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Beekeeping from Antiquity Through the Middle Ages

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Abstract

Beekeeping had its origins in honey hunting—the opportunistic stealing of honey from wild honey bee nests. True beekeeping began when humans started providing artificial cavities within which the bees could build comb for the queen to lay her eggs and the workers could process honey. By 2450 BCE, the Egyptians had developed sophisticated apiculture, and, within two millennia, beekeeping with horizontal hives had spread throughout the Mediterranean. During Europe's Middle Ages, honey and wax became important commodities for trade, and beekeeping in skep, log, box, and tree hives flourished to meet the demand. Other species of honey bees contributed to the development and spread of beekeeping in Asia beginning around 300 BCE. Meanwhile, beekeeping evolved independently in Mesoamerica with the stingless bee *Melipona beecheii*, as documented by archaeological finds and written accounts that survived Spanish conquest.

INTRODUCTION

Humans and honey bees have a long history of association. It is likely that proto-humans were interacting with honey bees long before the appearance of *Homo sapiens*, as chimpanzees will modify branches into a variety of tools to tear into nests of wild bees to steal the honey. These industrious chimpanzees also carry these tools from one nest to another, rather than simply discarding them (15, 34). This extant primate behavior suggests that early hominins may have also robbed honey bees of their produce.

Robbing wild bees of their honey is the oldest documented interaction with bees. Rock paintings in Spain depict honey hunters suspended from rope ladders as they harvest sections of honeycomb. These paintings are thought to date back 7,000 to 8,000 years, but they are not the oldest evidence of use of bee products (9, 29). Chemical evidence of beeswax has been detected in Anatolian pottery nearly 9,000 years old (72). However, this Neolithic evidence does not document that humans had developed beekeeping, as beeswax can also be collected by honey hunting.

True beekeeping requires that honey bees be provided with an artificial cavity within which the bees can build comb, constructing cells in which the queen lays her eggs and the workers deposit nectar and pollen to make honey and bee bread. The oldest definitive evidence of providing such a cavity for bees—and thus of true beekeeping—dates back to antiquity (3000 BCE to 500 CE) (56).

Much of the early understanding of ancient beekeeping draws upon the writings of Aristotle and other ancient philosophers and historians. Although books written during the nineteenth century focused on Western beekeeping, offering examples of straw skeps and log hives as the most primitive means of beekeeping, that view changed in the light of archaeological discoveries in Egypt starting in 1898, which inspired historians to reassess the early history of beekeeping. Frasier (40) focused on beekeeping from ancient Egypt and writings from Aristotle, Virgil, Cato, Varro, Columella, Palladius, and others covering the period from 2450 BCE to 400 CE. Ransome (71) extended the historical survey to include Europe's Middle Ages and early beekeeping in Mexico. Herrod-Hempsall (46), like many other authors, restricted his historical survey to the Middle East and Europe, but he did add additional information concerning medieval beekeeping.

Among the most important researchers of apicultural history was Eva Crane. She amassed a major library and a collection of artifacts and photographs that documented beekeeping throughout the world. Her book *The Archaeology of Beekeeping* (26) was global in its coverage. Crane's 1999 encyclopedic work on the world's history of beekeeping, *The World History of Beekeeping and Honey Hunting*, stands as the most important work on the subject (29). Since its publication, many new discoveries have furthered our understanding of early beekeeping. This review focuses on beekeeping from antiquity through the Middle Ages from 3000 BCE though 1500 CE. It is global in its geographical range, illustrating how beekeeping developed in isolation in many parts of the world.

BEEKEEPING IN ANTIQUITY

Several tantalizing discoveries suggest that people from the Levant region of the eastern Mediterranean have been continually collecting honey and beeswax for nearly 9,000 years. Three thousand years after this time of the earliest evidence of interaction between humans and bees, the practice had spread northward to the United Kingdom and Scandinavia and south to North Africa (72).

In 1961, in a cave near the Dead Sea in present-day Israel, over 400 objects were discovered, including copper vessels made through the lost wax process. To make these vessels, a beeswax model of the desired form was encased in wet sand or clay and then heated to harden the mold and

burn out the wax. Molten copper was then poured into the mold, resulting in a metal copy of the original wax form. These lost-wax items were found under a straw mat that was carbon dated to at least 3500 BCE. The amount of wax required for this process was significant, but, because the wax could have been collected from wild bees, these vessels do not constitute evidence of beekeeping (57).

