CHAPTER 1

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Honey bees (Genus *Apis*) are known to have evolved some 30 to 20 million years back (Culliney 1983). Indo-Malayan region is considered to be the centre of origin of the *Apis*. There are at least six known species in the genus, almost all of which occur in India. Among them, three common indigenous *Apis* species, namely *A. dorsata* Fabr., *A. florea* Fabr., *A. cerana* Fabr., are known for honey production; the last one is domesticated in hives and maintained for honey production.

Beekeeping has been practised in India since ancient times mainly for the precious honey stored by the bees in the combs. Honey was the first sweet food tasted by the ancient Indians inhabiting rock shelters and forests. They hunted bee hives for this gift of god. India has some of the oldest records of honey industry in the form of paintings by prehistoric man in the rock shelters. With the development of civilization, honey acquired a unique status in the lives of the ancient Indians. They regarded honey as a magical substance that controlled the fertility of women, cattle, as also their lands and crops.

Wild honey bee colonies of the giant honey bee and the oriental hive bee have been exploited for collection of honey. Tribal populations and forest dwellers in several parts of India have honey collection from wild honey bee nests as their traditional profession. The methods of collection of honey and beeswax from these nests have changed only slightly over the millennia. The major regions for production of this honey are the forests and farms along the sub-Himalayan tracts and adjacent foothills, tropical forest and cultivated
vegetation in Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra and Eastern Ghats in Orissa and Andhra Pradesh.

Beekeeping has been practiced in its simplest form in the rich forest regions along the sub-Himalayan mountain ranges, the Eastern and Western Ghats. The indigenous oriental honey bee, *A. cerana*, has been kept in wall niches, clay pots or other receptacles. With the introduction of modern beekeeping into the country, the bees are kept in wooden bee boxes, designed to suit the local bee type.

**Introduction of *Apis mellifera* in India**

The European honey bee, *A. mellifera* L. is found all over Europe and has spread to other continents during the last five centuries. The bee is similar in habits to *A. cerana*. It builds parallel combs in hollows of trees, walls or in shady places. Beekeeping with this species achieved a great success in most of the parts of India. Prolific queen, less swarming, gentle temperament and high honey yields make this species superior for commercial production.

The present day *A. mellifera* colonies in the country have descended from the successfully introduced colonies during the sixth decennial of the last century. Side by side with the development of apiculture using the indigenous bee, *A. cerana*, apiculture using the European bee, *A. mellifera*, gained popularity in Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Uttarakhand (Plate No. 1.1 A), Bihar and West Bengal. This has been greatly facilitated by large-scale destruction of beekeeping with the indigenous bee, due to the Thai sacbrood disease. The beginning of 1990s saw the major honey producing states of the country reel under the onslaught of the virus.

Efforts to introduce the European bees into India were made periodically since 1880s. In fact modern beekeeping was introduced in the country through import of the Italian race, namely, *A. mellifera ligustica*, in Langstroth and British Standard hives. Some of the earliest of these hives were kept in
Plate No. 1.1

Apis mellifera apiary in Nephelium chinensis orchard

Members of a *Apis mellifera* bee colony
Calcutta. There are reports of imports of small or large consignments of *A. mellifera* colonies in several parts of the country, e.g., in Bengal (Ghosh, 1920), in the Kashmir and Punjab regions (Rahman and Singh, 1940, 1945) and in the Kumaon Hills (Muttoo, 1952).

After a long gap, renewed attempts were made to introduce *A. mellifera* in to the country by the scientists of Punjab Agricultural University, Ludhiana (Atwal and Sharma, 1968). The habitat and the agro-climatic conditions then prevalent in the Punjab plains suited the exotic bees well, and their colonies grew in number. The University developed appropriate management technologies for rearing these bees in the plains, lower and upper valleys of Himalayas (Atwal and Sharma 1968). The number of colonies in the state increased rapidly during first ten years of introduction of *A. mellifera*. In the adjacent Himachal Pradesh, initial experiments with the European bee were not encouraging. However when the indigenous bees suffered a severe onslaught of the Thai sacbrood disease in 1984, there has been a gradual increase in *mellifera* colony number. After the colonies of the Indian bee were affected by sacbrood, beekeepers in Jammu and Kashmir introduced *A. mellifera* bees into the State.

