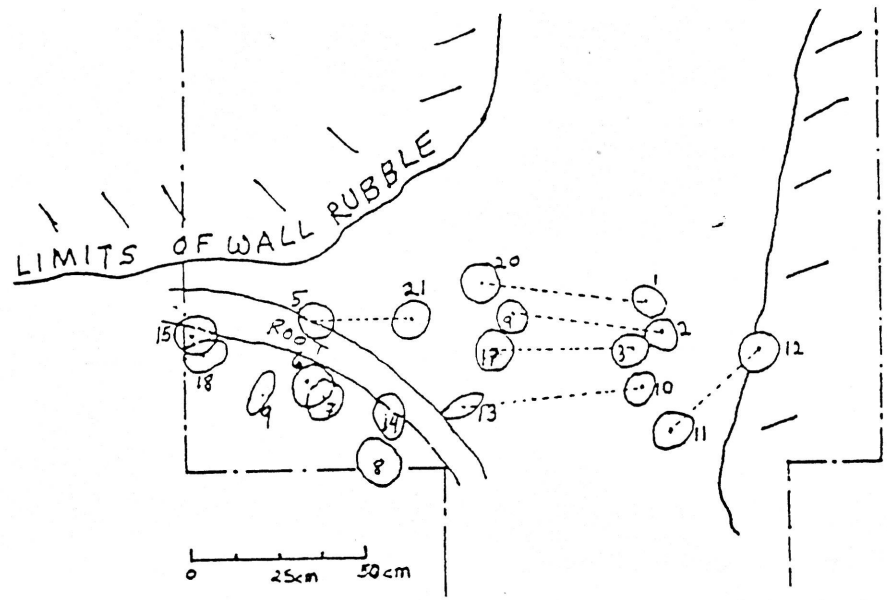

FIGURE 6. Plan of part of the excavated area at Buena Vista, Cozumel, Mexico, showing locations at which stone hive closures were found; those to the left of the root had been disturbed (Wallace, 1978). See text for explanation.

In northern Australia, evidence has been found that aborigines tended nests of stingless bees in trees (Dollin & Dollin, 1986). But unlike tree beekeepers in Europe, these people do not seem to have advanced to beekeeping with hives.

BEEKEEPING 1600 to 1851

Three separate streams of events, each of great significance in the history of bees and beekeeping, were set in motion from Europe in the 17th century. The honey bees, themselves, were taken to the New World, where previously honey and wax had been harvested only in the tropics from species of stingless bees. Beekeepers started to appreciate the fundamental facts of the life cycle and biology of bees. And developments in beekeeping methods gave beekeepers slightly more control over their bees, as well as greater opportunities for observing them inside the hive.

The Spread of Honey Bees over the World

Honey bees evolved in the Old World — Europe, Africa, and Asia. Prior to 1600 there were none in the New World — the Americas, Australia, and New Zealand. But early settlers in many parts of the New World managed to get hives of bees across the oceans to their new lands. European bees probably reached North America from England in 1622 (Smith, 1977), in the *Bona Nova*, the *Hopewell* or the *Discovery**. In 1985, with help from John Adams, I found the probable landing place of these ships, the site of the Old City Point Wharf on the James River, just below its confluence with the Appomattox. In 1688/89 bees were taken from France to St. Kitts and Guadeloupe in the Caribbean. The first honey bees were landed in Australia probably in 1822 and in New Zealand (from England) in 1839. Honey bees were not introduced to the west coast of North America until the early 1850s, when they were landed in California; from there they were taken to Oregon, and thence to British Columbia.

Discovery of Fundamental Facts about Honey Bees

The fact that honey bees could raise a queen from eggs or very young larvae was published in Germany by Nickel Jakob (1568). The first description of the queen bee as a female, which laid eggs and was the mother of all bees in the colony, was published by Luis Méndez de Torres in Spain (1586). Then in England Charles Butler showed (1609) that the drones were male bees, and Richard Remnant (1637) that the workers were females; Remnant had observed that they possessed "a neat place for the receipt of generation." Meanwhile in Italy, Prince Cesi (1625) had published the first drawings of bees made under a microscope. The primary facts about the mating of the

*In 1616, a ship also bound for Virginia took refuge in Bermuda during a hurricane. It carried hives of bees which were landed there, and the bees prospered (Hilburn, 1989).