The oldest evidence of true beekeeping comes from ancient Egypt and dates back to 2450 BCE. It is a relief from the Sun Temple of the Fifth Dynasty pharaoh Newossere Any that was discovered in 1898 south of the Great Pyramid of Giza. It shows beekeepers working hives, processing honey, and sealing honey in containers for storage. The relief shows that beekeeping was a well-established occupation by the Fifth Dynasty, indicating that beekeeping practices began or were introduced into Egypt centuries earlier. When this happened is unknown, but the Egyptians carved the first crude examples of the honey bee hieroglyph during the First Dynasty, approximately 3000 BCE (57).

The hives used by the Egyptians were horizontal hives made of dried mud and straw, which were stacked upon each other to create walled apiaries. Other beekeeping paintings and reliefs found in sites dating from Egypt's Twelfth (1991 BCE to 1786 BCE), Eighteenth (ca. 1569 BCE to 1315 BCE), and Twenty-Sixth Dynasties (664 BCE to 525 BCE) document the importance of honey in Egyptian society. Egyptian apiculture was a state-organized occupation, and honey was an important commodity for trade, food, and medicinal ingredients (23). Beeswax was an important part of magical and religious rituals; it was also used in cosmetics and for waterproofing boats (57).

Beekeeping was widespread in the Levant by 1500 BCE, as demonstrated by several Hittite laws that describe penalties for stealing swarms and beehives. These laws also attest to the value of bees in the local economy. One law in particular reveals that the fine for stealing a swarm of bees was about the same as the fine for stealing a sheep or five shekels of silver, and stealing empty hives incurred a fine of three shekels for each hive (3, 29).

The oldest known beehives were discovered in 2007 in Tel Rehov, now part of modern Israel, and they are horizontal hives similar to the ones illustrated in the Eighteenth Dynasty Egyptian tomb of Rekhmire. The Tel Rehov hives are contemporaneous with Egypt's Twenty-Second Dynasty and have been dated to approximately 875 BCE, when Egypt's influence included Tel Rehov. The number of hives found at Tel Rehov suggests that they were used primarily for wax production, as lost wax casting was a major occupation in the area (62). Parts of bees were found in these hives, including a wing that suggests that the race of honey bees used was *Apis mellifera anatoliaca*, which is now found in Turkey. *A. mellifera syriaca* is the subspecies of honey bee currently native to the region (12).

This importation of honey bees may have been common during the first millennium BCE. An Assyrian relief dating to 780 BCE describes how Shamash-res-usur, the governor of Suhu, introduced beekeeping into the region from the mountains of Habha (73). Beekeeping was well established in the region by the time of the First Persian Empire (559–330 BCE) (2).

Beekeeping with horizontal hives made out of a variety of materials spread throughout the Mediterranean region, and by 400 BCE, horizontal pottery hives were in use in Greece. These hives were approximately 65 cm long, tapering slightly from the 25-cm opening toward a blunt, closed end. The interior was incised with grooves to provide the bees with a textured surface area where they could affix their comb (**Figure 1**). A flat pottery lid was held in place over the hive's opening by a stick that was affixed to ropes made snug around the heavy, projecting rim of the vessel. If the hive needed to be enlarged, rings of pottery could be added to the opening between the hive and the lid, providing the bees with more space to build comb (4, 50). Such hives were likely placed into stone walls, some of which survive to this day (28). When they were no longer used for bees, these pottery hives were often repurposed as coffins for young children.



Figure 1

A horizontal hive (ca. 400 BCE) from a pottery works excavated east of Athens, Greece. Photograph by Gene Kritsky.

Although no hives or illustrations are known from ancient Rome, horizontal hives dating back to 250 BCE have been found in Iberia, when that region was part of the Roman Republic (16, 29). Fortunately, several books from 234 BCE to 300 CE include accounts of beekeeping that illuminate the practices of the day. Of these authors, Varro (116–27 BCE) provided details of variously shaped hives made from a variety of materials in use in his day:

> Some build round hives of withies (wicker) for the bees to stay in, others of wood and bark, others of a hollow tree, others build of earthenware, and still others fashion them of fennel stalks, building them square, approximately three feet long and one foot deep, but making them narrower when there are not enough bees to fill them, so that they will not lose heart in a large empty space. . .The best hives are those made of bark, and the worst those made of earthenware, because the latter are most severely affected by cold in winter and by heat in summer. (88, 16:15–16)

Varro confirms that the hives are placed in walls for protection and the beekeeper would remove lids to reach the honeycomb (88).

