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REVIEW ARTICLE

The past and present status of beekeeping in Libya

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Honey bees (*Apis mellifera* L.) are native in Africa, and traditional beekeeping has been practiced by Africans in all parts of the continent for many thousands of years. No doubt, the introduction of removable comb hives to many countries including Libya has significantly contributed to develop beekeeping industry. However, there is little scientific information published worldwide about beekeeping history, especially in Africa. This review article aims to shed light on the current state of keeping honey bees in Libya, bee plants and honey production, and pest and diseases recorded.

Pasado y presente de la apicultura en Libia

La abeja (*Apis mellifera* L.) es nativa en África y la apicultura tradicional ha sido practicada por los africanos en todo el continente durante miles de años. Sin duda, la introducción de colmenas con cuadros móviles en muchos países, incluyendo Libia ha contribuido significativamente a desarrollar la industria apícola. Sin embargo, hay poca información científica publicada mundialmente sobre la historia de la apicultura, especialmente en África. Este artículo de revisión pretende arrojar luz sobre el estado actual de la apicultura con las abejas de miel en Libia, las plantas de interés apícola y la producción de miel, y las plagas y las enfermedades registradas.

Keywords: *Apis mellifera*; Libya; beekeeping; bee plants; pests

Introduction

Libya is the fourth largest nation in Africa. It occupies 1,759,540 km^2, and has a very low population density: 3.55 inhabitants per km^2. It is located between geographic coordinates 19°–34° N and 9°–26° E. Libya's coastline (1,770 km^2) is the longest of any African country bordering the Mediterranean (Kort, 2007). The Libyan Desert, which covers much of Libya (up to 90%), is one of the most arid places on earth. Less than 2% of the national territory receives enough rainfall for settled agriculture, the heaviest precipitation occurring in the Jabal al Akhdar zone of Cyrenaica, where annual rainfall of 400 to 600 mm is recorded (Barich, Garcea, & Giraudi, 2006). All other areas of the country receive less than 400 mm, and in the Sahara Desert 50 mm or less occurs. The climate is mostly dry and desert like in nature. However, the northern regions enjoy a milder Mediterranean climate. A relatively narrow coastal strip and highland steppes immediately south of it are the most productive agricultural regions (Kort, 2007). Most commercial beekeepers are located in an agricultural belt that extends about 30 km from the coast.

History of keeping bees in Libya

Old world honey bees (*Apis mellifera* L.) are authochtonous in Africa, where the relationship between man and honey bees took several forms. It started with harvesting honey comb from wild honey bee nests in hollow trees and rock crevices, developed to swarm domestication in primitive hand made cavities from different materials, to modern beekeeping (Crane, 1999). Historically, honey hunting has been practiced in many countries, but little is known about honey hunting in the Mediterranean region. Graphic depictions of honey hunting can be found at numerous sites throughout Africa. Paintings show bees, the first honey hunters, and their primitive tools such as ladders, torches, and honey containers necessary to carry out the raids have been found on rock walls in Libya and many other countries (Altman, 2010; Buchmann, 2011). Few beekeeping records have been found relating to elsewhere in north Africa west of Egypt. The earliest likely one concerns Libya which adjoins Egypt: Herodotus (485–425 BC) wrote: "Next to the Maxyes of Libya are the Zaueces, whose women acts as their drivers when they take their chariots into war. Next to these are the Gyzantes, a people where their bees produce a great deal of honey, but, it is said, craftsmen make much more" (IV, pp. 193–194). Perhaps "their bees" were in hives, and the craftsmen made a sweet "honey" from dates or other fruits; Herodotus said later (VII, p. 31) that men in Lydia in Asia Minor "make honey out of the fruit of tamarisk" (Brittan, 1956a). Hunted honey would be harvested with smoke created by lighting dung and mud, which spoiled the flavor of honey. Furthermore, bee larvae, pollen, and wax would be mixed in with the honey.

