INTRODUCTION
Honey and honey bees has been known to man from the prehistoric times. The bees have been mentioned in the Vedas, the Ramayana, the Quran and other holy books. India has been traditionally an agricultural country and 80% of population live in villages. On this context, beekeeping has gained importance as an agricultural activity and has been inextricably linked with rural life. Beekeeping has been practiced with *Apis* species in Asia, for over at least 2,000 years in India (Singh 1962), in China for 1,000 years (Ma, Huang 1981) and perhaps about the same period in Japan (Sakai and Matsuka 1982).

Honey bees belong to the genus *Apis* of the order Hymenoptera. The bees (Apoidea) constitute a group of some 20,000 species with representatives at every level from solitary and non-social to community and true social like modern honey bee (Hargassim 1974). The three well known indigenous species of *Apis* are well distributed in India. The *Apis dorsata* Fabr., the rock bee the largest Indian species is distributed throughout India and Burma at lower altitudes. *Apis indica* F., the Indian hive bee is also found throughout India and Burma upto an altitude of 3,000 meters. *Apis florea* F., the little bee, builds small combs in open and is restricted to Bengal, Assam, Madras, Malabar and Central India (Fenemore and Prakash 1992).

Bees and flowering plants evolved simultaneously and established inseparable relationship. Establishment of this relation is also one of the most significant events of organic evolution (Deodikar 1962;
The rapid specialization in the flower structure has brought influence on the evolution of feeding habits and physiological sensory capabilities of insect visitors to help them to locate their food source more efficiently (Suryanarayana 1986).

Bees and plants are mutually dependent, the plants needing bees for their pollination, the bees needing plants because it is from the flowers that they collect all their food. This relationship stems from cretaceous times, roughly 100 million years ago, when the angiosperms (flowering plants) started to evolve. To transfer pollen from one individual flower or plant to another of the same species, plants began using pollinators instead of depending on wind and water as did their evolutionary ancestors. In order to attract pollinators angiosperms offer rewards in the form of pollen, nectar or oil, and make themselves conspicuous by developing flowers. Several insect groups evolved because they exploited these food sources, but none of them exploited them to such an extend as bees. Unlike butterflies and moths, flies or beetles, who only consume nectar and/or pollen on their adult stage, adult bees also collect these substance to feed their larvae (Velthius 1992).

Bee flowers showed complicated mechanisms of presentation of pollen and nectar to ensure that the pollinators get the reward and others discouraged. Change in feeding habit of bees has brought about significant changes in bee flower relationship. Most of the bees have
thus developed either polytrophy (foraging on many plant species) or oligotrophy (foraging on a few related plant species) or monotrophy (foraging exclusively on a single plant species). A similar progressive trend is also seen in the quality of food produced in the bee flowers. The early angiosperms have yielded large qualities of pollen serving as the only food to the pollinators. Later these flowering plants showed a gradual reduction in the quantity of pollen and steady increase in the production of nectar as an attractive food (Suryanarayana 1986). The bee flower association is perhaps the most fascinating example of co-evolution. Man, who has been constantly trying to understand this seemingly simple association has instead formulated a plethora of hypothesis. On the basis of intensive study it has been predicted that the foraging behaviour of the honey bee is flexible and individual foragers modify their behaviour selectively according to variation in colonies food requirements (Ribbands 1949; Free 1967; Nunez 1970; Seeley 1986; Kolmes and Winston 1988; Wolf and Schmid-Hempel 1990). Also, honey bees exhibit a remarkably high degree of fidelity to one flower species, time and location. Most foragers are known to selectively shift from one forage source to another and from pollen collection to nectar in response to quantitative and qualitative variations of environmental resources (Roch 1956; Free 1966; Free 1970; Orians and Pearson 1979; Weaver 1979; Nunez 1966, 1982; Winston and Fergusson 1985; Seeley 1986, 1987; Seeley et al. 1991).
The subject of bee flora is one of the most fascinating field of biological science which has been intensely studied by different workers especially taxonomists, ecologists, economic botanists, entomologists, agriculturists, ethologists, environmentalists and evolutionary biologists. Although information on bee flora is available in different areas, but much has been accumulated in selected areas such as melissopalynology, floral biology, flowering phenology, bee-pollination and pollination ecology and ethology. The collection of information on bee forage is extremely strenuous and almost impossible to provide an exhaustive account, as it is a multidisciplinary field of research. Further, several species and races of honey bees are distributed in different geographical regions of the world. In addition information on bee flora is available in several local languages. However, efforts were made to collect complete and exhaustive information in the field.