Columella (ca. 60 CE) records that hives were constructed from materials that were common in different regions. Some were made of cork, fennel sticks, or woven basketry materials. Like Varro, Columella argued that pottery hives were the worst (24, 30). These observations by ancient writers have been evaluated by testing the thermal properties of pottery hives, and the findings suggest that they were not as inferior as Columella claimed (39). Summaries of the beekeeping works of various Greek and Roman authors can be found in works by Crane (27), Fraser (40), and Whitfield (90).

The diversity of hive types described by Varro continued into the Common Era. Two log hives have been excavated in Germany near Oldenburg in the state of Lower Saxony. One was dated

by associated pottery to the second century and the other to between 400 and 500 CE. The latter hive was held together with wooden pegs and equipped with an oak cover (29, 31). A hive found in a peat bog near Wilhelmshaven, also in Lower Saxony, is the oldest known woven wicker hive, dating back to 200 CE. Only the crown or top portion of the hive was preserved but enough to show that the hive was round; associated fragments may be the remains of its bottom board (31).

In addition to the physical hives, much of what is known about apiculture and the use of honey during the Hellenistic period comes from several written accounts (23). Aristotle wrote about honey bee behavior but did not examine beekeeping. An unknown author sometimes referred to as Pseudo-Aristotle (29) did record some details of beekeeping, relating that yields ranged from 6 to 18 pints and that beekeepers had to leave sealed honeycomb for the bees to use during winter and smoked their hives to calm the bees (35, 50).

Migratory beekeeping also had its origins in antiquity. During Egypt's Ptolemaic period, correspondence from beekeepers to a Greek official mentions that hives were transported on donkeys (57). Columella (24) encouraged the moving of bees when food sources had been depleted, citing examples of bees being moved from one island to another. Pliny (69), a contemporary of Columella, described how hives were placed on boats and moved upriver to better foraging sites. The boats would gradually ride lower in the water as the hives filled with nectar.

BEEKEEPING IN EUROPE'S MIDDLE AGES

The Middle Ages, also known as the medieval period, began with the end of the Western Roman Empire around 500 CE and endured for a millennium. Although no illustrations of beehives are known from Europe between 500 and 1000 CE, there is considerable evidence that beekeeping flourished. Mead, a honey-based alcoholic drink, is mentioned in poems from the fifth century and in the epic of *Beowulf* in the eighth century (46, 63). Charlemagne (747–814) ordered that all manors had to keep bees and that two-thirds of the honey produced must be given to the Crown (49). Crane & Walker (32, 33) surveyed written records from England and Wales documenting beekeeping activities. Laws written during the reign of King Alfred, around 885 to 899 CE, proclaimed that the "stealer of bees" was subject to the highest fines (33).

Honey and wax were major trade commodities at the start of the Middle Ages. The 879 CE Treaty of Wedmore helped put an end to Viking raids, promoting trade between Norway and England. Furs and fish from Norway were exchanged for wool, malt, wheat, and honey. Contemporaneously, in the middle Dnieper basin (present-day Belarus and Ukraine), beekeeping became a profitable occupation because of the demand for honey and wax (80). Beeswax, in particular, was an important raw material and was used for adhesives, waterproofing, pigment binding in paints, and lost wax casting. Thus, the demand for beeswax contributed to its widespread trade throughout Europe (44).

The use of skep beehives as weapons may extend back to the life of Saint Gobnait, a nun who lived during the seventh century in Ballyvourney County in Cork, Ireland, who (in one version of the legend) drove off a band of would-be cattle thieves by shaking a beehive, releasing the angry bees to pursue the rustlers (53). In the year 908, Danes and Norwegians laid siege to Chester, England, but the defenders of the town broke the siege by throwing beehives over the town walls. Using beehives as weapons continued into the latter half of the Middle Ages, as documented by a 1326 English manuscript that includes an illustration of skep hives being thrown over castle walls (46).

The *Domesday Book* was a survey of the holdings of all the lands in England following 1066, when William the Conqueror became king of England. The survey included the number of beekeepers and hives in many counties. For example, three out of every ten landholdings in Essex had bees,

with an average of four to five hives per holding and a total of 601 hives accounted for in all of Essex. Similar numbers from Norfolk and Suffolk attest to the importance and prevalence of beekeeping in England. The hives used in the western counties were thought to be wicker skeps, which were smaller than the straw skeps that were more common in the eastern counties (41).