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Nine thousand years ago the Libyan Sahara was a green savannah (Gasse, Téhet, Durand, Gibert, & Fontes, 1990), a habitat to which *A. mellifera* is particularly well adapted. Yet there are large sand deserts of the Sahara precluding any survival of wild honey bees due the complete lack of vegetation. However, honey bees are present in many oases where they are often used by the local beekeepers for honey production and pollination, and also wild colonies are occasionally observed.

Greek sources indicate that Libyans were among the earliest people to practice the arts of civilization. They were, for example, accredited with being the first people to domesticate the dog, and to raise bees for honey (Sweeney, 2010). Beekeeping in Libya has been practiced traditionally since early times (Crane, 1999). Almost all traditional hives in North Africa were horizontal cylinders made of mud, clay or other materials that could be opened at either end (Hussein, 2001). Olive Brittan, beekeeper to the King of Libya Idris El-Senussi, demonstrated that Libyan beekeepers in Cyrenaica collected swarms which they have learnt to put into heavy wooden boxes, long, wide and shallow, capable of holding 15 combs. Two or three forked juniper sticks are jammed as pillars from floor to roof in the center or towards the front of the box to support the heavy brood combs (Showler, 2011). They used to cut out honey combs from the back and front entrances without killing the bees. These boxes, Brittan estimated, yielded about 18 kg of honey each year. It is said these boxes were in use more than 200 years ago, even before the Turkish era. Most families kept a hive or two but there were beekeepers with apiaries of up to 100 hives which they located in caves (Showler, 2011).

Until the 1950s, Libya was the third poorest country in the world. After the discovery of oil reserves in 1959, the Libyan economy changed dramatically (Kort, 2007). Modern beekeeping has developed only in recent decades with the adoption of modern beekeeping techniques using hives with movable combs in Libya (Keshlaf, 2002). The successful introduction of modern hives to the east of Libya after the ravages of the Second World War was due to the British beekeeper Olive Brittan in 1952 (Brittan, 1956b). Until today, beekeepers in the east region of Libya are still using Langstroth hives, whereas Dadant hives are used in the western region and are believed to be had been imported by the Italians during the occupation (1911–1932). Then, early in the 1960s, European strains of bee, primarily Italians, formed the basis of a honey producing industry. There are more than twenty governmental associations providing beekeeping equipment, hives, bee packages, medications, and imported queens, and sometimes marketing the produced honey. During the kingdom period, farmers were obligatory requested to maintain three honey bee colonies supplied free of charge with every cow they bought, from the agricultural authorities (pers. Comm.). Currently, there are more than 3,000 beekeepers, managing approximately 50,000 colonies (El Mabrook, 1996). Although many of these bees are non-migratory, they still produce an average of 250,000 kg per year. Because of increased management difficulties, limitation of floral resources and bee diseases, some beekeepers have had to reduce their operations. Many beekeepers manage 200 colonies or more; but the majority manage over 50 colonies in an apiary to harvest respectable amounts of honey. Keeping bees as a second job is very common in Libya. Now increased competition from adjacent apiaries appears to have reduced nectar availability and led to widespread disease. This, plus problems with defensive colonies, required that beekeepers now place no more than 30 colonies in an apiary.

Subspecies of Libyan honey bee

Apis mellifera L. is widespread in Africa, Europe and parts of Asia with a wide diversity of subspecies that can be classified with morphometric tools (Ruttner, Tassencourt, & Louveaux, 1978). Libya was so isolated, that its bees thus had no outside contact with other bees. The native bees have been described as predominantly of the Taillan race, *A. mellifera intermissa* (Hepburn & Radloff, 1998). Brittan (1956b) wrote in one article, "the race itself seems to be the purest one find this side of the Iron Curtain [the Libyan bee] is gentle apart from a natural intense fierceness during the great heat of the day, or when very strong through a long period of honey flows".

Brother Adam (1954), after a visit to Libya, considered that the honey bee colonies there were more aggressive than all he encountered in USA. Although honey bee queens have been frequently imported from Italy and Australia into Libya, generally these queens last only for one season and most requeened colonies rapidly lose their gentle character through subsequent crossing with the native bees. There are probably enough hygienic colonies in Libya to provide genetic stock for rearing more hygienic queens, but there is at present no queen rearing station in Libya.