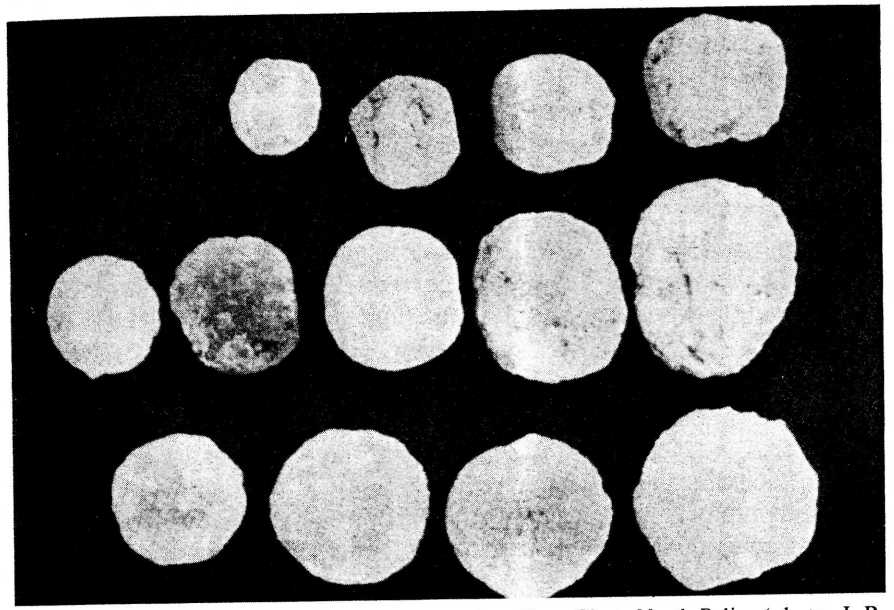

FIGURE 7. Thirteen of 37 hive closures excavated at Chan Chen, North Belize (photo: J. R. Andresen).

queen with a drone were not known until Anton Janscha in Slovenia described them (1771; see Fraser, 1951).

The nature of the materials collected by bees was also established only in the 18th century. Until Hornbostel in Germany described the true origin of beeswax (1744), beeswax was confused with pale yellow pollen carried to the hives, and thought to be collected from flowers. Nectar, on the other hand, was assumed to fall from the skies until 1717 when Vaillant in France showed that it is produced by flowers, in specific parts he called *mielliers*. The fact that the pollen collected by bees is the "male seed" of the flower, which fertilizes the ovum, was reported (1750) by Arthur Dobbs of Castle Dobbs in Ireland. Dobbs also observed that bees gathered pollen from only one kind of flower on each flight, and he suggested that disastrous cross-fertilization would result if this were not so. Then Sprengel (1793) established clearly the part played by bees in fertilizing flowers.

François Huber, a blind Swiss beekeeper, published his *Observations* (1792) which properly laid the foundations of modern bee science.

Developments in Beekeeping Techniques with Upright Hives

Between 1500 and 1851 certain skep beekeepers devised ways of taking the honey from hives without killing the bees. For instance, instead of killing a proportion of their colonies before winter, they united several colonies in a single skep, by driving the bees from a series of hives (each inverted) into

another placed mouth down above it. Or an extension was added above a straw skep, over a hole left in the top; it might be a smaller skep (a cap) or a glass jar (a bell). The bees stored honey, but they did not rear brood there; it was a honey super, which could be removed complete with honey combs, without disturbing the brood nest. Alternatively an "eke" was placed under the skep when the flow started; it was a straw cylinder a few inches high that formed an extension of the skep downwards.

The use of hives made of wooden boards allowed new scope for inventiveness. Some hives consisted of a tier of boxes, whereas others — collateral hives — had boxes at the sides for honey storage. Fraser (1958) gives some details.