The first scientific information on the geographic origin of honey was reported as early as 1895 by Pfister. Later, Young (1908) studied the honey pollen types in North America. Fehlmann (1911) studied pollen spectrum of swiss honeys and identified important plants useful to honeybees. Allen (1935) studied some important bee plants of Europe. Kannagara (1940) carried out bee botanical studies and listed some important useful plants for honey bees. Mutto (1941) studied the bee flora of Jeolikote area to promote beekeeping development programmes.
Sharma (1951) prepared a comprehensive list of garden flora, weeds, tree species, shrubs and other ornamental plants useful for beekeeping. Pellet (1951, 1952) made an extensive survey of honey plants of United States and listed valuable plants which are attractive to honey bees and also identified *Robimia semperflores* as the major bee plant for nectar yielding. Deodikar and Thakar (1953) studied the major honey plants of Mahabaleshwar hills and surrounding areas of Maharashtra State. Arnold (1954) identified 28 major and minor bee flower species of Florida. Robert (1954) had undertaken extensive survey and listed important bee plants of France.

Kartashova (1955) listed out bee plants of Tomsk region. Blake and Roff (1958) published useful scientific information on honey flora of South Eastern Queens Land, Australia.

Winston (1987) reported 118 flowering plant species which were important to honey bees as the source of pollen & nectar in Colorado. Thakar *et al.* (1962) evaluated several major and minor source of bee plants in Mahabaleshwar hills of India and determined their floral calendar. Pelimon (1966) studied certain plants as bee forage and their relative importance to beekeeping in Budares. Divan and Rao (1970) had undertaken extensive survey of bee flora including the study of altitudinal variation in bee forage of West Coorg, Karnataka. Ordetx *et al.* (1972) studied in detail the bee flora and their importance including distribution in Mexico. Suryanarayana (1975) carried out
extensive survey in the Western Ghats of Karnataka with particular reference to Coorg and adjacent area to identify bee forage plant and their distribution, abundance and utility to bees.

Adams et al. (1979) identified the honey bee flora by pollen analysis. Divan and Varthak (1980) identified the bee forage plants of Castlerock area of Karnataka State and provided the useful information on occurrence, distribution, abundance and time of flowering of the bee flower species. Sarwan and Sohi (1985) presented a comprehensive list of plants visited by honey bees, *Apis mellifera*, and *Apis cerana* in Punjab, India. Ferrazzi (1990) surveyed the Bormida valley, identified a variety of plants attractive for honey bees and recorded 200 bee flower species with the information of the flowering periods and their distribution including their value as a source of pollen and nectar.

Suryanarayana et al. (1992) studied the bee plants and listed 40 and 48 plant species useful as pollen sources to *Apis cerana* and *Apis mellifera* respectively. Sivaram and Reddy (1993a) conducted preliminary survey on the bee forage plants and their importance to honey bee. Anitha et al. 1993 studied the important honey sources consisting of both forest and cultivated flora and the quantity of pesticide sprayed annually and its impact on honey bees and crop production in South Karnataka.
The quality and quantity of nectar as well as its source greatly influence the foraging behavior of honey bees. Nectar is primarily a sugar solution with minute quantities of various other substances, which contribute to the characteristic aroma of the honey produced (Brown 1961; Mostowska 1965; Von Handel et al. 1972; Seogin 1979). The composition of floral and extra floral nectars showed variation from one plant species to another (Baker et al. 1978). Floral nectar with rich hexose sugar are less attractive to most Lepidopteran insects (Baker and Baker 1983). The ratio of sucrose, glucose and fructose vary from one flower species to another (Percival 1965). Honey bees preferred solution of single sugars in the following descending order, sucrose, glucose, maltose and fructose (Wykes 1952). Kartashova and Novikova (1964) revealed that in 12 dicotyledonous species sucrose and glucose occurred in greater quantities than fructose. Southwick et al. (1981) correlated sucrose/hexose ratio with flower morphology and showed that tubular flower had more sucrose than open flowers which had more hexose. El-Ranby et al. (1985) reported that in Gossypium barbadense levulose (84%) comprised highest percentage followed by dextrose (7.8%), sucrose (1.6%), and raffinose (0.78%). Nectar production by a flower depends not only on the secretary machinery in the nectary but also the rate of photosynthesis, respiration and sugar transport (Southwick, 1983, 1984). Nectar secretion is also effected by internal and external factors such as weather, soil and hereditary. Effect of weather has received more attention than any other factors (Shuel 1967; Kropacova and Hasl Bachova 1970; Waller et al. 1981,
Southwick 1984, Pinzauti 1985). Effect of various hereditary and external factors like differences among varieties, flower age, flowering habits and flower sex may also influence the nectar production (Girnik et al. 1971; Moffett et al. 1976; Degrandi-Hauffman and Collison 1982; Southwick 1984; Southwick and Southwick 1986).