The productivity of medieval beekeepers was impressive. Vernon (89) analyzed a 1269–1270 account book from Beaulieu Abbey in Hampshire County, approximately 95 miles southwest of London. The abbey held lands in Cornwall, Norfolk, and Hampshire. They frequently purchased empty skeps, as they killed their bees to harvest the honey and suffered high winter losses. The monks considered beeswax more important than honey because it was used for liturgies, candles, and votives and for sealing casks (70). They produced 155 pounds of wax that year. Their records of honey yields do not include the honey used by the monks themselves, but, even so, they recorded the production of 1,782 pounds of honey from their apiaries. They did not record the number of hives in their care in 1270, but estimates based on their honey production suggest that they had approximately 300 hives.

Forest beekeeping flourished during the Middle Ages in eastern Europe's woodlands, especially in what is present-day Poland, Ukraine, Russia, Latvia, Estonia, Lithuania, and Germany. Forest beekeeping evolved from honey hunting for wild nests in natural tree cavities. The honey hunters began enlarging tree cavities to facilitate the growth of the wild bee colonies they found, and this eventually led to carving artificial cavities into trees in the hope of attracting a colony—a practice that formed the foundations of true beekeeping in eastern Europe. To create a tree-cavity hive, the beekeeper would select a tall straight tree, preferably one with a woodpecker hole or other small cavity already present. Using ladders or ropes to reach the cavity, the beekeeper would saw a long, rectangular opening in the bark and use chisels to hollow out the trunk. When the cavity was completed, the opening would be closed with a board equipped with a small entrance hole and was marked to show ownership. To protect them from plundering bears and humans, the hives were placed at heights of between 5 and 25 m, and, if the tree was of sufficient size, the beekeeper might carve two or even three hives in a single tree, essentially creating a tree apiary. It was common to cut off the top of the tree above the highest hive to prevent high winds from snapping the trunk at the weakened areas. Several species of trees were used for these tree hives, but many beekeepers preferred oaks and pines. Later, presumably to prevent the hives from deteriorating after the death of the tree, the hive could be cut away from the rest of the trunk and moved to an apiary of similar log hives or suspended in another tree (11, 29, 51, 74, 91).

There is very little written information about the practices of beekeeping during the Middle Ages, but more details have been discovered from a source that has only recently been made widely available for study. Illuminated manuscripts—transcribed books that include elaborately decorated initials, marginalia, and miniature illustrations—date to late antiquity, but they became more common during the Middle Ages. They were produced by monks, who copied books on commission for the nobility and wealthy patrons. The decoration of these manuscripts ranges from simple scrolls and flourishes to complex illustrated panels and borders, which sometimes depict animals and scenes of daily life, including honey bees and beehives. Fortunately, many of the libraries that hold these medieval manuscripts are making high-quality digital scans available for study through the Internet.

The first books known to include beekeeping illustrations are the Exultet Rolls created in southern Italy between 900 and 1200. Their name refers to the opening lines of a hymn praising the pure beeswax paschal candle, which was lit on the eve of Easter (30, 42). Several of the hymns were sung in praise of the bees that provided the beeswax, and the accompanying illuminations include the first illustrations of beekeeping since the Twenty-Sixth Dynasty reliefs from ancient Egypt, which were made over 1,500 years earlier.



Figure 2

Bees flying into a skep as depicted an early thirteenth-century bestiary (18). The original is in the British Library (**http://www.bl.uk/catalogues/illuminatedmanuscripts/ILLUMIN.ASP?Size=mid&IllID=55682**), in the public domain.

Some of the illustrations show rectangular beehives constructed from boards, whereas others show cylindrical hives made of hollow logs. The hives tend to be two to three and a half times as long as wide; many are horizontal and lying on their sides, and some are stacked. One illustration shows two rectangular hives supported on legs. The beekeepers interacting with these illustrated hives are not wearing any protective clothing and are shown cutting away honeycomb with knives. The Bari Exultet Roll, which dates to 1025, shows a beekeeper using a cylindrical container to capture a swarm bivouacking in a tree. It also shows two men using what is presumably smoke to collect a wild colony from a tree (6, 8, 30).