The other states, which took up beekeeping with *A. mellifera* are Uttar Pradesh, Bihar and Bengal. During 1990s, Rajasthan, Andhra Pradesh and few locations in the southern states of Kerala and Tamil Nadu introduced *A. mellifera* for beekeeping. *A. mellifera* is now present in almost all parts of India.

**Status of *mellifera* beekeeping in India**

Successful introduction of *mellifera* bee species has revolutionized beekeeping and honey production in the country. There are many attributes that make *mellifera* more successful and better suited for commercial beekeeping. *A. mellifera* workers are larger than the indigenous hive bee species and have
large foraging range and high forage carrying capacity. However the bees need plentiful floral sources and can not survive in the regions with scant supply of pollen and nectar. There were about 150,000 colonies of *A. mellifera* in the country in 2003-04. India produces over 57,000 tonnes of apiary honey, mainly from *A. mellifera*, and during 2003-04, about 30,000 tonnes of honey were exported.

**Flowering Plants useful to Honey Bees**

Plants provide pollen and nectar to bees. These materials together provide all the essential nutrients to honey bees for their growth and survival. Bees process them into honey, beeswax, royal jelly and other items, for immediate consumption or for storage and later use. Plants therefore constitute the major source of raw material for beekeeping.

A colony of *A. mellifera* has a queen bee, which gets a regular supply of food in the form of royal jelly from the worker bees; a few hundred male bees or drones, which are reared in the colony during seasons of abundant floral availability and are fed by the worker bees with bee bread and several thousands of sterile female bees called worker bees, which consume pollen and nectar in order to perform a variety of duties within the hive and outside (Plate 1.1, B). Honey bees need pollen for their body growth, for production of food for the queen and drones, for nursing larvae to grow into adult bees and for general health and hygiene of their colony. They need nectar to meet their day-to-day energy requirements. In order to preserve nectar for future needs, it is converted into honey by partially digesting the complex sugar molecules and removing about $\frac{3}{4}$th of the water in it.

A colony of honey bees needs about 30 kg of pollen and 200 kg of honey in a year. Each flower provides but a few milligrams of pollen or nectar. Bees have therefore to visit hundreds of thousands of flowers (Plate 1.2 A,B). However all flowering plants do not provide food of the required quality. Because of this,
Plate No. 1.2

Apis mellifera
nectar forager on
Adhatoda zeylanica

Apis mellifera
pollen forager on
Sorghum vulgare
the bees, which gather food, have to select food plants from among a host of other plants. Availability of food plants for at least 8 months in a year is essential for bee colonies to survive.

Pollen contains proteins, carbohydrates, fats, minerals, vitamins, essential oils, and colouring materials. Of these the digestible protein is an important constituent that determines the bees' preferences to different plant species. In many plants pollen is released in the mornings. A few, like cucurbits, offer pollen in the evenings. Bees collect pollen when freshly produced. Bees adopt their foraging behaviour to suit the mode of presentation of pollen in the flowers. Pollen is packed into small balls on the third pair of legs. On returning to their hive, they seek a pollen store cell, drop the two pellets into it and resume their foraging.