Ruttner (1988) concluded, based on morphometric analyses of adjacent countries, that the Libyan honey bees belong to *A. m. intermissa*, but El Banby (1977) concluded that bees from northeast Libya belong neither to *A. m. intermissa* nor to *A. m. lamarckii*. Shaibi investigated honey bee populations of *A. mellifera* in Saharan and coastal locations in Libya to fill the North Africa gap of biogeography and distribution of honey bees (Shaibi, Fuchs, & Moritz, 2009). They found that Libyan honey bees are different, morphologically and genetically, from adjacent subspecies; and majority of Libyan bees (92%) belongs to the oriental evolutionary lineage (O). They also found local impact of imported European honey bees. They suggested to name the Libyan bees as a separate subspecies (Shaibi, Muñoz et al., 2009). Another study compared the non-fragmented coastal population with the oases of Brak and El Kufrah using 15 polymor-

phic microsatellite loci assessing the mating frequency, colony density, gene diversity, and population differentiation. They found that the honey bee population of the remote oasis of El Kufrah is well isolated, whereas those of the oasis of Brak and the coastal regions show genetic footprints of introgression by commercial beekeeping (Shaibi, Fuchs, & Moritz, 2009). The isolated El Kufrah population showed no indications of inbreeding, suggesting that the endemic population size is sufficient to ensure sustainable local survival (Shaibi, 2013).

Bee plants

Like most of other African countries, a pollination service is not practiced in Libya (Corner, 1984). Therefore, honey is considered to be the most important if not the sole income for beekeepers. There is no large scale cultivation of orchids or horticultural crops. Sometimes beekeepers are requested to offer honey to the farmers as a rental fee for the flowering crop. Clearly, beekeepers rely on non-crop wild plants, which occurs in different regions of the country. Apparently, migratory beekeeping is commonly practiced for honey production (Keshlaf, 2002).

The main honey plants in Libya include: eucalyptus tree (*Eucalyptus* spp.), acacia tree (*Acacia* spp.), orange tree (*Citrus* sp.), stone fruit (*Prunus* spp.), thyme "Za'atar" (*Thymus capitatus* L.), wild-sage (*Lantana camara*), Chinese hibiscus (*Hibiscus rosa-sinensis*), alfalfa (*Medicago sativa*) and many wild plants (Hussein, 2000; Keith, 1970; Keshlaf, 2002; Zboray, 2013). Of these types, eucalyptus honey, from *Eucalyptus* sp. flowers, is one of the main honeys produced and consumed in Libya, especially near the coast where its extensive trees flower in November and December. Because of the consecutive blooming of eucalyptus species, it is categorized to be the most important source of nectar and pollen to colonies during drought periods (Owayss, 2005; Rateb & Hussein, 2012).

In the western region of Libya, there are three main honey flows, the heavier from spring flowering plants in late March and April. In May to June, many beekeepers move their colonies in to hilly country to the east of the Tripoli for the second flow, from wild flowers of sider (*Zizaphus Spina-christi*) which offer the highest price of western honeys. Then, June to July, colonies usually migrated to thyme pastures. Both sider and thyme are commonly used as traditional medicines, customers believing in the healing powers of its honey. In the eastern region there are other bee plants such as the schamiry tree (*Arbutus pavarii*), endemic to Libya, occurring only in the Green Mountain (Al-Jabal Al-Akdar) and flowering in November to December; its unique honey (hanoon) is bitter in taste and commands a premium price. Carob trees (*Ceratonia siliqua*) are grown in the regions of El-Beida, Shahat, Sousa, Al-Abrage. The tree presents a great industrial and pharmaceutical importance (Hamed, Ezzat, & Al-Okbi, 2003), and is considered as an important component for re-vegetation, environmental conservation and valuable bee plant. Numerous varieties of tamarisk (*Tamarix* spp.) of the Libyan desert provide an exceptional honey flow in the southern region (Zboray, 2013), and the consecutive blooming of *Tamarix* species supports both bees and beekeepers.