Missing from the Exultet rolls are images of skeps, which likely reflects that skeps were not widely used in Italy, where the Exultet rolls were created. The first illustrations of skeps are found in the popular bestiaries (**Figure 2**), which described animals both real and fictional, including details of the natural history of the animals and occasional moral lessons. Given the economic importance of the honey bee at the time, it is not surprising that it was included in several bestiaries, and the accompanying illustrations provide insights into medieval beekeeping. The *Worksop Bestiary* (MS M. 81), held by the Pierpont Morgan Library in New York, was produced around 1185 in England. It shows a beekeeper releasing a captured swarm from a bag, and the bees making their way into a skep beehive (67). The twelfth-century *Aberdeen Bestiary*, also from England, shows an apiary of three wicker skep hives resting on a short-legged table (1).

In the *Bodleian Bestiary*, which dates from 1220 to 1250, the passage regarding the honey bee includes a colorful illustration of a woven wicker hive. The accompanying text shows that thirteenth-century beekeepers knew about several aspects of honey bee development. It begins, "Bees (*apes*) are so called because they hold on with their feet, or because they are born without feet (*pedibus*). Later they both grow feet and wings." The description goes on to point out that

they construct their "castles" out of wax, and that they "flee from smoke" (7, p. 177). However, the author fancifully describes how bees spring forth from worms found in the putrefying flesh of cattle, whereas rotting horses produce hornets (7).

Other manuscripts provide additional insights into European hive development. The *Lilienfelder Concordantiae caritatis*, written around 1350 in Germany, illustrates two kinds of upright log hives typical of German forest beekeeping. One consists of a hollow log with a large rectangular cutout allowing access to the hive's interior, which is covered by two boards held in place with pegs. An opening cut in the bottom edge of the upper board forms the hive's entrance. The other is a basic log hive without doors, standing upright on a small stool (81–83).

Illuminated manuscripts also offer glimpses of the evolution of protective clothing. The Flemish Psalter manuscript, Douce 6, from between 1320 and 1330, shows a beekeeper wearing a simple veil—basically, just a cloth covering his head. This is one of the earliest examples of a beekeeper wearing protective clothing of any kind (14). The Holkham manuscript (MS 307; ca. 1400) includes a frontispiece for a French version of Virgil's *Georgics* that shows a beekeeper wearing a more tailored cowl (25, 29). The Bodleian Library's Rawlinson Manuscript (G. 98) shows mid-fifteenth-century beekeepers wearing protective clothing that would not appear out of place today (13). In all three of these manuscripts, the beekeeper is striking a flat drum, a practice known as tanging the bees, which was intended to encourage a swarm to land so that it could be captured by the beekeeper.

Purposefully constructed platforms upon which the beehives would be placed are also illustrated in various manuscripts. The *Tacuinum Sanitatis*, a book on horticulture and health based on an eleventh-century Arabic manuscript and produced between 1390 and 1400, shows skeps on shelves attached to a building and supported by legs at the front. In the foreground, the beekeeper cuts honeycomb out of an open skep that is lying on its side. A woman is standing next to the hive, holding an empty bowl to receive the comb. Unlike the hives on the shelves in the background, no bees are shown flying around this hive, suggesting that the bees were killed prior to harvesting the comb (10). The killing of the bees at harvest is illustrated in a 1485 Italian manuscript in the British Library in London, England, that shows a large fire pit adjacent to an apiary where beekeepers are working box hives (19).

A version of Virgil's *Georgics* from approximately 1460 includes an illustration of straw skeps placed in a bee shelter—a low stand equipped with a slanted roof to help protect the hives from rain and snow (55). These open shelters still left skeps vulnerable to the elements, and sometimes additional protection was required. Wicker skeps were often plastered with mud that was allowed to dry to protect the hive (68), and, in some instances, hackles made of thatch were constructed and placed over the hive. One such hive, raised above the ground on a low table, was illustrated in a mid-fifteenth-century manuscript (5).

A more permanent method of protecting skeps from the elements (and from theft) involved the construction of niches in garden walls or the sides of buildings. Bee niches, also called bee boles or bee garths, date back to 1250 and were often placed in south-facing walls to give the bees the warmth of the winter sun. The most basic niches were simple square or rectangular recesses, but others were domed with rounded backs or featured gabled roofs and other appealing details. They were made in stone or brick walls and in some cases lined with plaster and fitted with doors or bars to discourage thieves (56).

While these developments were taking place in Europe, apiculture also flourished in the Levant during the Middle Ages. Beekeeping in Egypt changed little from what had been practiced during antiquity. Bees continued to be housed in horizontal hives made of dried clay and stacked in a manner reminiscent of the ancient reliefs from tombs and temples (57). Archaeological evidence dating to Mamluk Palestine during the Crusader period (1095–1291) shows that beekeeping was

practiced using horizontal mud and straw cylinders or large repurposed jugs as hives. The cylindrical hives were stacked in a manner consistent with wall apiaries in the ancient world, whereas the jugs would be placed horizontally and cemented in place with mud, creating a walled apiary (79).