There may be significant differences in the average sugar concentration and volume of nectar of different species (Percival 1965). Different species and varieties may have nectar with different average sugar concentration. Even within a single flower, the sugar concentration is subjected to considerable fluctuation by temperature and relative humidity (Southwick and Southwick 1983). The attractiveness of a species may differ at different time of the day and at different stages of flowering (Brewer and Dobson 1969; Moffett et al. 1976). Echigo (1970) determined the sugar contents of Pumpkins and Milkvetch by gas liquid chromatography and results were glucose (27.29%), fructose (35.47%) and sucrose (30.61%) and glucose (29.28%), and fructose (35.61%) and sucrose (30.78%) respectively. Studies on nectar sugar concentration of *Heavea brasiliensis* revealed 30% in the early morning, 80% at 10.00h with an average sugar concentration 75% (Wongsiri et al. 1985).

Fahn (1948) investigated the daily secretion of 66 indigenous and cultivated plants of Israel. Sugar contents of these species varied from 0.13 mg to 2.68 mg per flower. He found that the quantity of
nectar secretion was related to the size of the nectary and similar relationship was not established with nectar concentration. He also found variations in the ratios of sucrose, glucose and fructose in different plant species. Temperature, humidity, soil, moisture, time of the day, flower age and root pressure were important factors influencing nectar secretion (Fahn 1949). Divan and Varthak (1980) suggested that moist soil, fine sunshine, cool breeze, humid weather and wide variation in daily temperature are beneficial for good nectar secretion. Rowley (1976) who studied sugars of 40 common Philippines nectar and showed that sucrose, glucose and fructose constituted 2 to 95% of total sugars. Maltose was also detected in 2 species.

In India, Montogomery (1958) evaluated 38 plant species for their nectar sugar concentration. Polygonum lonicera, Aster sp., Helianthus annuus and Bideus had 50% or more concentration of sugar. Working on similar lines, Sharma (1958) determined the sugar concentration of some Punjab honey plants. Major honey sources were Brassica sp. (36%), Berberis sp. (48%), Peach and Pear (70%) and Tecoma gradiflora (14%) Raya (Brassica juncea) had the highest average of sugar concentration of 52%. Sathyanarayana (1975) observed that the sugar concentration of nectar of Syzygium cumini varied from 15 to 72%, where as Allium cepa ranged from 67 to 75% (Rao and Lazar 1980). Twenty three different plant species were studied by Sharma (1980) on nectar concentration and revealed that sugar concentration varied from 14 to 70%. Highest percentage of sugar concentration (79%) was found in Silver Oak.
Grevillea robusta. A variation of 35 - 52% was found in major honey plants.

Generally, honey bees preferred sugar concentration of 20 to 40%. Dhaliwal and Bhalla (1980) correlated bee visitation with nectar sugar concentration and revealed that sugar concentration varied from 14 to 70%. Hourly fluctuation in the sugar concentrations of different crops have been studied. In Carvia callose the sugar concentration increased from morning until 14.00h and then remained constant. Similarly, in Thelepaepale oxiocephale, sugar concentration in the nectar increased from 35 to 40% at 08.00h to 64% at 15.00h and then decreased slightly after 16.00h (Phadke 1964; 65). Reddi and Reddi (1982) investigated pollination biology of Ipomoea kentrokaulos and found an increase in sugar concentration from 52% at 09-00h to 71% to 17.00h. Extra floral nectar is produced at the junction of the pedicel with the flower at a rate of 8 ul per day.