Nectar has sucrose, fructose and glucose, in varying proportions, essential oils, minerals and other material in traces. Bees prefer sucrose and fructose to glucose or an equal mixture of these sugars. The concentration of sugars in nectar varies. Bees prefer a concentration of about 35 per cent. Nectar is collected by sucking it from nectaries through proboscis. Salivary gland secretions are added to the nectar in this process. The nectar is then taken into the honey stomach, where some more digestive enzymes are added. On returning to the hive, nectar is regurgitated and passed on to the nectar seeking house bees through their proboscis. After similarly passing through several nectar seeking bees, it is finally deposited in a honey store cell. Some house bees take a small portion of this enzyme-enriched nectar and evaporate the water in it by making a thin film of the liquid in the mouth parts and exposing it to the wind currents created by fanning of wings. After the honey attains the required consistency – about 80 per cent sugars and 20 per cent water - the honey cell is sealed.

The honey production season depends upon the floral preferences of the bees as also the flowering periods of such preferred plant species. Confirmatory
evaluation of the utility of these plants is made through melittopalynological studies. Microscopical analysis of honey provides information on several aspects of the biology of honey bees, their floral preferences and information on places suitable for beekeeping.

**Objectives of the present investigation**

Most of the major honey producing countries in the world use *A. mellifera*. The available literature on the foraging behaviour and floral preferences relate to this bee species. However this information is specific to the country or region. Moreover, in a majority of these countries *A. mellifera* is the only species occurring in the respective specific ecological conditions, while in India there are at least three other species that share the same habitat. This reduces the utility or application of the available data in this country.

In India, *A. mellifera* was introduced for beekeeping only during the past few decades in areas with rich bee forage potential, in vast agricultural areas, orchards and sometimes in urban areas and is now commonly kept bee species. Most of the apiary honey sold in the market at present is of *A. mellifera* and is harvested mainly from cultivated areas. There are constraints in the production and in the marketing of *mellifera* honey in India due to lack of knowledge on the sources of honey, unreliability of production, lack of facilities for transport, storage, processing and marketing of honey. Although beekeeping with *A. mellifera* has been popular for over a decade, information on the floral preferences of this species in India is scarce. To protect the interests of both the producers and consumers, it is necessary to collect basic information on the botanical composition, seasonal availability and other characteristics of honeys produced by this bee species.

There have been a few sporadic attempts to study the foraging behaviour and floral preferences of *A. mellifera* in India. During the past few years *A. mellifera* beekeeping is making rapid progress and production of honey has
been on the increase. Beekeepers need new vegetation regions to keep the bee colonies for production. Likewise, they need information on the availability of pollen and nectar from the corresponding plant species. The important constraint for progress of *mellifera* beekeeping has been the scanty information available on their floral resources. The present investigations were aimed at gathering information on the botanical aspects of *A. mellifera* beekeeping on the following lines, by utilizing melittopalynological methods.

1. Inference of botanical origin of *mellifera* honeys, as also, distinguishing unifloral and multifloral honeys.

2. Identify the major nectar sources based on palynology.

3. Determination of absolute pollen count of unifloral honeys.

4. Identification of migratory sites for effective production.

The data generated from the study is analysed further to resolve the major constraints in marketing of *mellifera* honeys, particularly on the following aspects.

   a. Collection of basic data on floral sources, their distribution, availability of forage during different seasons.

   b. Important sources of nectar that help in honey production.

   c. Characterizing *mellifera* honeys from different geographical regions.

   d. Inference of season of production of honey.

   e. Preparation of migratory schedules for different regions of the country.

   f. Differentiation of *A. mellifera* honeys from those of other species.

   g. Assessment of potential for *A. mellifera* honey production in India.
h. Study the foraging behaviour of _A. mellifera_ in different regions and biotic factors.

The present studies are intended to contribute to our knowledge on different aspects of melittopalynology of _mellifera_ honeys in India.

The results are expected to give the beekeepers information on peak periods of nectar flow and honey production. This study would thus be useful to the beekeepers in organizing their methods of bee management. These studies would also help in effective management of floral resources that can result in augmenting the honey production.

The present investigations relate to the honeys produced from the _mellifera_ bee colonies by beekeepers in different parts of the country. Efforts have been made to collect honey samples from different phytogeographical regions of India. The results of these studies are presented in the following chapters.