There are many gaps in the history of medieval beekeeping. Missing entirely are details regarding migratory beekeeping during that period. The practice definitely continued, as documented by a 1555 Renaissance text that describes how beehives were carried from place to place by people, but if the terrain was "marshy or flat," up to 20 straw skeps could be transported on a horse-drawn cart (29, 60).

BEEKEEPING IN ASIA

The majority of works on apicultural history are Eurocentric in nature, but apiculture developed independently in several parts of the world. These independent origins of beekeeping are related to the prevalence of different species of honey bees. Eleven species of honey bees are recognized and can be placed into three broad groups. The five species of cavity-nesting bees include the honey bee, *A. mellifera*, the species that occurs in Europe, the Middle East, and Africa and that is most familiar to the Western world. The two species of dwarf honey bees are about the size of a house fly, whereas the four species of giant honey bees are double the size of *A. mellifera*. Unlike the cavity-nesting bees, the dwarf honey bee *A. florea* attaches its small, circular comb to the branch of a tree or shrub, whereas the giant bee *A. dorsata* constructs very large combs that hang from the underside of large tree branches or rock ledges. The exposed combs of both the dwarf and giant honey bees are protected by bees that cover the comb (76).

The oldest known interaction of humans and honey bees in Asia is shown in Mesolithic rock paintings from central India, which depict intrepid honey hunters climbing trees to collect the combs of the giant honey bee, *A. dorsata* (61), a practice that still takes place today. Records from China's Chin dynasty (265–290 CE) also describe taking *A. dorsata* combs from a rock wall. However, beekeeping developed in Asia with the cavity-nesting honey bee *A. cerana*. This species is smaller than *A. mellifera*, and it constructs smaller combs and produces less honey.

Chinese references to bees and honey date back to a reference to honey being used for medicinal purposes some 3,500 to 4,000 years ago. The oldest Chinese pictographs for honey bee were carved on bones that date to 1000 BCE, and the Chinese word for honey, *mi*, was written by 300 BCE (58). Beeswax candles were presented to Emperor Gao in 202 BCE (66). However, these discoveries do not establish that true beekeeping had been developed, and it appears that beekeeping started relatively late in China compared to Egypt and the Levant. The oldest beekeeping reference dates to 158–166 CE and is found in the biography of a Confucian scholar who kept bees (66). The first details of ancient Chinese beekeeping date to the third century CE and describe how the interior and exterior surfaces of "wooden containers" with a small entrance hole were completely rubbed with beeswax. During the swarming season, two or three bees were captured and placed in the box. The bees would be permitted to leave, and eventually the container would fill with bees (66).

Chinese knowledge of beekeeping expanded over the following millennium. Chinese records indicate that beekeepers were aware of the different castes, understood swarming, and knew how to unite and separate colonies. In 1273, the book *Fundamentals of Agriculture and Sericulture* was produced by the Mongol government and included a chapter on bees that described their hives as "a small house" or a woven cylindrical basket with the ends sealed with mud. The chapter also describes tasks the beekeeper should carry out during the course of a year, including splitting the colony if inspection showed that it was strong, with more than one "king." This beekeeping chapter was composed two hundred years before any similar book was produced in Europe, and

these records are critical to understanding the evolution of beekeeping in China, as no direct illustrations or archaeological evidence of Chinese apiculture have yet been discovered (66).

Little is known of the origin of beekeeping in Korea and Japan, as records are sparse and contradictory. Park & Yeo-Chang (65) note that apiculture was practiced in Korea as early as the first century CE, but little detail is provided to determine whether this was honey hunting or true beekeeping. Honey hunting was definitely being practiced in Korea by 300 CE (29) and true beekeeping by the middle of the seventh century. Written records indicate that beekeeping was also introduced to Japan from Korea during the seventh century (65), but detailed information about specific practices has yet to be found.

Beekeepers in Vietnam were housing bees in basket and box hives by the eighth century (29), and there is a relief at Angkor Wat in Cambodia dating to 1000 CE that shows bees being collected in logs, boxes, or pottery hives (64). Unfortunately, we have scant information about early beekeeping in Laos, Thailand, the Philippines, Myanmar, and Malaysia.