Libyans use honey primarily for medicinal purposes, also for many handmade sweets, especially baklava, a popular Middle Eastern dessert. Brittan (1956a) praised Libyan honeys including shibrook honey from the caroob tree, min honey from the shaiee tree, and hanoon honey from schamiry tree. High standards of Libyan honeys were confirmed by Owayss (2005) who measured the physicochemical characteristics of Libyan eucalyptus honey.

The Libyan honey market is rich in unifloral honeys. Locally produced honey brings a premium price, ranging from 25 to 50 Diners (about US $20 to 40) per kg, with the exception of Hanon "bitter" honey with 70 Diners. Most of the honey produced by commercial beekeepers is sold directly to the costumers. Often, it is sold in along roadsides in a great variety of glass jars. There is very little marketing effort, as honey is generally sold as quickly as a beekeeper can produce it. Imported honey sells about US $7 per kg in grocery stores, but despite its lower price, consumers prefer the local honey because of its quality and authenticity. Although crystallized honey is widely misinterpreted as an indication of foul play by the producer, and buyers are happy to get honey directly from trustful beekeepers as soon as it has been extracted.

Honey yields are generally low, about 10–15 kg per year (Hussein, 2000), due to limited bee flora, inadequate winter feeding, the prevalent practice of splitting colonies just before honey flow, and debilitating influences such as pesticides and diseases. As a result, demand for both honey and bee packages are always higher than supply. There is continuous demand for bees; swarm sell for about 250 LD (about US $200), which provides additional profitable income for beekeepers. Normally the beekeeping season commences earlier in the eastern region, but different types of hives used make it difficult to supply bee packages from eastern to western regions. Capturing swarms in a bait hive (particularly in spring) is a procedure that being used by many beekeepers to increase colony numbers. Beekeepers usually do not requeen such colonies. However, this eventually could cause problems as beekeepers unintentionally select for bees that are more apt to swarm.

There is an increased demand for royal jelly and other bee products, which can be used mainly for traditional medication. Lack of knowledge and unavailability of modern equipment are the reasons why these additional incomes are often wasted by beekeepers. Only raw bees wax is collected by some beekeepers, and is used in the manufacture of foundation but with only very limited quantities. Lately, the University of Tripoli

offered free training courses for beginners and commercial beekeepers to improve their skill, encouraging them to obtain benefit from other bee products, and hence develop the beekeeping industry.

Pests and diseases

Most of the recognized honey bee pests and disease are present in Libya (Agleyo, 1997). The honey bee ectoparasitic mite *Varroa destructor*, is a serious threat to beekeeping in Africa, and was first reported to be present in Libya in 1976 (Crane, 1979). Mites were introduced with infested bee packages imported from Bulgaria (Al Fallah, 2000) to Algabal Elakder, and then spread rapidly throughout the country. Hopefully the barrier created by the Sahara will prevent its spread into the sub-Sharana African honey bee population. Shaibi reported that Oases of Al Kufrah, in the Libyan desert (Shaibi & Moritz, 2010) and Australia are the only varroa-free regions worldwide (Holland, 2012). A recent survey study of varroa mite distribution in Libya showed the presence of mites in all apiaries of the north, east and south regions (Keshlaf, unpublished data). Infested European bee colonies die within two years if left untreated (Gregorc & Planinc, 2002), but Libyan bees seems to have a good hygienic behavior, since colonies will survive more than five years without medication (pers. obs.). Kefuss (1995) found that *A. m. intermissa* colonies from Tunisia, which also occur in Libya, had the highest level of hygienic behavior of several subspecies of *A. mellifera* (*A. m. mellifera, A. m. ligustica, A. m. carnica, A. m. caucasica*) that he tested from France, Tunisia and Chile. Furthermore, *A. m. intermissa* actively groomed off *V. destructor*, as shown by a great number of injured mites dropping from naturally infested colonies (Boecking & Ritter, 1993). Both grooming and removal activities of *A. m. intermissa* provide evidence for active mechanisms of resistance against *V. destructor.*