Throughout these centuries the minds of beekeepers in the most progressive areas were constantly occupied with the problem of getting more control over the bees and their activities, and of monitoring what was going on inside the hive, including the brood nest. Observation windows in hive walls were easy enough to make, but they did not enable the beekeeper to see much of what was going on inside. The Italian astronomer M. Maraldi found single-comb observation hives in the garden of the French Royal Observatory in Paris in 1687 (Réaumur, 1740). Huber's leaf hive (1792) came more than a century later; it consisted of a number of frames hinged together at one side like the leaves of a book, and the bees built combs in the frames. It was invaluable for his observations, but was an observation hive only and quite unsuited to practical beekeeping.

Meanwhile in England Sir George Wheler (1682) described woven wicker hives that he had seen used in Greece. The open end was uppermost, and was covered with wooden 'bars' about 1½ inches wide (Fig. 8). Each bar was made slightly convex on its underside, and the bees attached their combs along the ridges so formed, i.e. one along the underside of each bar. What distinguished this hive from all the other "bar hives" then known was the fact that the bees did not attach their combs to the hive walls. (The hive was wider at the top than at the bottom, so the hive walls sloped inward.) In spring the beekeeper removed half the combs from each hive and placed them in an empty one, thus doubling the number of occupied hives. The Greek beekeepers had in fact produced a workable movable-comb hive. Somewhat similar top-bar hives have been found in several parts of Vietnam (Fig. 9), where I saw some still in use in 1989.

Wheler's report had a considerable influence on hive development in European countries, and between 1650 and 1850 box hives with top-bars and frames were invented (Walker, 1928), but after two centuries of effort there was still failure on a fundamental point: whatever bars or frames were used, the bees attached their comb also to the walls of the hive, and the combs could

therefore be removed from the hive only by cutting them out. For instance about 1806 a Ukrainian beekeeper Petr Prokopovich produced the first frame hive to be used on a commercial scale (about 10,000 of the hives were made; see Haydak, 1957). This hive had three vertical compartments in a single box, the top one having wooden frames with notched bee passages in the end-bars; the frames were removed from the back of the hive, but as the bees attached the frames to the hive walls with comb or propolis, this was not at all easy.

It is difficult for us now, with the problem solved and therefore no longer a problem, to enter into the minds of the experimenting beekeepers, who struggled to obtain a convenient workable hive, with combs they could easily remove from it. I do not think these struggles would have been pursued so

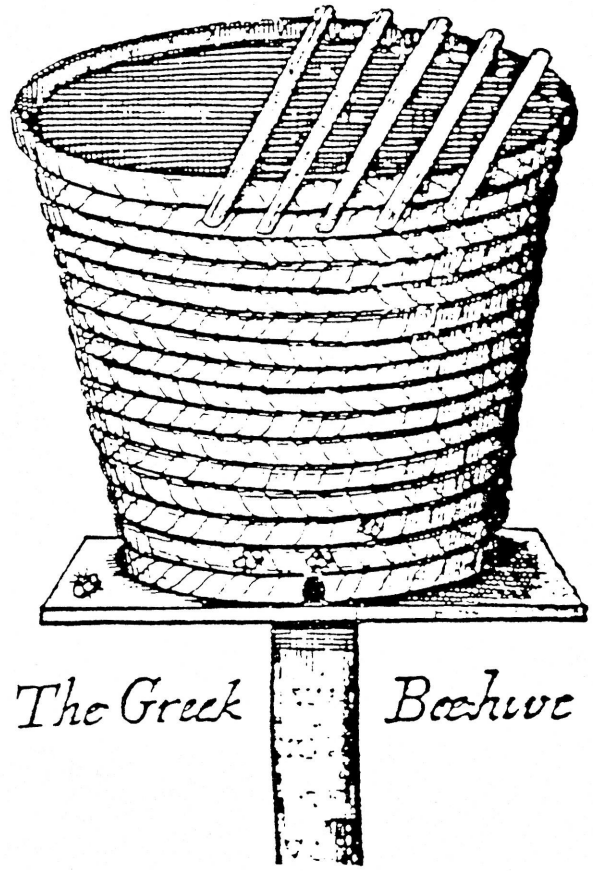

FIGURE 8. Early movable-comb hive used in Greece (Wheler, 1682).

assiduously if the same beekeepers had been using horizontal hives, with their greater scope for bee management; on the other hand it is possible that the honey bees of northern Europe would not have prospered in such hives.