Beekeeping appears to have developed independently in India. Honey, likely robbed from the giant honey bee, *A. dorsata*, is mentioned in *Rājatarangiṇī*, a historical text written by Kalhana in 1148 that states that honey was hunted in Kashmir since "ancient times" (45, 75). Crane (29) was struck by the similarities between traditional Greek beekeeping and Indian beekeeping and suggested that members of Alexander the Great's army who remained in India may have introduced horizontal pottery hives from the Mediterranean region. Shah (75) suggested that after Shah Mir, a Muslim ruler of Turkish descent, took control of Kashmir in 1341, he imported skilled craftsmen (including beekeepers) from Islamic countries and thus introduced beekeeping to Kashmir.

The relatively late development of beekeeping throughout Asia is likely related to the presence of other natural sweeteners such as sugarcane in India and maltose (made from fermenting germinated barley or rice) in China (29). The presence of other species of honey bees that produce nests in the open that could be robbed for honey and beeswax further lessened the need for true beekeeping. A common thread throughout the region is the introduction of beekeeping by migrating peoples, which may have occurred in India as early as 327 BCE (29).

BEEKEEPING IN MESOAMERICA

The Maya enjoyed a robust beekeeping tradition by the time the Spanish arrived in the early sixteenth century. They used honey as a trade commodity with the Aztecs (54), to pay tributes, and as an ingredient in drinks, including *atole*, a gruel that was flavored with honey (38). They had created hieroglyphs for bee, hive, and honeycomb (22, 48, 59). They held ritual dances during the year to encourage the gods to provide flowers for the bees and to aid the bees in their work (84–86).

Maya beekeeping in the Yucatan did not revolve around a species of *Apis*, as did beekeeping in Europe, the Middle East, and Asia. Rather, the Maya developed meliponiculture using the stingless bee *Melipona beecheii*. Like true honey bees, *M. beecheii* is a cavity-nesting bee that produces honey, but *M. beecheii* does not make combs of pure beeswax. Instead, it produces cerumen—beeswax mixed with plant resins (52). These stingless bees do not store their honey in a comb but in rounded so-called honey pots, which are larger than brood cells and made of cerumen (78).

It is likely that, similar to beekeeping in the forests of Europe, meliponiculture developed as a progression from honey hunting to providing bees with an artificial cavity for their manufacture of honey pots and brood cells (52). Discoveries of cached beehives dating back to the Maya Late Preclassic period, between 300 BCE and 250 CE, offer the oldest evidence of beekeeping in Mesoamerica (20). Similar remains of beehives have also been documented in the Classic period between 250 and 900 CE (21). Excavations of Late Preclassic ruins on Cozumel unearthed several