The nectar sugar concentration of (Brassia compestris) increased from 09.00h (15.2%) reached peak at 14.00h (40.4%) and then decreased (Tanda 1984b). In rubber tree (Heavea brassiliensis) sugar concentration increased from 39.50% at 08.00h to 73% at 10-30h and this increase was followed by the increase in temperature and decrease in relative humidity (Shakuntala Nair and Wakhle 1983). The floral reward and honey bee visitation rates on the soapnut tree was studied by Reddi et al. (1980). Pistillate flowers produced nectar nearly 3
times more than that of staminate flowers. Nectar was sucrose predominant type with sucrose 85.5% and glucose and fructose 7.25% each. Sihag and Kapil (1983) analysed the nectars of 44 plants visited by Apis florea. and Apis dorsata. The Phase of the blooming period does not commence simultaneously in all the honey flora participating in the main honey flow. In plains, there may be such altered blooming of bee plants which may be either for one lengthy honey flow or for a number of independent honey flows.

Depending on the soil type, climatic factors and the habitat of the vegetation, the time of the blooming may change for even one and same nectar plant (Rodionov and Shabarshov 1986). The time of plant growth and blossoming period in the plains do not coincide with that on the hill tops. The honey plants participating in the main honey flow do not confine everywhere, each of them has restricted to quite definite climatic condition and particular region or area. Therefore the types of honey harvest are not similar in all area and regions of a country.

Pollen is the principal source of non-liquid food and is rich in protein and lipid. It is directly responsible for the growth and development of the honey bees. Pollen is available in the anther of the flower after dehiscence. The colour of the pollen varied from plant to plant.
Honey bees are known to exhibit preferences in pollen selection, but the basis for preference is not clearly understood. Honey bees have a strong tendency to collect certain species of pollen (Nye and Mackensen 1965, 68; Cale 1971). Pollen odour (Levin and Bohart 1955) and colour (Lepage and Boch 1968; Boch 1982) are important factors in pollen attractiveness.

The weight of the pollen load depended upon the species from which the pollen had been gathered (Naim and Bisht 1979). *Apis cerana* collected on average pollen load of 0.008 g from Mustard, 0.019 g from *Brassica juncea*, *Pyrus malus* and *Zea mays* (Punjabi et al. 1969). Dhaliwal (1970) compared the pollen collected by *Apis mellifera* reared in *Apis cerana* combs, and found that the comb cell size affected the pollen carrying capacity of the foragers.

1987), Sun flower (Free 1964; Panchabhavi et al. 1976; Wakhle et al. 1978; Basavanna 1979), Cauliflower (Sharma et al. 1974; Adalakh and Dhaliwal 1979; Tewari and Singh 1983; Verma and Joshi 1983; Woyke 1987), Cardomom (Pattanshetti and Prasad 1973; Chandran et al. 1980; Madhusoodanan and Dandin 1981; Joseph and Mohandas 1985) has been provided.

Honey bees select the most profitable crop by counter play of choice and memory (Ribbands 1949). Flower consistancy of individual honey bees during a single foraging trip, successive foraging trips and days (Betts 1935; Maurizio 1953; Frish 1967; Free 1970) has been known for a long time. The duration of flower consistancy varied from a few trips to a life time (Ribbands 1949). As a result of flower consistancy, individual foragers tend to collect only one type of pollen (Free 1963; Sekiguchi and Sakagami 1966) and return to the same small area over a series of foraging trips (Free 1966; Levin 1966).