The crucial step which gave the desired movable-comb wooden hive was not taken until 1851, at which time — as we have seen — European honey bees had completed their colonization of almost the whole world.

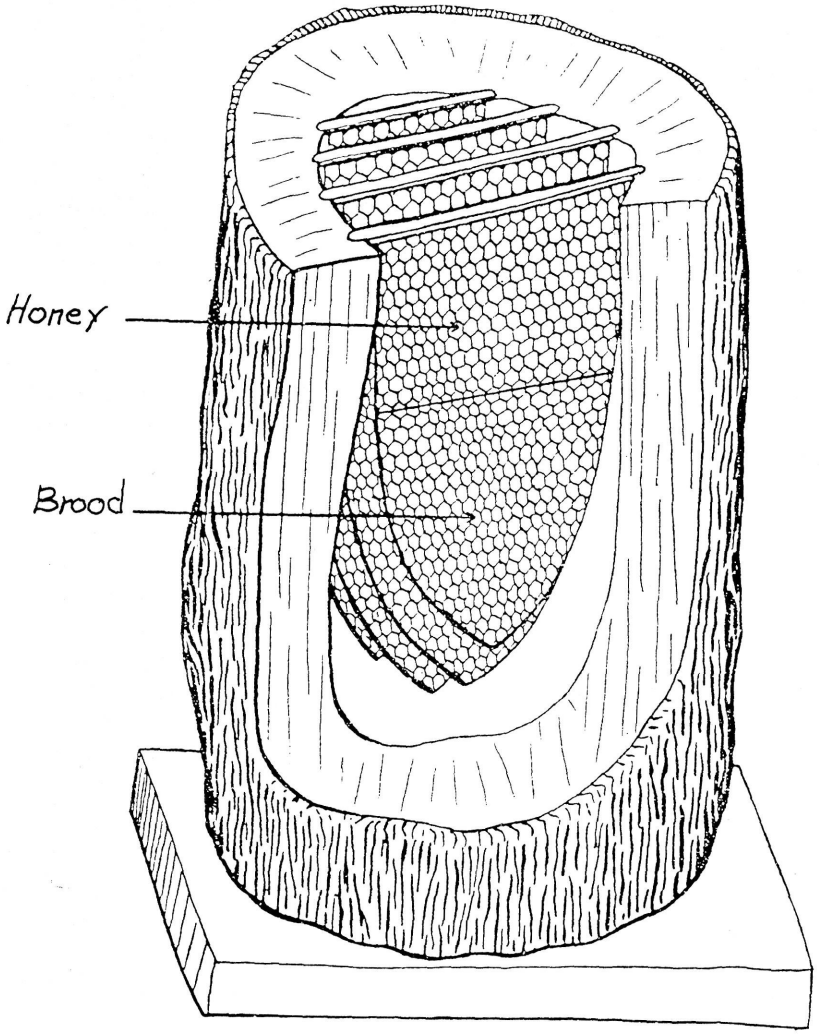

FIGURE 9. Vietnamese movable-comb hive (Toumanoff & Nanta, 1933).

BEEKEEPING 1851 AND AFTER

Lorenzo Lorraine Langstroth (Fig. 10) was born in Philadelphia. As a child he had shown a rather unusual interest in insects, and this was revived when, as a young pastor in Andover, Massachusetts, he visited a friend who kept bees, and saw a glass globe filled with combs of honey. Before he returned home he bought two colonies of bees in box hives. He soon also acquired a Huber leaf hive and in due course obtained various books on bees, including Huber's (1792), Bevan's (1838) and Munn's *Description of the bar-and-frame hive* . . . (1844 and 1851 editions). Johansson and Johansson (1967) found that Langstroth had marked the passage in Munn's book: "The frames with their contents can be lifted out [because of the proper space left between them]." Langstroth used a bar hive described by Bevan and put in it complete frames with "the distance of the bars from each other . . . nicely adjusted." He deepened the grooves on which the bars rested, leaving about 3/8 inch between the cover and the bars, because this facilitated the removal of the cover board on which the glasses rested. (This is the origin of our present top bee-space.) Then came the key development, which cuts the history of beekeeping into two halves. In the fall of 1851, Langstroth wrote in his diary:

