STUDIES ON SOME ASPECTS OF THE BIOLOGY OF THE HONEYBEE, *Apis Cerana indica* (*Fab*).

By

RIGAPHY SYNTEM

DEPARTMENT OF ZOOLOGY
SCHOOL OF LIFE SCIENCES

Thesis submitted in fulfilment of the requirement of the Degree of

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C E R T I F I C A T E

I certify that the thesis entitled "Studies on some Aspects of the Biology of the Honeybee, Apis cerana indica (Fab.)" submitted by Miss Rigaphy Syntem for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong embodies the record of original investigation carried out by her under my supervision. She has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. degree. This work has not been submitted for any degree of any other University.

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(RIGAPHY SYNTEM)

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GENERAL INTRODUCTION

Apiculture or bee-keeping is quite an interesting job based not only on the bee being economical but specially on their social life which is said to have attained perfection.

'Working on an apiary where the air is saturated with the sweet perfume of flowers in the bee-hive garden, along with the spicy odour of bee bread and honey is quite beneficial for one's health, relaxing the nervous system and enhancing one's physical powers', is what a bee-keeper of Meghalaya said.

The bibliography of bee is extensive starting right from the time of Aristotle, Cato, Varro, Pliny, Columella, Palladius, who studied them for years together varying from twenty to fifty years. The real history of bees began in the Seventeenth century, but of course to talk of its economical life, one of the workers who really toiled hard on the improvement of rearing system was L.L. Langstroth (1851). He invented a wooden box with movable frames for the bees to live in; and thus this box came to be known as 'Langstroth's hive'. With time, specially in Western countries, more improvements came in, that one can say that there is no need for the bees to construct their hives, everything is readymade for them; their only work is manufacture of honey. The different inventions apart from Langstroth's hive was the beewax foundation in 1857 by

Johannes Mehring, a German, and the extractor in 1865 by Major Hrushka, an Austrian. Under the influence of the industrial revolution; enterprising individuals further developed these ideas. In United States, Root A.I., produced a roller press that made wax foundation commercially, and Langstroth, C. Dadant and M. Quinby (1875) modified the extractor to suit the needs of the commercial bee-keeper.

The life of a bee-colony is diversified and intricate. They exhibit social organisation. The remarkable qualities of social life are mass phenomena that emerge from the meshing of these simple individual patterns by means of communication. Wheeler in his tract: "Emergent Evolution and the Social (1927)" anticipated this property of the subject - "Owing moreover to the loose and primitive characters of the integration and size of the components even the densest societies, it is possible to ascertain the behaviour of the parts and to experiment with them more extensively than with chemical and organismal wholes. Since the part of the latter are either microscopic or ultra microscopic and are always compactly integrated, that analysis becomes very difficult and involves a considerable of statistical inference."

In a colony or hive an overwhelming majority of individuals are females. But during their course of evolution they completely lose their ability to mate rendering them incapable of continuing the species. They cannot reproduce because neither their body size, nor their

strongly degenerated sexual organs will permit it. "Organs in rudimentary condition plainly show that an early progenitor had the organs in a fully developed condition; and this in some cases implies an enormous modification in the descendants". (Ref. Charles Darwin (1859) Origin of Species). However, these bees preserved their maternal instinct, as can be observed in their case of progeny, and on emergency one of the female workers can even lay eggs; (in the absence of queens accidently) when there are no more eggs (brood cells) in the hive, for a successor. At the same time they acquired certain biological properties which subsequently becomes highly developed, which are of great importance for the survival of the colony like building their nest, foraging for food, feeding innumerable brood cells, maintaining temperature and guarding their nest. In brief, they began to accomplish all the jobs necessary for their life and activity of their community. Thus they came to be called - worker bees.

Among the great number of the colony of worker bees, it is only the queen that has preserved her sexual instinct and is capable of reproducing, a function which has become the most vital one in the queen's life. The morphological transformation and physiological changes which the bees (workers and queen) have undergone during the course of evolution is highly expedient. They marked a biological process which resulted in the further prosperity of the species.

The queen is constantly in the nest, except for mating and swarming flight. She is the most important individual in a colony. The entire population of the hive depends on her. Nevertheless, in many ways the life and activity of the queen is determined by the colony as a whole.

Female bees (fertile queen and worker bees) are the foundation of a bee colony; it is biologically complete, it can make its own nest, procure its food reserves, and continue its race by reproduction.

Drones are considered to be seasonal residents of the hive. They are male bees and the bee species cannot multiply without them. They are apart from mating, helpless individuals, where they cannot even feed themselves and have to depend on the worker bees for their bee-bread.

The honeybees, like many other social insects, live in nests/hives, constructed by themselves, where all the vitally important processess of the colony's life takes place. These hives are made up of wax secreted by the worker bees. A unique feature about the bee-hives is that it is constituted of a large number of wax cells, which are in the form of regular hexagonal prisms. The three sides of the bee cell pyramid are set, in plane projection, at co-equal angles at 120° to one another, but the three apical angles are co-equal angles of 109° (cf. Thompson, 1966).

These hives are made up of brood. Brood is a term commonly use to designate the young of the bees that has just emerged from the cell. It may be young bees just before they come out from the cells, the larvae in various stages of growth or even eggs. Sealed brood is of light to dark brown colour depending on the age and colour of the comb itself. The cappings are made of wax and fibrous material, smooth and slightly convex, with around four cells to an inch. The cappings over honey are white, bluish white or yellow and are more or less irregular and somewhat flattened. The honey may be either in worker or drone cells. The presence or absence of brood reveals the real condition of the colony. It is the presence of eggs or young larvae that shows that the bees have a queen and are beginning to rear brood. This usually occurs during the early spring, but with the progress of season brood are usually present in all stages of growth. But things can happen the other way round too, that is, the presence of unsealed brood and specially absence of eggs indicates a queenless colony. The amount of brood and the manner in which the eggs are laid - whether scattered or irregular patches gives one a fair idea (even without seeing) of the quality of their queen. As goes the saying, "By their fruits, ye shall know them".