The presence of the bee louse, *Braula coeca*, in Africa was reported in Tunisia in 1978 (Smith & Caron, 1985). Because of trade activities, the parasite then propagated in Egypt, where it was encountered in the areas of the Nile Delta, then in Algeria in 1981 (El niweiri, El-Sarrag, & Neumann, 2008), and in Morocco and Libya later (Neumann & Elzen, 2004). In a recent study, occurrence of *B. coeca* was detected only in apiaries of the western region of Libya. In weak colonies, more than eight lice were observed on the queens (Keshlaf, unpublished data). Due to the similar appearance, some beekeepers cannot differentiate between varroa mites and bee lice, so no proper control method is practiced. Libyan beekeepers have a problem with the greater wax moth *Galleria mellonella*, which causes much damage to stored combs (Agleyo, 1997). Also during summer, they infest weakened colonies. Many beekeepers avoid infestation by treating stored supers with paradichlorbenzene, but a growing number store supers using the freezing method to avoid contaminated honey.

Small hive beetles, *Aethina tumida* Murray, represent no threat in sub-Saharan Africa since they are endemic to this region (El niweiri et al., 2008) and local bees coevolved with them. They only represent minor pests in Africa since they infest weakened colonies (Neumann & Elzen, 2004). In the northern part of Africa, their presence was reported in Egypt along the Nile river and in Sudan (Hassan & Neumann, 2008), but they do not seem to have established there, according to recent large scale surveys that found them to be either absent or very scarce (Hassan & Neumann, 2008). Like varroa mites, they developed into serious problems when they were exposed to new hosts (European honey bees) in the USA, Australia and now southern Italy (Mutinelli et al., 2014). Although small hive beetle is not yet reported in Libya, further action needs to be done to prevent its introduction from Egypt or from southern Italy. Restrictions on the importation of hive products or beekeeping equipment from Egypt are regulated by the government. Furthermore, import of honey bee packages is prohibited. These measures could prevent the introduction of foreign pests and diseases to which Libyan bees are not adapted, and to which they could be susceptible.

Several diseases common in the temperate areas, such as European foulbrood, *Melissoccoccus plutonius,* have been observed occasionally (pers. obs.) in early to mid-spring, the period when colonies should be building up to maximum populations, therefore, they may not provide extractable surplus of honey. The fungal disease chalkbrood has been reported (Agleyo, 1997), and for control beekeepers often advised to maintain populous colonies, and also to select colonies which show resistance for package bee production.

In Africa, *Paenibacillus larvae larvae* has never been diagnosed south of the Sahara except for one unconfirmed observation from the Johannesburg area of South Africa (Govan, Leat, & Allsopp, 1999). Libyan honey did not show any sign of contamination of *P. larvae larvae* spores (Fries, Wei, Coleman, & Raina, 2001). Hygienic behavior and physiological susceptibility of the bees may influence the incidence of the disease. It is well documented that bees with the ability to detect and remove diseased brood can be completely AFB resistant (Spivak & Gilliam, 1998).

Bee-eater birds, *Merops apiaster*, feed on honey bees and other insects. The first generation of birds are usually observed in April–May, and in July–August peak population is noticed. Keshlaf (2002), and Al Fallah, Alfituri, and Hmuda (2010) demonstrated that bee-eaters did not affect bee flight activity during their field experiments at summer. Although worker honey bees can constitute more than 90% of a bird's eaten insects (Simonthomas & Simonthomas, 1980), beekeepers often neglect these birds. They can be a serious pest if they arrive earlier, especially during the mating of new virgin queens.

Habitat loss in Libya could prove to be the most significant factor affecting honey bee populations. Although

the human population doubled in size between 1970 and 2000 implying the development of cities and settlements, the decrease in the forested area through land exploitation has a greater impact. Wild honey bees mostly nest in hollow trees so deforestation could affect them drastically.

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