> Pondering, as I had so often done before, how I could get rid of the disagreeable necessity of cutting the attachments of the combs from the walls of the hives, and rejecting, for obvious reasons the plan of uprights, close fitting (or nearly so) to these walls, the almost self-evident idea of using the same bee space as in the shallow chambers came into my mind, and in a moment the suspended movable frames, kept at a suitable distance from each other and the case containing them, came into being. Seeing by intuition, as it were, the end from the beginning, I could scarcely refrain from shouting out my "Eureka!" in the open streets.

Langstroth's intuition was justified. The bees did, in fact, "respect" *the bee-space left between the hive and the frames* in which the combs were built. They did not build comb across the space, and the frames could, therefore, easily be lifted out from the top of the hive. Being rectangular, the frames were economical in construction. All had the same length, so any one could be replaced by any other, in the same or in another hive. Also, unlike some other bar or frame hives, Langstroth's could be tiered — built up from a number of hive boxes one placed above another — and this is of great practical utility when working a heavy honey flow.

Langstroth's movable-frame hive was in common use in the United States by 1861. T. W. Woodbury introduced movable-frame hives into England in 1862, and from 1869 onwards the writings of Charles Dadant in the French and Italian journals spread its use in continental Europe; it was soon introduced in many other countries.

FIGURE 10. Lorenzo Lorraine Langstroth, 1810-1895.

With the use of this hive, modern beekeeping began, and development in the next half-century was in the nature of an explosion compared with the slow and halting progress of the previous centuries. In 1857, Johannes Mehring in Germany produced the first matrix for making beeswax comb foundation; the resulting sheets of foundation saved beeswax, and encouraged the bees to build regular worker comb in the frames. A superimposed honey chamber (super) furnished with such framed combs built on foundation was a valuable appliance. If means could be found to extract the honey without destroying the combs, the whole could be re-used in the hive. In 1865 Franz von Hruschka, an Austrian, produced a contrivance in which honey combs could be spun round and the honey extracted by centrifugal force (see Büdel, 1963).

Slot queen excluders had been used by Prokopovich and others in the early 1800s, to prevent a queen from getting into the honey chamber and thus

to keep it free from brood; these were now improved. Then by using a bee escape such as that made in 1891 by E. C. Porter in the United States, it became possible to clear bees out of the honey chamber before removing the frames of honey.

The pattern of modern beekeeping was thus established in the half-century between 1850 and 1900. Equipment invented in that period, or based on principles appreciated then, has since undergone important developments, and also greater mechanization. Beekeeping is now much more efficient and productive than in Langstroth's time, but in principle the hive we use today is based on his design in 1851.

OTHER BEES OF ECONOMIC IMPORTANCE TO MAN

The honey bees in most of the New World, and in Europe whence they came, are various races of the European honey bee *Apis mellifera* —Italian, Caucasian, Carniolan, and so on. There are other races in the Mediterranean region, and in Africa south of the Sahara are tropical races of *Apis mellifera.* Ruttner (1988) gives information on individual races.

In Asia there is a greater variety of honey bees, three representative species all being widely distributed: *Apis cerana, Apis dorsata* and *Apis florea. Apis cerana*, the native hive bee of Asia, is very similar to *Apis mellifera* but slightly smaller. It is kept in hives similar to those used for *Apis mellifera* but smaller, and with smaller combs containing smaller cells. There are several races of *Apis cerana*, some of which extend through much of tropical Asia, and others along the eastern parts of Asia as far north as Korea, the U.S.S.R., and Japan. In areas where introduced European honey bees thrive, these surpass the native bees in honey yields, and in certain other characteristics desirable in hive bees. Beekeepers in agricultural areas of China, Japan, Taiwan, and elsewhere have therefore largely replaced their native hive bee by the European bee. In mountains and other uncultivated regions where *Apis mellifera* has not succeeded, beekeeping is still done with *Apis cerana.*

The two other *Apis* species both live in tropical Asia, and both build a nest in the open, consisting of only one comb. *Apis dorsata*, the giant bee or rock bee, gets its names from its large size and its habit of nesting on rock faces. It produces much honey, and in many countries of tropical Asia more honey is harvested from wild nests of *Apis dorsata* than from hives of *Apis cerana* or *Apis mellifera*. The comb of the little bee *Apis florea* yields only a few pounds of honey or less.