Despite this strong tendency, occurrences of more than one colour of pollen in an individual pellets collected by honey bees have been detected (Hodges 1954; Free 1963; Jay and Jay 1984; Davis 1991). Against this back ground of a general tendency for flower consistancy, wide variation in the foraging condition, particularly the time of pollen availability, nectar volume, nectar - sugar concentration and accessibility occur (Percival 1955; Corbet 1978 b). Recently, evidences for behavioral flexibility of bees foraging on different
floral resources are emerging. Foragers will shift from one type of flower to another due to a variety of reasons. A colony of honey bees adjust its process of selection of plant species in relation to its colony's food requirements, a rate of resources acquisition and unloading time (Seeley 1987; Seeley and Levien 1987). Unloading time is a function of the rate of nectar arrival, the concentration of nectar required, and the amount of unfilled comb in the colony (Seeley 1989). A colony of honey bees also shows a preference for different portions of a foraging area at different times & adjusts its rate of recruitment and abandonment in accordance with the profitability of specific flower species (Gould 1976; Weaver 1979; Rossel and Wehner 1982; Winston 1987; Seeley et al. 1991).

Floral calender that catalogues the flower, their value to bees, their abundance and time and duration of bloom, contains essential information for sound management of beekeeping. Floral calenders are required for each ecological region in which beekeeping is practiced. Floral calenders for different regions are useful for planning migratory beekeeping. Another important aspect of bee botany is the flowering time of important bee plants, this is particularly, valuable information for planning bee management schedules. On the basis of floral calendar the honey calendar, thus a beekeeping calendar can be prepared (Zamarlicki 1984). The fundamental importance of beekeeping is the proper understanding bee botany, foraging behavior of bees, and pollination (Kevan 1984). The bee floral calendar is also essential
for each ecological region to practice commercial beekeeping. Floral calendars which provide information on the list of flowers and their value to honey bees, abundance of bee plants, phenological aspects and type of bee forage are essential for sound scientific beekeeping management (Kevan 1984). Floral calendars of several ecological regions help to chalkout ways of overcoming the dearth period.

Primitive methods of beekeeping have been practiced in almost every country from times immemorial. Beekeeping is an agriculturally and forest based village industry and as such it is of great importance for farmers. By investing limited expense, beekeeping can be practiced to obtain maximum subsidiary income with other agricultural practices.

In India, beekeeping first came to Bengal in 1882 and then to Punjab in 1883. Thus, beekeeping in India was established as a modern industry only after the invention of movable frame hives in 1882 and the transfer of this technology to India. In India the beekeeping industry evolved from different bases and practices and fits under various categories of rural activity. E.g., Village cottage industry, Agro-based rural industry, Forest based industry, Decentralized industry, Subsidiary part time industry and also a profitable hobby (Reddy 1994). It was only in the later part of the 19th Century that some steps were taken to modern beekeeping in different parts of the country. In this context, beekeeping is a scientific method of
conservation and rearing of bees for production of honey, wax, royal jelly, pollen, bee venom and pollination of crop plants (Reddy 1994).

Modern beekeeping techniques that were originally developed in countries such as U.S.A., U.K. and West Germany, have been adapted and modified to suit local condition with emphasis on special requirements in India. The theory of beekeeping management is simple but its practice requires keen observation and close attention. Beekeeping is practiced under wide agro-climatic conditions in the plains and hills upto 2,700 meters above sea level. Recognition of regional differences in the floral and environment has resulted in the formulation of appropriate technique to capture, establish and manage the colonies in different seasons and for different purpose.

The growth and development of beekeeping has been very slow because of vast area and multitude of beekeepers involved. Beekeeping is not developed uniformly in all region, and many potential areas remain unexposed for no apparent reason. Though beekeeping is a many faceted activity, the value of many aspects like bee pollination, wax production, medicinal properties of honeys, dietary importance of honey have yet to be realised. The yield of honey per colony per year is found to be very low. By applying modern methods of beekeeping and sound management it is possible to increase the yearly production. Tropical countries like India has an advantage over other countries because of the variety of flora, and the suitable rich climate for beekeeping almost throughout the year.
The present studies are aimed to investigate following aspects on Bee flora and Beekeeping practices of Malnad region of Karnataka.

1. Survey, and Identification of bee forage plants.
2. Classification of bee flora.
3. Determination of the quality and quantity of bee flora.
4. Determination of nectar - sugar concentration of nectar yielding plants.
5. Preparation of the floral calenders of bee forage plants.
6. Evaluation of 10 selected major bee plants.
7. Evaluation of the honey potentials of the area.
8. Evaluation of beekeeping potentials of the area.