A healthy colony of bees in their hives looks more dead than alive, their movements are slow incoherent and incomprehensible. But the fact is that, everyone of the little almost motionless groups in the hive is incessantly working each at a different trade. The bee is above all

even to a greater extent than the ant, a creature of the crowd. She can only survive in the midst of a multitude. When she leaves her hive which is so densely packed that she will dive for an instant into the flower filled space as the swimmer will dive to the sea filled with pearls, but under pain of death it behoves her at regular intervals to return and breathe the crowd as the swimmer must return for air. Isolated bees and however abundant the food or favourable the temperature, ~~they~~ is will die in a few days, not of hunger or cold, but of loneliness. From the crowd, from the city, she derives an invisible aliment that is necessary to her as honey. This craving will help explain the spirit of the laws of the hive. For in them the individual is nothing her existense conditional only; and herself, for one indifferent moment, a winged organ of the race. Her entire life is a sacrifice to the manifold everlasting being whereof she forms part (Maeterlinck 1958).

Bees apart from having a highly social organised pattern of living are also very sensitive creatures. Their learning capacity is impressive in several respects. They are able to learn signals in every known sensory modality. Honeybees can learn quickly to orient themselves with respect to attractive odours but not at all with respect to repellants (Von Frisch, 1919).

Insects are provided with a great variety of external sense organs having characteristic structural

differences in both the cuticular and the cellular parts. It is very difficult, however, to isolate the various types of organs for experimental purposes, and for this reason we can, in most cases, only form an opinion as their probable function based on a study of their structure; and the structure is often so widely different from that of any organ of known function in other animals that many insect sense organs cannot yet be satisfactorily identified as receptors of any group of stimuli. The sense organs of insects, therefore, are generally classified on a purely anatomical basis. The receptor complex formed of the cuticula, the sense cells or group of sense cells and the associated chitogenous cell is called sensillum.

Von Frisch (1919,1921), Ribbands (1953), Schwarz (1955), Fisher (1957) and Martin (1964, 1965) have established that the sense of smell of the honeybee worker is closely comparable to that of man. Even though the anatomy of the organs of olfaction is entirely different, in bees and men, it is surprising that their olfactory relation are nevertheless so nearly the same, (Von Frisch, 1919). The sense of smell is located in the antennae (Von Frisch 1921). A glimpse through the microscope shows that the antennae of bees are densely covered with sense organs some of which are organs of touch and others of smell.

Another interesting phenomena exhibited by bees is swarming. What is swarming? Swarming is applied to the act of a family of bees leaving their home to establish a new

home elsewhere; i.e., reproduction of a colony. This term is also applied to a colony after it has established itself in its new home to distinguish it from a parent colony (A.I. Root; 1966).

There are several prevailing conditions which lead to this very act, apart from reproduction. Usually the exact time of issuing of the swarm that is normal and prosperous, is during the spring time. But at other times even though the colony is ripe with excess population and surplus honey, yet it stays as such without swarming; whereas at other times a colony stubbornly persists on carrying out this programme even though nothing is ready. This condition at one season might effect only one colony and at other seasons a majority of the colonies. Depending on the flow of nectar in spring, just preceding the main flow, may also start furious swarming (Demuth; 1958).

Earlier it was taken to believe that it is the queen who decides every task which takes place in the hive (thus the name). But with time and more investigations this was not found true. She is not the colony's queen, she issues no orders, she obeys as meekly as the humblest of her subjects, the masked power which was considered by some workers as the "spirit of the hive", but she is considered as a unique organ of love, the mother of the city. She founded it, she peopled it with her own substance, all who moves within its walls - workers, males, larvae, nymphs and the young princessess - whose approaching birth will hasten

her own departure; all these have issued from her flanks (Macterlinck 1958).

Swarming is also influenced by other factors such as photoperiod, genetics, physical crowdings, and the age of the queen. Old queens have a greater tendency to swarm than young ones.

Never is the hive more beautiful than on the eve of its heroic renouncement, where it takes off to its new home. This is not of course the end of swarming, where happiness resides, but an understanding among themselves is essential about the new nest site. Lindauer (1961) first showed, a similar 'democratic' process which is employed by honeybee swarms in choosing nest sites.

Keeping all these in view, certain biological aspect of the bees (Apis cerana indica Fab.) are worked out.

The area of research which has been selected is mainly Cherrapunji, but some experiments were also carried out in Shillong and few others in Umroi of Meghalaya (which lies between latitudes of 25°N and 26°N and longitudes of 90°E and 92°E).

The aim of this research programme is to gather some more basic knowledge on the life of this particular insect, the honeybee (Apis cerana indica Fab.); and also information on some of its peculiar behavioural pattern which has intrigued mankind.

A glimpse through the literature shows that a major work has been carried out on the individual components by a number of workers, but this insect being ~~or leading~~ a social ~~life~~ insect that ~~makes up~~ forms a colony; it would be interesting to study its socialization and behaviour ~~which makes it form a colony~~; or the different activities which involves the colony as a whole.

Thus, with all this in mind, efforts are being made to carry out the work, with the available facilities.