In the 1980s evidence was accumulated in parts of Asia for the existence of certain other honey bee ecotypes and species:

— a species *Apis koschevnikovi*, similar to *Apis cerana*, in Sabah (northeast Borneo)

— a possible species *Apis andreniformis*, similar to *Apis florea*, in part of Yunnan, China
— ecotypes of *Apis dorsata* or possibly different species,
laboriosa in the high Himalayas
breviligula in the Philippines, except Palawan
binghami in Sulawesi

Different species of stingless bees are native to tropical Asia, Africa, Australia, and America. In America and Africa they are kept in hives for their honey (Nogueira-Neto, 1970). Archeological evidence for early beekeeping with these bees in Central America was referred to earlier; see Figures 6 and 7.

In the present century, agricultural practices have become more intensive and mechanized, and attention has been directed towards keeping bees for pollination, as well as for producing honey and wax. Honey bees are unsurpassed as pollinators in that large numbers of bees can easily be brought to a crop, and the bees are good general pollinators. Nevertheless, certain other bees are individually far more efficient pollinators of certain crop plants. In parts of the temperate zones, certain bumble bees (*Bombus*) are reared for pollinating red clover and other crops whose florets have long corolla tubes, and also for greenhouse crops. A soil-nesting alkali bee *Nomia melanderi*, native to parts of the northwest of the United States, is a very efficient pollinator of alfalfa, and is reared commercially for the purpose. *Megachile rotundata*, an efficient pollinator from Europe, also pollinates alfalfa well and is more adaptable in its nesting habits; it nests in stems and can be mass-reared in "banks" of man-made tubes of the appropriate diameter.

THE PATTERN OF BEEKEEPING TODAY*

Beekeeping is now spread over almost all the habitable parts of the world, and according to official statistics produces over 2 billion pounds of honey a year from more than 50 million hives. The estimated human population of the world is about 5 billion, so there are nearly a hundred times as many people as hives of bees. Beekeeping is practised over a greater area of the earth's surface than perhaps any other single branch of agriculture, and the success of certain other branches of agriculture depends on it, because of the need for crop pollination.

The patterns of beekeeping tend to be different in the Old and New Worlds. In general the Old World is more densely populated with honey bees, as it is with people, but the New World gives richer honey harvests. The average annual honey yield per hive is now about 48 pounds in the New

*Figures in this section are quoted from *Bees and beekeeping: science, practice and world resources* (Crane, 1990), which gives detailed statistics and fuller information on beekeeping in the various regions.

World and 31 pounds in the Old World. There is a net "flow" of exported honey from the New World to the Old World, China being the only large exporter in the Old World, contributing 100 million pounds.

In the New World beekeeping equipment tends to be simple, uniform, and — because labor is expensive — mechanized as far as possible. Langstroth hives are commonly used, whereas some European countries have a wide variety of "standard" hives which take frames, and hence foundation, of different shapes and sizes. Some of the hives are complicated, and in ways that decrease rather than increase honey production. The greater mechanization in the New World enables an individual beekeeper to manage more hives — up to 1000, or even 2000 in the USA. In European countries one man can look after 100-300 hives, although this number is steadily increasing.

In the New World there are more commercial beekeepers, although they still number less than 10 per cent of the total. Average annual honey yields in most individual countries vary from 40 to 80 pounds per hive, and in the best beekeeping districts they are 200 or even 300 pounds. The Old World has a higher proportion of hobby beekeepers, who may get an annual harvest of 10 to 40 pounds of honey per hive. Sideline beekeepers — those who look after a substantial number of hives in their spare time from regular employment —are sure of an income even in a bad season.

In good areas beekeeping can be done (although not with maximum efficiency) without knowing a great deal about the bees themselves, and the beekeepers are not necessarily very interested in them — or in beekeepers' organizations. At the opposite end of the scale, the strongest beekeepers' organizations are in the European countries with a high density of hives, each giving a small return — for instance Austria, Czechoslovakia, the Netherlands, and Switzerland. Such beekeepers often need a good knowledge of bees in order to maintain their colonies at all.