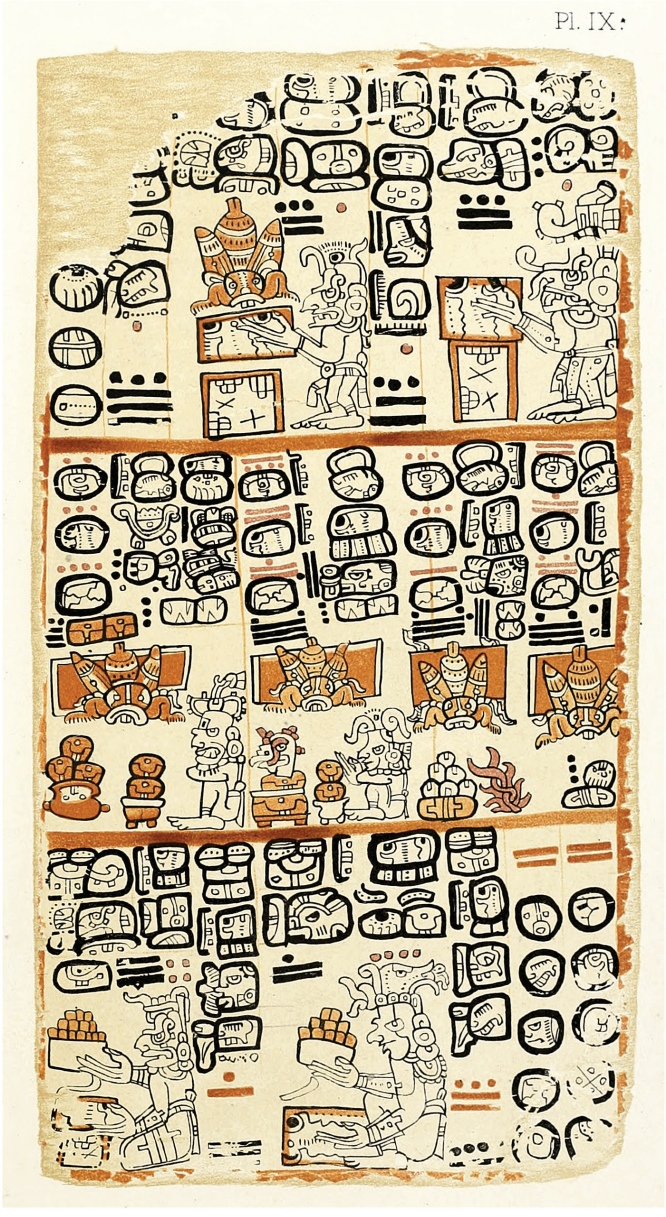


Figure 3

A page from the *Madrid Codex* showing the stingless bees with their hives (17); in the public domain.

limestone discs, which may have plugged the ends of hollow log beehives (39, 47, 77). This idea is supported by a cylindrical ceramic beehive that was described from the Late Preclassic period, which was the same shape as a log hive and included two ceramic discs that were inserted at each end (92).

Maya meliponiculture on Cozumel grew during the Late Postclassic period (900–1521), at which time the Maya made pottery censers decorated with beekeeping imagery (43, 92). One

shows a god associated with the stingless bee holding honey pots. The other shows a male deity wearing a necklace with a central beehive pendant (91).

An important record of Maya beekeeping is the *Madrid Codex*, which was created around 1400. The last ten pages of the codex includes details of Maya beekeeping, including images of log hives (both interior and exterior), the harvesting of honey, and the deities associated with beekeeping (**Figure 3**) (17, 22, 37, 84, 87, 92).

Maya beekeeping arose independently of Old World beekeeping, as their ancestors crossed the Bering Strait several millennia before Maya beekeeping began. Although *Apis* bees had once existed in North America, they were extinct by the time the ancestors of the Maya migrated south (36), so any possible tradition of honey hunting was likely long forgotten when their descendants arrived in Mesoamerica. Once they reached the tropics, the Maya encountered the sweet windfall produced by stingless bees and the first steps toward meliponiculture began.

CONCLUSION

Although much has been gleaned regarding the history of beekeeping around the world, there are many knowledge gaps that will require future apicultural historians to be alert to publications outside of entomology. Documenting early beekeeping history will require keeping up with archaeological discoveries of new artifacts, visiting museums and archives to study original objects, searching through previously unpublished works, reevaluating older sources, scouring the Internet for digitized manuscripts that might include illustrations of hives, and thinking of novel combinations of search terms that might turn up important, obscure resources. There is much more to be discovered about the history of beekeeping in Asia and particularly in Africa, where horizontal hives are still kept in the Sudan and hung from trees in Tanzania and Kenya. The paucity of written accounts from these regions presents a challenge in deciphering this history, but it is a challenge worth meeting.

SUMMARY POINTS

1. The oldest documented association of humans with bees dates back to 7000 BCE.
2. The oldest definitive illustration of beekeeping dates back to 2540 BCE from Egypt, and the oldest known beehives date to 875 BCE from what is present-day Israel.
3. Horizontal beehives made from a variety of materials predominated beekeeping in antiquity.
4. Beekeeping flourished during Europe's Middle Ages with increased demand for honey and beeswax for trade.
5. Beekeeping developed in Asia starting around 370 BCE.
6. Beekeeping using the stingless bee *Melipona beecheii* evolved independently in Mesoamerica.

FUTURE ISSUES

1. Considerable gaps remain in the history of beekeeping practices, especially in Europe dating from 500 to 1000 CE.

2. The early history of Asian beekeeping needs work to fully understand its origin and diffusion throughout the region.
3. Knowledge of ancient African beekeeping is essentially nonexistent because of the lack of written records prior to 1500.
4. Entomological historians need to become skilled in surveying obscure sources to recognize evidence of past apiculture.

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RELATED RESOURCES

The following websites include an easy to use search for the apicultural images found in their illuminated manuscripts.

British Library. **https://www.bl.uk/catalogues/illuminatedmanuscripts/welcome.htm**
Bodleian Library at Oxford University. **http://bodley30.bodley.ox.ac.uk:8180/luna/servlet**
The Morgan Library. **http://corsair.themorgan.org**