Since the end of World War II, a factor that has affected the whole beekeeping industry — largely adversely — is the ever-increasing speed and availability of air transport. This enabled honey bees to be taken relatively easily from one country or continent to another, and unfortunately diseases and parasitic mites sometimes went with the bees. Starting in 1951, the tracheal mite *Acarapis woodi* was transported with bees to South America, then to Asia, Africa and North America. The damaging external mite *Varroa jacobsoni* was transported from Asia to Europe before 1970, and thence (or directly) to Africa and to South, Central and North America. Another damaging Asiatic external mite, *Tropilaelaps clareae*, is now also spreading around the world. In 1956 queens of tropical African honey bees were introduced to Brazil, and as a result of hybridization, "Africanized" bees have spread through South and Central America and into Mexico and the United

States. Crane (1988) provides some details of these early dispersals.

Individual Continents

Europe (excluding the U.S.S.R.) has about 15 million hives of bees, giving a density of 8.3 per square mile, compared with the world average of 1.3. The average honey yield is about 24 pounds per hive. In spite of the great density of bees, the honey produced does not satisfy the demand, and Western Europe is the world's great honey-importing region. Europeans are in general familiar with honey because it is part of their heritage from past centuries, when beekeeping belonged to the pattern of life of every rural community, and the towns were small enough to keep in touch with the country around them. Just as tradition has helped to maintain honey consumption and an interest in bees among the general public, so it has played a material part in sustaining centers of learning where research on bees was carried out, even where honey production was not economically important. Such centers were very active between 1950 and 1980, but in the 1980's there have been cuts in funding, and some centers have been closed or absorbed into more general ones.

The honey production of Europe (excluding the U.S.S.R.) is probably about 360 million pounds a year, and around 340 million pounds are imported into Western Europe from New World countries and China, of which about a third is re-exported. West Germany alone imports 163 million pounds. Countries of Eastern Europe import much less honey, and export more: for instance Hungary about 35 million pounds, and Bulgaria and Romania about 11 million pounds each.

U.S.S.R. Bees and honey have been important in Russia throughout historical times. The Soviet State gives much encouragement to beekeeping in both public and private sectors. Activities are organized by means of a centrally planned and controlled network of organizations throughout each of the 15 Republics of the Union, which includes large territories in both Europe and Asia. More than half the colonies of bees perished in World War II, but the number has since reached the pre-war figure of 10 million, and is now about 8 million; the annual honey production per hive has doubled within the last 10 years or so, to about 50 pounds. The total honey production is about 400 million pounds.

Asia. Statistics are still difficult to establish for many countries of Asia. There are possibly about 13 million hives in Asia excluding the U.S.S.R., many of them traditional types without movable frames. A considerable part of the honey produced in the tropical south is collected from wild nests of *Apis dorsata*. Beekeeping gives an average annual honey yield per hive of up to 40 pounds; the total production is recorded as around 550 million pounds. Production is increasing with the use of the more productive European bees. After 1950, China developed beekeeping greatly in suitable areas, and in

1980-1982 this country was the world's largest exporter of honey. At present it has about 6 million hives of European *Apis mellifera* and 1 million of the native *Apis cerana*; they produce 350 million pounds of honey a year of which 100 million pounds is exported. Japanese imports are at the present about 70 million pounds a year, higher than for any country except West Germany.

Greater quantities of royal jelly are produced and consumed in Eastern Asia than anywhere else. During the mid-1980's, China produced 880,000 pounds a year, Taiwan 510,000 pounds and Thailand 26,000 pounds; Japan imported 441,000 pounds.

Africa. Beekeeping conditions on the north coast of Africa are not dissimilar from those in other Mediterranean countries, but many beekeepers still use traditional hives. Africa has some 14 million hives of bees in all, and many in tropical countries south of the Sahara are also traditional hives, from which beeswax as well as honey is harvested; they give a wax yield that is about 8 to 10% of the honey yield (compared with 1½ to 2% with modern hives). In tropical Africa the native honey bees (*Apis mellifera*) swarm freely and build their nests in tree or rock cavities, and also in hives hung in trees. There are vast areas of wooded country that provide bee forage, and shade for hives. Some tribes developed a tradition of beekeeping and harvesting from wild colonies, and to these peoples the production and sale of beeswax has been an accepted form of livelihood. The total beeswax production of Africa is several thousand metric tons a year, and has represented most of the beeswax offered on the world market. The total amount of honey collected from hives in Africa is 200 million pounds; some of it is made into honey beer.

Farther south, productive beekeeping is carried out with modern hives, mostly by descendants of settlers from Europe (Anderson *et al.*, 1983). In the extreme south of Africa the climate is again more Mediterranean, and there is even a different native race of honey bees — the Cape bee *Apis mellifera capensis*.

The Americas. We have seen that the continents of the New World —North and South America, and Australasia — give higher harvests from bees than the Old World. Figures quoted for the 1970's (Crane, 1975) showed a higher differential than today; in the Old World increasing beekeeping efficiency has raised yields, and in parts of the Americas yields have been reduced by intensive agricultural practices, and variously affected by the spread of Africanized honey bees.

The United States and Canada together have about 5 million hives, with an average annual honey yield per hive of about 40 pounds in the United States and 140 pounds in Canada — the highest national average in the world. Beekeeping is still mostly a hobbyist pursuit, but there are several thousand

full-time or part-time professionals, with holdings of up to several thousand hives. In areas in the East the climate is more like that of Europe, and honey yields are lower; most holdings are comparatively small, and — as in Europe — there tends to be a greater interest in the bees themselves.

There are nearly 8 million hives in South and Central America including Mexico. Tropical regions are the home of many species of native stingless bees (Meliponinae), and also of the Africanized honey bees that spread through and beyond Brazil from 1957 onwards. The average annual yield per hive in Central and South America as a whole is about 42 pounds, and the total annual production about 320 million pounds, 230 million pounds of this are exported — 120 million pounds from Mexico alone, which is at present the world's largest honey exporter.

Australasia. There are about 800,000 hives in Australasia and the Pacific islands together. Migratory beekeeping to a succession of honey flows in Australia makes it possible to obtain some of the highest annual honey yields per hive in the world; the average for the whole country is about 100 pounds. Most of the honey comes from different eucalypts, some of which give copious yields during their rather infrequent flowering periods, which may occur only once every 2, 4 or more years. The honey yield declines as the indigenous forest is cleared in successive areas, even where the stands of trees may be replaced by nectar-bearing agricultural crops.

Australia produces about 55 million pounds of honey a year and exports 22 million pounds or more. New Zealand produces about 13 million pounds and also exports. The eucalypts are not native to New Zealand, and beekeeping there is more similar to that in parts of America. Especially during the past few decades, beekeepers in New Zealand and Australia have contributed a number of developments in beekeeping equipment and techniques.

Pacific islands can be safe havens from diseases and pests, and queen rearing has been developed on some of them, notably Hawaii.

CONCLUSION

With all the changes noted in this chapter, two factors in beekeeping are, so far, beyond the power of man to change materially: the climate which determines what bee forage will flourish, and the habits of the bees themselves. Perhaps the challenge presented by these factors helps to mold beekeepers into the class of people that they are.

Beekeeping thus follows a varied and interesting pattern in different parts of the world. It is a pattern which has changed through the centuries with man's colonization of new regions, and which now changes every decade with changing agricultural practices, for these affect the forage which gives the bees — and the beekeepers — their harvest. As new areas are brought into

cultivation, new crops grown, and new agricultural methods used, the pattern of beekeeping inevitably changes. New bee forage may be provided by new crops, but the promotion of a clean agriculture by killing weeds before they flower, and the rapid harvesting of fodder crops, both reduce the bees' forage. In some areas the control of insects which damage agricultural crops has destroyed many wild bees and other beneficial insects, whose nesting places may also be endangered by the reduction of waste land. This has left the so-called domesticated honey bee as the only pollinator available in large enough numbers and has brought a new form of return to the beekeeper, in pollination rental.

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